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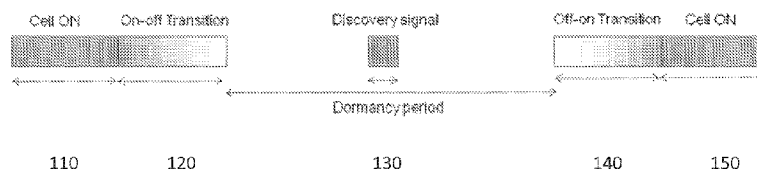


Figure 1

(57) **Abstract:** Various communication systems may benefit from discovery of dormant network elements. For example, certain communication systems may benefit from small cell ON/OFF switching enhancement and related discovery procedures.



DESCRIPTION

TITLE:

Dormant Cell Discovery

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CROSS-REFERENCE TO RELATED APPLICATION:

[0001] This application is related to and claims the benefit and priority of U.S. Provisional Patent Application No. 61/898,655, filed November 1, 2013, the entirety of which is hereby incorporated herein by reference.

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BACKGROUND:

Field:

[0002] Various communication systems may benefit from discovery of dormant network elements. For example, certain communication systems may benefit from small cell ON/OFF switching enhancement and related discovery procedures.

15

Description of the Related Art:

[0003] Study of small cell physical layer enhancements is associated with third generation partnership project (3GPP) radio access network (RAN) working group (WG) 1. One of the topics of that working group is small cell ON/OFF operation: facilitation of ON/OFF switching of the small cells to, for example, reduce network energy consumption and interference during the times when the network load is low.

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[0004] In past long term evolution (LTE) releases, namely before release 12 (Rel-12) cell search was simply based on the primary synchronization signal (PSS)/ secondary synchronization signal (SSS)/ cell-specific reference signal (CRS), and the cells were assumed to be ON all the time. If a cell is not ON, it is assumed to be not transmitting anything and would therefore never be found by UEs.

25

[0005] Use of the PSS/SSS/CRS as a dormant cell discovery signal is mentioned in 3GPP RAN WG1#74bis document R1-134257. However, there is no conventional mechanism for UEs to distinguish between dormant cells and active cells under such an approach.

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SUMMARY:

[0006] According to a first embodiment, a method can include discovering a base station based on a discovery signal. The method can also include determining whether the base station is active or dormant by attempting to detect a further signal that is not the discovery signal.

5 **[0007]** In a variant, the discovery signal may be one or more of PSS/SSS/CRS, PSS/SSS, CRS, CSI-RS, PRS, PDCCH or PBCH.

[0008] In a variant, the discovery signal may include a signal not normally transmitted by an active cell.

10 **[0009]** In a variant, the method includes determining that the base station is dormant when the further signal is not detected.

[0010] In a variant, the method includes determining that the base station is active when the further signal is detected.

[0011] In a variant the further signal can include a physical broadcast channel.

[0012] In a variant, the further signal can include downlink control information.

15 **[0013]** In a variant, the further signal can include a system information block.

[0014] In a variant, the further signal can include a specific CSI-RS pattern.

[0015] In a variant, the further signal can include or relate to a positioning reference signal.

20 **[0016]** In a variant, the method can additionally include receiving, from a base station, a configuration to report measurements for one or more cells.

[0017] In a further variant, the configuration from the base station can indicate to report only active cells, only dormant cells, or both active cells and dormant cells.

25 **[0018]** According to a second embodiment, a method can include determining that a base station is dormant. The method can also include providing a report of a measurement on the base station. The method can further comprise including in or with the report an indication that the base station is dormant.

[0019] In a variant, the indication can be explicit and in another variant the indication can be implicit.

30 **[0020]** In a variant, the indication can include a single bit indicating active state or dormant state.

[0021] In a variant, the indication can be a grouping of the measurement report in a first group to indicate active status and in a second group to indicate dormant status.

35 **[0022]** According to a third embodiment, a method can include sending a discovery signal from a base station. The method can further include, when the base station is active, sending a further signal that is not the discovery signal. The further signal can be configured to explicitly or implicitly indicate that the base station is active.

[0023] In various variants, the further signal can be any of the further signals mentioned in the variants on the first embodiment. Likewise, the discovery signals can be any of the discovery signals mentioned in the variants on the first embodiment. Furthermore, configuration information can be sent as described in variants on the first embodiment.

5 [0024] According to a fourth embodiment, a method can include receiving a measurement report from a user equipment. The method can further include determining whether a base station referred to in the measurement report is in an active state, based on an indication associated with the measurement report.

10 [0025] In various embodiments, the indication can be as described above in the variants on the second embodiment.

[0026] According to fifth through eighth 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 perform the method according to a respective one of the first through fourth embodiments in any of their variants.

[0027] According to ninth through twelfth embodiments, an apparatus can include means for performing the method according to a respective one of the first through fourth embodiments in any of their variants.

20 [0028] According to thirteenth through sixteenth embodiments, a non-transitory computer-readable medium can be encoded with instructions that, when executed in hardware, perform the method according to a respective one of the first through fourth embodiments in any of their variants.

[0029] According to seventeenth through twenty-first embodiments, a computer program product can encode instructions for performing the method according to a respective one of the first through fourth embodiments in any of their variants.

[0030] According to twenty-second and twenty-third embodiments, a system can include the apparatuses according to the fifth through eighth embodiments or the ninth through twelfth embodiments, respectively.

30 BRIEF DESCRIPTION OF THE DRAWINGS:

[0031] For proper understanding of the invention, reference should be made to the accompanying drawings, wherein:

[0032] Figure 1 illustrates time frame operation of ON/OFF status of a small cell.

[0033] Figure 2 illustrates a method according to certain embodiments.

35 [0034] Figure 3 illustrates another method according to certain embodiments.

[0035] Figure 4 illustrates a system according to certain embodiments.

DETAILED DESCRIPTION:

[0036] Small cell ON/OFF and discovery enhancements can be made with respect to semi-static time scales. More specifically, certain embodiments can improve the efficiency of conventional ON/OFF mechanisms by facilitating shorter transition times to and from dormant, or OFF, periods.

[0037] Enhancements can include improvement to UE procedures related to cell activation/deactivation, handover, and the like to reduce the transitions times between the ON and dormant states. Additionally, or alternatively, enhancements can include transmission of downlink (DL) discovery signals to facilitate timely discovery of dormant cells.

[0038] Figure 1 illustrates time frame operation of ON/OFF status of a small cell. Thus, Figure 1 provides an example of a situation that can face a particular small cell. At 110, the small cell can be active. Then, during for example a low network load, the network may decide to turn a cell OFF. The decision to turn the cell OFF can be followed at 120 by an ON-OFF transition period, during which the network empties the cells from UEs using, for example, handover, connection release, redirecting RRC_IDLE mode UEs to different frequency layers, and so on. Once the eNodeB or some other controlling network node is satisfied that there are no longer UEs camping on the cell it may decide to turn the cell OFF and start a dormancy period at 130. During the dormancy period at 130, the eNodeB may still transmit, for example periodically, some downlink (DL) signals allowing for the UEs supporting the dormant mode to discover and measure the dormant cell. The eNodeB can subsequently enter an OFF-ON transition 140 during which time it is loaded up with UEs. Finally, the eNodeB can return to a fully ON state 150.

[0039] Enhanced UE procedures to reduce cell ON/OFF transition times are, as mentioned above, one way to enhance such a process. However, the use of discovery signals and the related UE measurements and reporting are another way to enhance the process, and certain embodiments may address such signals, measurements, and reporting.

[0040] The DL discovery signals can be based on signals present in LTE. For example, in LTE Releases up to and including Release 11, the cell discovery operation, such as synchronization, cell search, and radio resource management (RRM) measurements, can be based on the following: primary synchronization signal (PSS), secondary synchronization signal (SSS), and cell-specific reference signals (CRS, also sometimes called common reference signals).

[0041] Based on these signals, the UE can first acquire time and frequency synchronization

via PSS/SSS, after which the UE can know the measured cell physical cell identity (PCI). From the PCI, the UE can determine the transmitted CRS configuration, from which the UE can do the RRM measurements, such as reference signal received power (RSRP) or reference signal received quality (RSRQ).

- 5 **[0042]** Furthermore, using channel state information reference signal (CSI-RS) for RRM measurements (namely, CSI-RSRP or RSRP measurement based on CSI-RS signals) may be possible.

[0043] The PSS/SSS/CRS structures can be the same or different during the ON and the OFF (dormancy) periods, depending on whether it is beneficial for the legacy UEs to be able
10 to find the dormant cells or not. A similar structure of discovery signals can be used in accordance with certain embodiments.

[0044] Retaining current PSS/SSS/CRS structures can permit existing UE receiver structures to be partly reused, making it more probable that all (or at least most) UEs can support cell discovery of dormant cells. Moreover, such structures can permit existing eNB
15 transmitter implementation to be reused. Legacy UEs that are able to detect the cells and report them according to legacy reporting procedures can see the cells just as existing cells.

[0045] One further benefit of keeping exactly the same discovery signal structure during the ON and the dormant period is that the UE may not need to know whether the cell is in the dormant or in the ON state: the measurement procedures can be exactly the same. As a
20 result, the network does not need to indicate or otherwise signal to the UEs the exact state (i.e. ON or OFF) of the cell.

[0046] On the other hand, upon reporting the measurement results based on discovery signals, it can be beneficial for the eNB/ serving gateway (SGW)/ mobility management entity (MME) to know the state of the discovered cell. Also even if the network is aware of the state
25 of each cell, the information on the dormancy state can be useful from the UE RRM measurement reporting design point of view. Certain embodiments, therefore, allow for the UE to distinguish whether the discovery signals correspond to a dormant (OFF) state or an active (ON) state of a cell.

[0047] Certain embodiments provide mechanisms and solutions allowing for a user equipment (UE) to distinguish whether the discovery signals correspond to a dormant (OFF)
30 or an active (ON) cell as well as the related measurement reporting definitions.

[0048] Thus, certain embodiments may enable a network to determine when dormant cells are to be reactivated, by allowing the dormant cell to transmit a PSS/SSS/CRS signal as the discovery signal.

35 **[0049]** Certain embodiments involve the UE looking for an additional signal that dormant eNBs will not transmit. The UE in this way may easily identify the state of cell as dormant or

active by reusing existing reference signals for both active cell and dormant cell discovery. Moreover, the user equipment can use this information on the state of cell as dormant or active in UE measurement reporting.

[0050] Thus, in general certain embodiments may provide a way for UEs to detect and report measurements on dormant small cells, so that the network can determine when these dormant cells are to be reactivated.

[0051] A method according to certain embodiments can use cell discovery methods for dormant cells that include the UEs determining if the discovery signal they detected is from a dormant cell. Moreover, certain embodiments provide a way to report in the measurement report of the dormant small cell the fact that the cell is dormant.

[0052] Transmission of at least one or more of existing legacy PSS/SSS/CRS signals by dormant cells can be used for discovery. Then, on detection of a discovery signal, the UE can take a further step of determining whether the eNB is transmitting additional signals that only an active cell will transmit. If the additional signals are not discovered, the UE can know that this is a dormant cell. Alternatively, the UE may detect signals that only a dormant cell would transmit and if such signals are detected, use this information to know whether the cell is a dormant cell or not. The UE, on measurement of the signals from the dormant cell it has discovered, can report the measurements to the eNB with an indication that the cell is a dormant cell.

[0053] Certain embodiments can include two aspects, each of which can exist to allow for a UE and/or an eNB to identify the state of the cells that the UE has detected and measured, as to whether the cells are dormant, from the measurement reports alone.

[0054] According to a first aspect, a UE procedure is defined for verifying whether a given discovery signal is transmitted by a dormant or an active cell. Upon detecting the discovery signal (for example, one or more of PSS/SSS/CRS/CSI-RS/PRS), the UE can also check whether some other predefined signal / channel / message is present, to determine whether the cell is dormant or active, either via the presence or absence of the predefined signal/channel/message.

[0055] According to a second aspect, a UE measurement reporting procedure can be defined for distinguishing dormant (OFF) cells from the active (ON) ones. The eNodeB can configure a UE to search for dormant cells as well as active cells. Upon reporting the measurements (for example, RSRP, RSRQ and the like) of cells, the UE can also indicate whether the discovered cell appears to the UE to be dormant or active.

[0056] With respect to the first aspect, various options can be considered for the predefined signal / channel that can be used to indicate whether the cell is in active or dormant state. For example, in a first option the UE may try to decode physical broadcast channel (PBCH).

If a CRC check passes, the UE can decide that the cell is in active state. In a second option, a predefined PDCCH downlink control information (DCI) (for example, DCI 1A) can be transmitted with its CRC scrambled with a known C-RNTI (which could be predefined in specifications or implicitly/explicitly configured by eNB), and if the UE detects the DCI (for example via a passed CRC check), it can consider the cell to be dormant state). Alternatively, the UE may search for, for example, DCI format 1C with its CRC scrambled with SI-RNTIs.

[0057] According to a third option, one of the system information blocks (SIBx) can be used. For example, a UE can try to decode a SIB based on explicit or implicit configuration of SIB scheduling. For example, SIB1 is normally always transmitted in subframe #0 of each radio frame, but since the cell is dormant, the SIB could be transmitted at a fixed location that the UE knows implicitly (e.g. via the detected PCI of the cell) or explicitly (i.e. via additional signalling from the serving cell).

[0058] According to a fourth option, a specific CSI-RS pattern can be utilized for reporting CSI-RS RSRP. This may be a subset or specific configuration of existing CSI-RS patterns or a modified CSI-RS structure. The CSI-RS indication can be accompanied by a specific CSI-RS muting pattern indication. According to a fifth option, positioning reference signals (PRSs) may be used to enhance further cell detection during dormant times. The cell can indicate expected ranges for RSTD, RSRP for PRS or similar measurement quantity that the UE uses. The cell PRS positions can be inferred from the cell PCI, which can be known after cell discovery.

[0059] Figure 2 illustrates a method according to certain embodiments. The following UE procedure provides examples and non-limiting illustrations of certain embodiments. At 210, the UE can receive the discovery signal configuration (or determine it from other configurations), as well as the RRM measurement configurations. Then, at 220, the UE can detect the discovery signal.

[0060] At 230, the UE can verify whether the discovery signal is sent by an active or a dormant cell. The verification can include performing one or more of the following operations. For example, the verification can include, at 231, trying to decode PBCH. If a CRC check passes, the UE can know the cell is in an active state. The verification can also include, at 233, trying to detect the DCI, for example via a passed CRC check. If detection is successful, the UE can know that the cell is in an active state. The UE may search for a particular DCI format.

[0061] The verification can further include, at 235, detecting an SIBx based on implicit knowledge, such as fixed or PCI-dependent position, or explicit knowledge, such as SI-RNTI in physical downlink control channel (PDCCH) or explicit signaling from serving cell. The

verification can additionally include, at 237, performing CSI-RS RSRP computation based on a specific CSI-RS pattern. The verification can also include, at 239, enhancing cell detection based on PRS, for example via PRS detection, RSRP for PRS, RSTD measurement or other similar operation.

5 [0062] At 240, the UE can send measurement reports to the eNB. The measurement reports can include information about the state of the discovered cell, namely whether the discovered cell is active or dormant. This information can be conveyed in various ways. For example, a separate measurement report can be sent for dormant cells. For example, in such a report the UE may report only the dormant cells, based on an eNB configuration. The
10 UE may additionally send another measurement report for active cells similarly to conventional measurement reporting rules.

[0063] There are also other alternatives. For example, a UE can send measurement reports according to existing specifications but can indicate for each reported cell whether the cell appeared active or dormant to the UE. This indication may, for example, be conveyed with
15 one additional bit.

[0064] Figure 3 illustrates another method according to certain embodiments. The following eNB procedure provides examples and non-limiting illustrations of certain embodiments. The eNB can perform the following operations in support of, for example, discovery signal operation. These procedures are listed corresponding with the UE procedures discuss above
20 with reference to Figure 2.

[0065] As shown in Figure 3, at 310, the eNB can configure and transmit a discovery signal. Moreover, at 320, the eNB can configure RRM measurements for a UE. Then, at 330, the eNB, as a part of the discovery signal configuration, can transmit a signal that is used as verification of status. This verification signal may be sent conditional upon whether the eNB
25 is in active or dormant state.

[0066] More specifically, as the verification signal the eNB can transmit, at 331, PBCH. Alternatively, or in addition, the eNB can, at 333, transmit a current or a discovery cell specific PDCCH format. The format can be associated with dormant discovery signal UE procedures.

30 [0067] At 335, the eNB can transmit SIBx in a particular location that is associated with dormant cell discovery UE procedures. The eNB may indicate this location to other eNBs/UEs. An indication of this location may be by, for example, X2 signalling or SI-RNTI. Alternatively, the location may be, for example, a fixed (predetermined) position or a PCI-dependent position.

35 [0068] At 337, the eNB can signal a particular CSI-RS configuration that is associated with dormant cell discovery UE procedures. Moreover, at 339, the eNB can transmits and signal

PRS, which is associated with dormant cell discovery UE procedures.

[0069] Finally, at 340, the eNB can receive a measurement report from the UE, indicating whether the cell is in active or dormant state. The eNB performing the reception of the measurement report may be different from the eNB that is measured and reported by the UE.

5 A given eNB may be capable of performing all of the functions of both configuring the UE and receiving the measurement report, as well as providing signals that the UE can use to discover and verify the state of the eNB. Thus, for example, one eNB or other base station can configure a UE to measure other, for example neighboring, eNBs or cells.

[0070] Certain embodiments may have various benefits and/or advantages. For example, 10 certain embodiments may allow a UE and eNB to determine which cells are dormant. Depending on the network architecture, the dormancy cell tag of the report can be beneficial, as the network may be able to assess the pool of reported dormant and non-dormant cells and enable faster turn ON/OFF procedure for the cells.

[0071] Moreover, certain embodiments can allow co-existence with legacy UEs. For 15 example, legacy UEs may not be confused by existing signals and can treat them without further problems. Also, depending on the scenario, the legacy UEs may be able to perform RRM measurements on dormant cells. Furthermore, certain embodiments avoid the need for explicitly signaling a cell state of dormant or active to the UEs.

[0072] Figure 4 illustrates a system according to certain embodiments of the invention. In 20 one embodiment, a system may include multiple devices, such as, for example, at least one UE 410, at least one first eNB 420 or other base station or access point, and at least one second eNB 430. In certain systems, UE 410, first eNB 420, second eNB 430, and a plurality of other user equipment may be present. Other configurations are also possible. The first eNB 420 may be, for example, an active eNB and the second eNB 430 may be, for 25 example, a dormant eNB, at a particular time.

[0073] Each of these devices may include at least one processor, respectively indicated as 414, 424, and 434. At least one memory can be provided in each device, as indicated at 415, 425, and 435, respectively. The memory may include computer program instructions or computer code contained therein. The processors 414, 424, and 434 and memories 415, 30 425, and 435, or a subset thereof, can be configured to provide means corresponding to the various blocks of Figures 2 and 3. Although not shown, the devices may also include positioning hardware, such as global positioning system (GPS) or micro electrical mechanical system (MEMS) hardware, which can be used to determine a location of the device. Other sensors are also permitted and can be included to determine location, elevation, orientation, and so forth, such as barometers, compasses, and the like. 35

[0074] As shown in Figure 4, transceivers 416, 426, and 436 can be provided, and each

device may also include at least one antenna, respectively illustrated as 417, 427, and 437. 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, first eNB 420 and second eNB 430 may additionally be configured for wired communication, and in such a case antenna 437 would also illustrate any form of communication hardware, without requiring a conventional antenna.

[0075] Transceivers 416, 426, and 436 can 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.

[0076] Processors 414, 424, and 434 can 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 can be implemented as a single controller, or a plurality of controllers or processors.

[0077] Memories 415, 425, and 435 can 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 can be used. The memories can 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 can be any suitable form of computer program code, for example, a compiled or interpreted computer program written in any suitable programming language.

[0078] The memory and the computer program instructions can be configured, with the processor for the particular device, to cause a hardware apparatus such as UE 410, first eNB 420, and second eNB 430, to perform any of the processes described above (see, for example, Figures 2 and 3). Therefore, in certain embodiments, a non-transitory computer-readable medium can be encoded with computer instructions that, when executed in hardware, perform a process such as one of the processes described herein. Alternatively, certain embodiments can be performed entirely in hardware.

[0079] Furthermore, although Figure 4 illustrates a system including a UE, first eNB, and second eNB, embodiments of the invention may be applicable to other configurations, and configurations involving additional elements.

[0080] 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 invention 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 spirit and scope of the invention.

[0081] Glossary

5	[0082]	3GPP	Third Generation Partnership Program
	[0083]	ASIC	Application Specific Integrated Circuit
	[0084]	CPU	Central Processing Unit
	[0085]	C-RNTI	Cell RNTI
	[0086]	CRC	Cyclic Redundancy Check
10	[0087]	CRS	Cell-specific Reference Signal
	[0088]	DCI	Downlink Control Information
	[0089]	DL	Downlink
	[0090]	eNB	eNode B (Base Station)
	[0091]	GPS	Global Positioning System
15	[0092]	FDD	Frequency Division Duplexing
	[0093]	HARQ	Hybrid Automatic Repeat Request
	[0094]	HDD	Hard Disk Drive
	[0095]	LTE	Long Term Evolution
	[0096]	MAC	Medium Access Control
20	[0097]	MIB	Master Information Block
	[0098]	MIMO	Micro Electrical Mechanical System
	[0099]	MME	Mobility Management Entity
	[0100]	NCT	New Carrier Type
	[0101]	PBCH	Physical Broadcast Channel
25	[0102]	PCI	Physical Cell ID
	[0103]	PDCCH	Physical Downlink Control Channel
	[0104]	PDSCH	Physical Downlink Shared Channel
	[0105]	PHY	Physical (layer)
	[0106]	PRS	Positioning Reference Signal
30	[0107]	PSS	Primary Synchronization Signal
	[0108]	RAM	Random Access Memory
	[0109]	RAN	Radio Access Network
	[0110]	Rel	Release
	[0111]	RNTI	Radio Network Temporary Identifier
35	[0112]	RRM	Radio Resource Management
	[0113]	RSRP	Reference Signal Received Power

	[0114]	RSRQ	Reference Signal Received Quality
	[0115]	RSTD	Received Signal Time Difference
	[0116]	SGW	Serving Gateway
	[0117]	SIB-1	System Information Block #1
5	[0118]	SI-RNTI	System Information – Radio Network Temporary Identifier
	[0119]	SSS	Secondary Synchronization Signal
	[0120]	TD-LTE	Time Division (TDD) LTE
	[0121]	UE	User Equipment
	[0122]	UL, U	Uplink
10	[0123]	WG	Working Group

WE CLAIM:

1. A method, comprising:

discovering a base station based on a discovery signal; and

5 determining whether the base station is active or dormant by attempting to detect a further signal that is not the discovery signal.

2. The method of claim 1, wherein the discovery signal comprises one or more of PSS/SSS/CRS, PSS/SSS, CRS, CSI-RS, PRS, PDCCH or PBCH.

3. The method of claim 1, wherein the discovery signal comprises a signal not normally transmitted by an active cell.

10 4. The method of any of claims 1-3, wherein the determining comprises determining that the base station is dormant when the further signal is not detected.

5. The method of any of claims 1-3, wherein the determining comprises determining that the base station is active when the further signal is detected.

15 6. The method of any of claims 1-5, wherein the further signal comprises a physical broadcast channel.

7. The method of any of claims 1-5, wherein the further signal comprises downlink control information.

8. The method of any of claims 1-5, wherein the further signal comprises a system information block.

20 9. The method of any of claims 1-5, wherein the further signal comprises a specific CSI-RS pattern.

10. The method of any of claims 1-5, wherein the further signal comprises or relates to a positioning reference signal.

11. The method of any of claims 1-10, further comprising:

25 receiving, from a base station, a configuration to report measurements for one or more cells.

12. The method of claim 11, wherein the configuration from the base station indicates to report only active cells, only dormant cells, or both active cells and dormant cells.

13. A method, comprising:

determining that a base station is dormant;

providing a report of a measurement on the base station; and

including in or with the report an indication that the base station is dormant.

5 14. The method of claim 13, wherein the indication is explicit.

15. The method of claim 14, wherein the indication comprises a single bit indicating active state or dormant state.

16. The method of claim 13, wherein the indication is implicit.

10 17. The method of claim 16, wherein the indication comprises a grouping of the measurement report in a first group to indicate active status and in a second group to indicate dormant status.

18. A method, comprising:

sending a discovery signal from a base station; and

15 sending, when the base station is active, a further signal that is not the discovery signal, wherein the further signal is configured to explicitly or implicitly indicate that the base station is active.

19. The method of claim 18, wherein the further signal comprises at least one of a physical broadcast channel, downlink control information, a system information block, a specific CSI-RS pattern, or a positioning reference signal.

20 20. The method of claim 18 or 19, further comprising:

sending, from a base station, a configuration to report measurements for one or more cells.

21. The method of claim 20, wherein the configuration from the base station indicates to report only active cells, only dormant cells, or both active cells and dormant cells.

25 22. A method, comprising:

receiving a measurement report from a user equipment; and

determining whether a base station referred to in the measurement report is in an active state, based on an indication associated with the measurement report.

23. The method of claim 22, wherein the indication is explicit.

5 24. The method of claim 23, wherein the indication comprises a single bit indicating active state or dormant state.

25. The method of claim 22, wherein the indication is implicit.

26. The method of claim 25, wherein the indication comprises a grouping of the measurement report in a first group to indicate active status and in a second group to indicate dormant status.

10 27. An apparatus, comprising:

means for discovering a base station based on a discovery signal; and

means for determining whether the base station is active or dormant by attempting to detect a further signal that is not the discovery signal.

15 28. The apparatus of claim 27, wherein the discovery signal comprises one or more of PSS/SSS/CRS, PSS/SSS, CRS, CSI-RS, PRS, PDCCH or PBCH.

29. The apparatus of claim 27, wherein the discovery signal comprises a signal not normally transmitted by an active cell.

30. The apparatus of any of claims 27-29, wherein the determining comprises determining that the base station is dormant when the further signal is not detected.

20 31. The apparatus of any of claims 27-29, wherein the determining comprises determining that the base station is active when the further signal is detected.

32. The apparatus of any of claims 27-31, wherein the further signal comprises a physical broadcast channel.

25 33. The apparatus of any of claims 27-31, wherein the further signal comprises downlink control information.

34. The apparatus of any of claims 27-31, wherein the further signal comprises a system information block.

35. The apparatus of any of claims 27-31, wherein the further signal comprises a specific CSI-RS pattern.

36. The apparatus of any of claims 27-31, wherein the further signal comprises or relates to a positioning reference signal.

5 37. The apparatus of any of claims 27-36, further comprising:

means for receiving, from a base station, a configuration to report measurements for one or more cells.

38. The apparatus of claim 37, wherein the configuration from the base station indicates to report only active cells, only dormant cells, or both active cells and dormant cells.

10 39. An apparatus, comprising:

means for determining that a base station is dormant;

means for providing a report of a measurement on the base station; and

means for including in or with the report an indication that the base station is dormant.

40. The apparatus of claim 39, wherein the indication is explicit.

15 41. The apparatus of claim 40, wherein the indication comprises a single bit indicating active state or dormant state.

42. The apparatus of claim 39, wherein the indication is implicit.

20 43. The apparatus of claim 42, wherein the indication comprises a grouping of the measurement report in a first group to indicate active status and in a second group to indicate dormant status.

44. An apparatus, comprising:

means for sending a discovery signal from a base station; and

25 means for sending, when the base station is active, a further signal that is not the discovery signal, wherein the further signal is configured to explicitly or implicitly indicate that the base station is active.

45. The apparatus of claim 44, wherein the further signal comprises at least one of a physical broadcast channel, downlink control information, a system information block, a specific CSI-RS pattern, or a positioning reference signal.

46. The apparatus of claim 44 or 45, further comprising:

5 means for sending, from a base station, a configuration to report measurements for one or more cells.

47. The apparatus of claim 46, wherein the configuration from the base station indicates to report only active cells, only dormant cells, or both active cells and dormant cells.

48. An apparatus, comprising:

10 means for receiving a measurement report from a user equipment; and

means for determining whether a base station referred to in the measurement report is in an active state, based on an indication associated with the measurement report.

49. The apparatus of claim 48, wherein the indication is explicit.

15 50. The apparatus of claim 49, wherein the indication comprises a single bit indicating active state or dormant state.

51. The apparatus of claim 48, wherein the indication is implicit.

52. The apparatus of claim 51, wherein the indication comprises a grouping of the measurement report in a first group to indicate active status and in a second group to indicate dormant status.

20 53. An apparatus, comprising:

at least one processor; and

at least one memory including computer program code,

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

25 discover a base station based on a discovery signal; and

determine whether the base station is active or dormant by attempting to detect a further signal that is not the discovery signal.

54. The apparatus of claim 53, wherein the discovery signal comprises one or more of PSS/SSS/CRS, PSS/SSS, CRS, CSI-RS, PRS, PDCCH or PBCH.

55. The apparatus of claim 53, wherein the discovery signal comprises a signal not normally transmitted by an active cell.

5 56. The apparatus of any of claims 53-55, wherein the determining comprises determining that the base station is dormant when the further signal is not detected.

57. The apparatus of any of claims 53-55, wherein the determining comprises determining that the base station is active when the further signal is detected.

10 58. The apparatus of any of claims 53-57, wherein the further signal comprises a physical broadcast channel.

59. The apparatus of any of claims 53-57, wherein the further signal comprises downlink control information.

60. The apparatus of any of claims 53-57, wherein the further signal comprises a system information block.

15 61. The apparatus of any of claims 53-57, wherein the further signal comprises a specific CSI-RS pattern.

62. The apparatus of any of claims 53-57, wherein the further signal comprises or relates to a positioning reference signal.

20 63. The apparatus of any of claims 53-62, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to receive, from a base station, a configuration to report measurements for one or more cells.

64. The apparatus of claim 63, wherein the configuration from the base station indicates to report only active cells, only dormant cells, or both active cells and dormant cells.

25 65. An apparatus, comprising:

at least one processor; and

at least one memory including computer program code,

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

determine that a base station is dormant;

provide a report of a measurement on the base station; and

5 include in or with the report an indication that the base station is dormant.

66. The apparatus of claim 65, wherein the indication is explicit.

67. The apparatus of claim 66, wherein the indication comprises a single bit indicating active state or dormant state.

68. The apparatus of claim 65, wherein the indication is implicit.

10 69. The apparatus of claim 68, wherein the indication comprises a grouping of the measurement report in a first group to indicate active status and in a second group to indicate dormant status.

70. An apparatus, comprising:

at least one processor; and

15 at least one memory including computer program code,

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

send a discovery signal from a base station; and

20 send, when the base station is active, a further signal that is not the discovery signal, wherein the further signal is configured to explicitly or implicitly indicate that the base station is active.

71. The apparatus of claim 70, wherein the further signal comprises at least one of a physical broadcast channel, downlink control information, a system information block, a specific CSI-RS pattern, or a positioning reference signal.

25 72. The apparatus of claim 70 or 71, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to send, from a base station, a configuration to report measurements for one or more cells.

73. The apparatus of claim 72, wherein the configuration from the base station indicates to report only active cells, only dormant cells, or both active cells and dormant cells.

74. An apparatus, comprising:

at least one processor; and

5 at least one memory including computer program code,

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

receive a measurement report from a user equipment; and

10 determine whether a base station referred to in the measurement report is in an active state, based on an indication associated with the measurement report.

75. The apparatus of claim 74, wherein the indication is explicit.

76. The apparatus of claim 75, wherein the indication comprises a single bit indicating active state or dormant state.

77. The apparatus of claim 74, wherein the indication is implicit.

15 78. The apparatus of claim 77, wherein the indication comprises a grouping of the measurement report in a first group to indicate active status and in a second group to indicate dormant status.

79. A computer program product encoding instructions for performing a process, the process comprising the method according to any of claims 1-26.

20 80. A non-transitory computer-readable medium encoded with instructions that, when executed in hardware, perform a process, the process comprising the method according to any of claims 1-26.

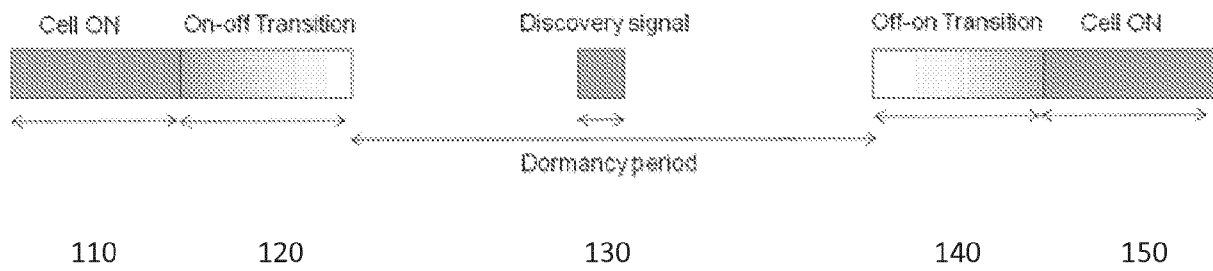


Figure 1

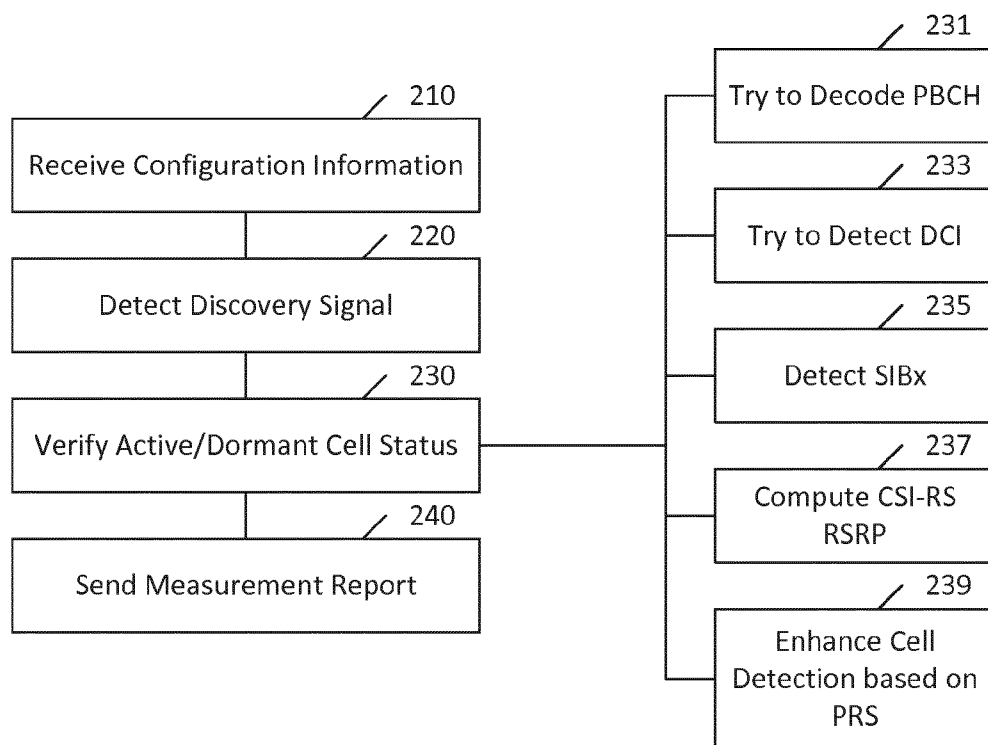


Figure 2

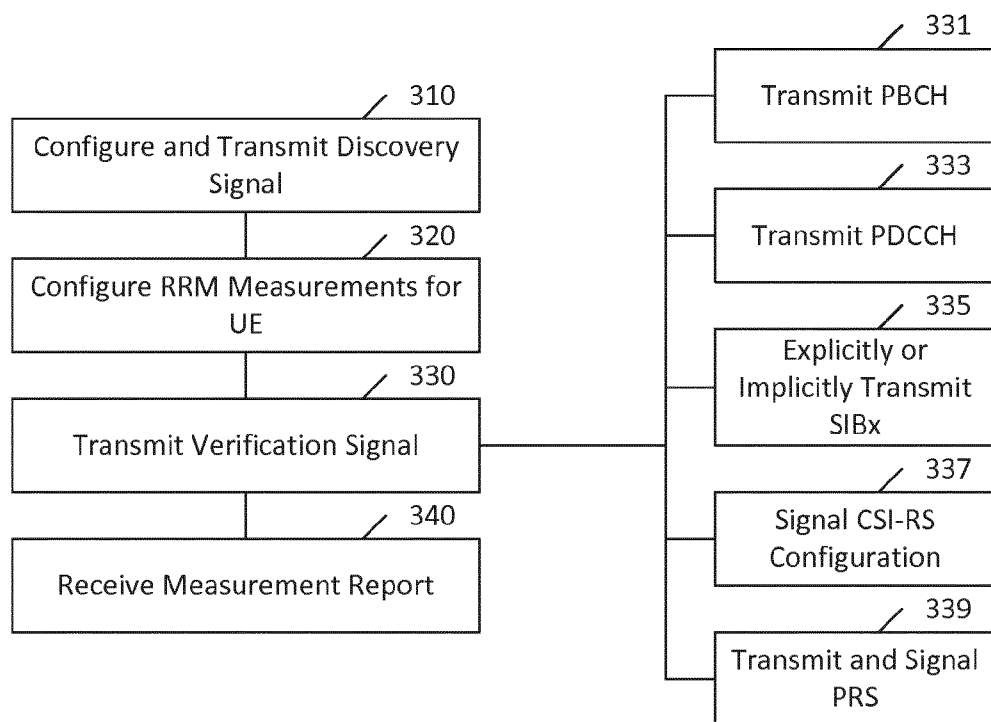


Figure 3

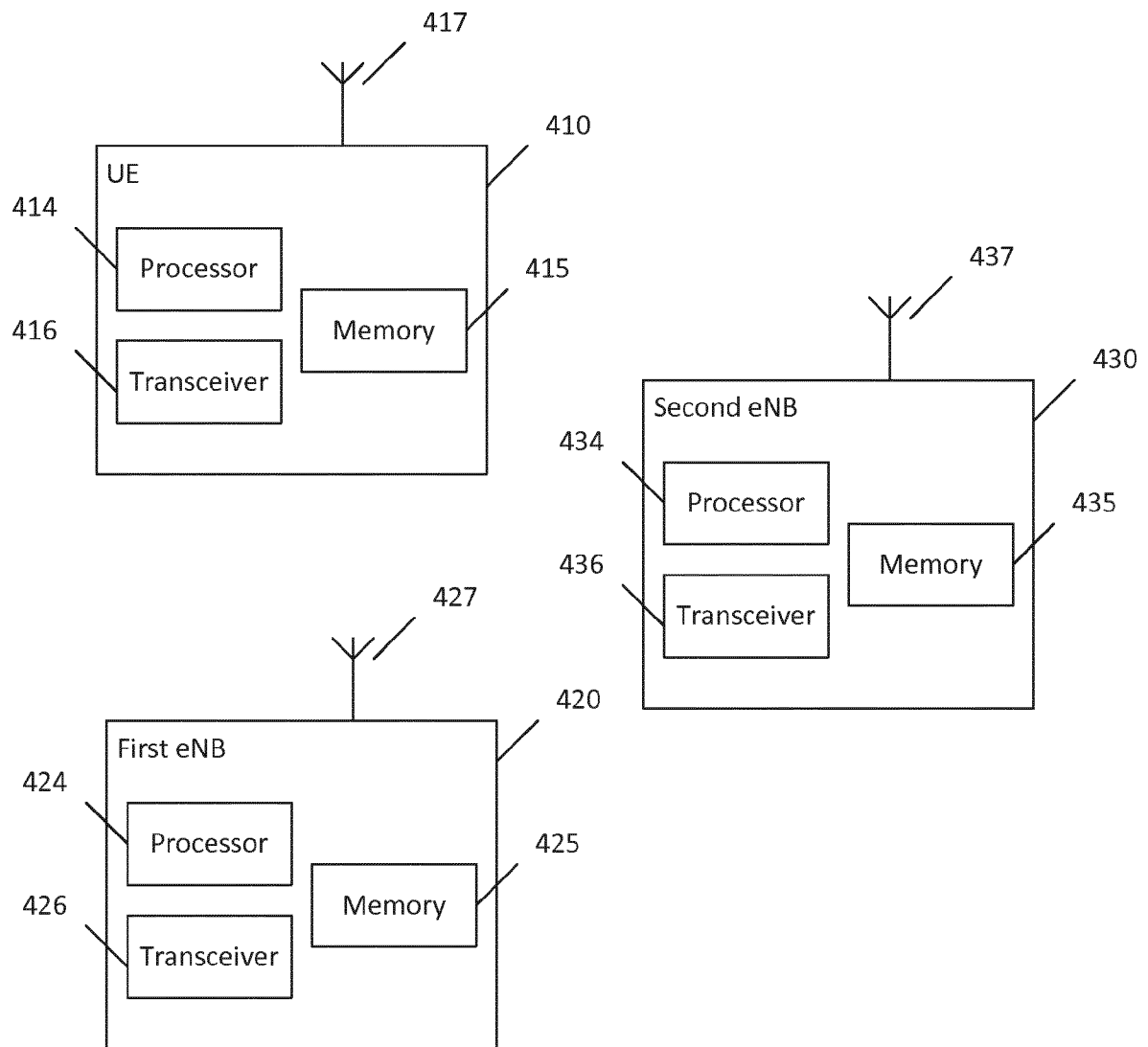


Figure 4

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2014/073423

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W48/16 H04W52/02
ADD.

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

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)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ZTE: "Considerations on transition procedures of small cell on/off scheme", 3GPP DRAFT; R1-134318 CONSIDERATIONS ON TRANSITION PROCEDURES OF SMALL CELL ONOFF SCHEME, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA , vol. RAN WG1, no. Guangzhou, China; 20131007 - 20131011 28 September 2013 (2013-09-28), XP050717462, Retrieved from the Internet: URL: http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_74b/Docs/[retrieved on 2013-09-28] page 1, paragraph 2.2 figure 2 ----- -/-	1-12, 18-21, 27-38, 44-47, 53-64, 70-73, 79,80



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

16 January 2015

Date of mailing of the international search report

23/01/2015

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2014/073423

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FUJITSU: "Discussion on discovery and measurement of turned-off small cells", 3GPP DRAFT; R1-134257 DISCOVERY AND MEASUREMENT OF SMALL CELLS, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG1, no. Guangzhou, China; 20131007 - 20131011 28 September 2013 (2013-09-28), XP050717420, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_74b/Docs/ [retrieved on 2013-09-28] page 3, paragraph 3.2 page 4, paragraph 3.3 figure 2	13-17, 22-26, 39-43, 48-52, 65-69, 74-78
A	----- "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Small cell enhancements for E-UTRA and E-UTRAN - Physical layer aspects (Release 12)", 3GPP STANDARD; 3GPP TR 36.872, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. V12.0.0, 20 September 2013 (2013-09-20), pages 1-78, XP050712719, [retrieved on 2013-09-20] page 42, paragraph 7.2.2 - page 43 -----	1-80