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(54) **Title:** METHOD FOR OPERATING A CELLULAR RADIO ACCESS NETWORK AND CELLULAR RADIO ACCESS NETWORK

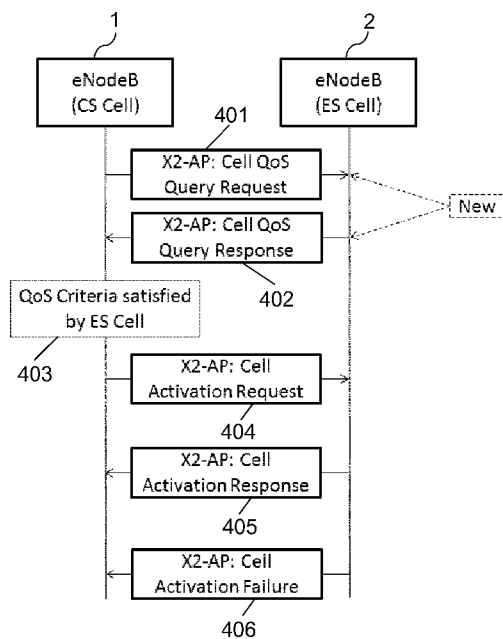


Fig. 4

(57) **Abstract:** A method for operating a cellular radio access network, said network comprising a compensation cell (1) and at least one energy saving cell (2), wherein the coverage area of said at least one energy saving cell (2) is at least partly covered by the coverage area of said compensation cell (1), is characterized in that said compensation cell (1), while said at least one energy saving cell (2) is either in an energy saving mode or partly or fully in a switched off state, detects when a mobile station (3) enters the coverage area of said at least one energy saving cell (2), and that, prior to deciding on an activation of said at least one energy saving cell (2), performance parameters of said at least one energy saving cell (2) are acquired by said compensation cell (1) and/or exchanged between said compensation cell (1) and said at least one energy saving cell (2). Furthermore, a corresponding cellular radio access network is disclosed.

METHOD FOR OPERATING A CELLULAR RADIO ACCESS NETWORK AND CELLULAR RADIO ACCESS NETWORK

5 The present invention relates to a method for operating a cellular radio access network, said network comprising a compensation cell and at least one energy saving cell, wherein the coverage area of said at least one energy saving cell is at least partly covered by the coverage area of said compensation cell.

10 Furthermore, the present invention relates to a cellular radio access network, comprising a compensation cell and at least one energy saving cell, wherein the coverage footprint of said at least one energy saving cell is at least partly covered by the coverage footprint of said compensation cell.

15 Energy efficient cellular networks are one of the key focus areas of network vendors, operators and standardization bodies across the world. The motivation to make radio access networks more energy efficient is derived from environmental aspects as well as from economic perspective for CAPEX (CAPital EXpenditure) and OPEX (OPerational EXpenditure) reduction. Currently there is active study ongoing in 3GPP considering energy saving enhancement solutions for LTE-
20 Advance networks (for reference, see 3GPP RP-122035, "Study on Energy Saving Enhancement for E-UTRAN"). The main intention of the study is to consider the criteria for switching energy saving cells on or off, thereby saving energy. Currently, there are solutions proposed as part of this (for reference, see 3GPP R3-130337, "Summary of Intra-LTE ES enhancements for overlapping scenario") mainly
25 considering conditions for switching off an energy saving cell and there has been limited focus on switching on enhancements.

30 Quality of service (QoS) requirements of a UE (User Equipment) is one of the main considerations while deploying a cellular network. High quality of service or experience from an end user translates to higher revenue generation from an operators' perspective. Thus, any energy saving enhancement considered should also take this key factor into account. This essentially means that potential switching off or on of a cell should not degrade the QoS requirements guaranteed for the end

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user, as also described in the above mentioned 3GPP RP-122035, "Study on Energy Saving Enhancement for E-UTRAN".

Fig. 1 shows one of the scenarios considered in this study where compensation cells and energy saving cells have an overlapping coverage footprint. Here, energy saving (ES) cells are those which could be potentially turned off/on for saving energy and compensation cells are those which compensate for the ES cells. As shown in Fig. 1, the energy saving cells in this scenario are deployed within the coverage area of compensation cells for capacity or coverage enhancements. The assumption here is that the ES cells are connected to compensation cells via an X2 interface. The solutions considering which cell should be potentially turned on based on conditions such as location of the UE in proximity to an ES cell, load of compensation cell, etc. are considered in 3GPP TR 36.927, "E-UTRA: Potential solutions for energy saving for E-UTRAN".

Fig. 2 shows the cells connected through an X2 interface and signaling involved between them for activating a cell (for reference, see 3GPP TS 36.300, "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRAN); Overall description; Stage 2"). Here, based on certain conditions, compensation cell eNB (Enhanced NodeB, according to 3GPP terminology) sends activation request to an ES eNB in order to activate it. Once the ES cell is activated, a UE within its coverage can connect to the cell and using the resources from the cell to engage in data transfer.

Current considerations for sending the Cell Activation Request over X2 is based on cell load. This essentially means that if the cell load of compensation cell is high, it sends activation requests to ES cells. But the drawback of this mechanism is that if UEs within the coverage footprint of ES cells are not engaged in data transfer consuming significant amount of load, even after activating the ES cells the load conditions of the compensation cells will not improve. Another key drawback is that with the currently defined and considered mechanisms, there is additional signaling load for sending activation requests as well as energy consumption for switching on the cells.

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In view of the above, it is an objective of the present invention to improve and further develop a cellular radio access network and a method for operating such network of the initially described type in such a way that the network operation expenses are reduced without affecting QoS performance from an end user's perspective.

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In accordance with the invention, the aforementioned object is accomplished by a method comprising the features of claim 1. According to this claim such a method is characterized in that said compensation cell, while said at least one energy saving cell is either in an energy saving mode or partly or fully in a switched off state, detects when a mobile station enters the coverage area of said at least one energy saving cell, and that, prior to deciding on an activation of said at least one energy saving cell, performance parameters of said at least one energy saving cell (2) are acquired by said compensation cell and/or exchanged between said compensation cell and said at least one energy saving cell.

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Furthermore, the above mentioned objective is accomplished by a cellular radio access network comprising the features of claim 14. According to this claim such a network is characterized in that said compensation cell is configured to detect, while said at least one energy saving cell is either in an energy saving mode or partly or fully in a switched off state, when a mobile station enters the coverage area of said at least one energy saving cell, and wherein said compensation cell is further configured, prior to deciding on an activation of said at least one energy saving cell, to acquire and/or exchange with said at least one energy saving cell performance parameters of said at least one energy saving cell.

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According to the invention it has been recognized that the above objective can be solved by enabling the compensation cell to make an intelligent decision on whether to activate an energy saving cell or not. To this end, the compensation cell is configured to acquire, prior to cell activation, performance parameters of mobile stations or terminals (in 3GPP terminology denoted UE, User Equipment) entering the coverage area of the energy saving cell and/or to exchange these performance parameters with the energy saving cell. Thus, the present invention can be regarded as a method for acquiring quality of service support from base stations. As a result, applying the method according to the present invention reduces the total energy

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consumption and OPEX of the network from operators' perspective, while at the same time provides ubiquitous coverage and enhanced QoS performance from end users' perspective. Moreover, the present invention enables mobility optimization and effective offloading data traffic from the compensation cell.

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Embodiments of the present invention provide an optimized cell switching on feature, thereby enabling energy savings and interference mitigation: Energy savings are achieved by optimizing the cell switch ON time, while interference level reduction without affecting QoS performance is achieved for intra-frequency, co-channel deployments, where unnecessary switching ON of energy saving cells avoids added interference in the network. Furthermore, embodiments of the present invention provide significant optimization in signaling load: For the cost of additional QoS query requests, unnecessary signaling for handovers can be avoided.

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It is noted that the solution according to the invention is applicable to any cellular wireless system supporting cell activation and handover functionality. This functionality is also applicable for base stations or cells where only one or more individual Radio Access Technologies have been switched off rather than the whole base station.

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According to a preferred embodiment the performance parameters of the energy saving cell that are acquired by the compensation cell may include, for instance, the QoS supported by the energy saving cell, the amount of radio resources and/or radio access spectrum available at the energy saving cell, and/or the operational state and/or capacity of the backhaul interface of the energy saving cell. The latter would account for non-ideal or non-functional backhaul conditions.

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In some embodiments, the process of acquiring the performance parameters of the energy saving cell or any communication with the energy saving cell may be triggered according to predefined criteria, preferably by considering the number of mobile stations that move into the coverage area of the energy saving cell. Additional or alternative trigger criteria may relate to, if available, QoS requirements of the (one or more) mobile stations entering the coverage area of the energy saving

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cell, for instance, based on active bearers and their QoS requirements, based on application-layer requirements, based on expected traffic patterns, or the like.

5 According to a preferred embodiment the compensation cell analyzes the performance demands, including, e.g., QoS and/or subscription profile and/or traffic requirements, of the mobile stations entering the coverage area of the energy saving cell. In this regard it is important to note that a mobile station's data traffic requirements could depend not only on the DL (Downlink) traffic load, but also on the UL (Uplink) traffic generated by the mobile station. Since this could depend on
10 the buffer status report (BSR) sent by the mobile station requesting UL resources, it may be provided that the compensation cell also takes into consideration the mobile stations' BSR when analyzing the mobile stations' performance demands. In this way, a current traffic and anticipated future traffic and radio resource requirement based cell activation could be realized. For instance, a UL BSR based activation of
15 energy saving cells would enable cell activation based on for e.g. anticipated future UL traffic requirements of the mobile stations. In this context, activation could also depend on the service requests sent by the mobile station, requests for downlink resources or any other information from which the compensation cell can deduce an expected traffic requirement.

20 With respect to optimized network operation in terms of energy efficiency, it may be provided that the compensation cell activates an energy saving cell only in case the performance parameters of that energy saving cell satisfy the performance demands of the mobile station(s) entering the coverage area of the energy saving
25 cell.

30 With respect to further optimized network operation in terms of energy efficiency it may be provided that the compensation cell activates an energy saving cell only in case the performance demands of the mobile station(s) entering the coverage area of that energy saving cell exceed a predefined threshold. For instance, if a mobile station is engaged in voice calls or other data transfers involving low amounts of data and is therefore not using significant amount of the resources of the compensation cell's base station, the energy saving cell may not be activated (although, basically, the performance parameters of the energy saving cell would

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satisfy the performance demands of the mobile station). On the other hand, if the mobile station is engaged in heavy data transfer when moving into the coverage area of the energy saving cell, then this cell may be activated, e.g. by the compensation cell sending an activation request to the energy saving cell's base station (ES eNB), provided the performance parameters of the energy saving cell as acquired by the compensation cell indicate that the ES eNB can handle the traffic generated by the mobile station.

According to a preferred embodiment, the compensation cell analyzes the speed and/or mobility state of the mobile station entering the coverage area of said at least one energy saving cell, and activates said at least one energy saving cell (e.g. by sending a cell activation request) only in case the moving speed of the mobile station is below a predefined threshold. More specifically, in some embodiments it may be provided that if a mobile station is moving fast (i.e. with a velocity exceeding a configurable threshold) relative to the ES cell size, or is in medium or high mobility state while the ES cell is a small cell, no cell activation procedure is executed, i.e., in particular, that a ES cell activation request should not be sent. The mobility state of mobile station entering the ES cell could be estimated based on a cell selection based mechanism, as currently defined in 3GPP TS 36.331, "E-UTRA: RRC Protocol Specification", Ver. 10.5.0, Mar.2012, or using GPS or any other UE speed determination mechanisms.

With respect to an effective acquisition of the performance parameters of the energy saving cell, the compensation cell may send a respective query request to the energy saving cell using any interface with the energy saving cell, preferably via the X2-interface. If the query results in that the performance parameters of the energy saving cell (which is in a switched off or energy saving mode), satisfies the QoS or traffic requirements of the mobile station(s), a cell activation message may be sent to the energy saving cell.

Regarding the query request it may be provided that the compensation cell, before sending the query request considers the QoS requirements of the mobile station(s) by analyzing the service requests made by the mobile station(s), as considered in WO 2012/055984 A2. Alternatively, this analysis could be performed also after

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5 sending the query request. According to a still further alternative, the compensation cell could send a request to the energy saving cell to enter an intermediate state after which the performance (in particular QoS) query request is sent. In any case, the combination of QoS or data traffic requirements from the mobile station(s), as well as the results from the performance parameters query, is used by the compensation cell or eNB before sending an ES cell activation request.

10 According to a preferred embodiment, the mobile station could deduce some QoS/radio information encoded in a reference signal transmitted periodically on the air interface of the energy saving cell. According to a further alternative, it may be provided that the compensation cell sends certain performance related information to the energy saving cell, including but not limited to, the number of mobile stations, radio resources, QoS/bandwidth requirements to the energy saving cell. Upon receiving this information, the energy saving cell could then answer with a message
15 containing a flag that indicates certain conditions/behavior, for instance 'yes', 'no', or 'decides to switch on?'.

20 Generally, the energy saving cell may be configured to support reporting the performance parameters queried by the compensation cell in various ways. For instance, the energy saving cell could either use the same interface for its response the compensation cell had used for its query request beforehand, or it could quickly wake up and send a short information burst to a mobile station located in the coverage area of the energy saving cell, wherein the short information burst could contain base station capabilities such as QoS support /radio information, etc. The
25 mobile station may detect this information and may inform the compensation cell as to which energy saving cell to activate with more detailed cell information such as for e.g. cell ID, etc.

30 In some embodiments, the network may comprise a status database which, for instance, may be implemented on an OAMP (Operations, Administration, Maintenance and Provisioning) entity, or which may be provided by any external network operator, or other third party deployed entity which provides energy saving configurations to the Radio Access Network or eNBs/cells. This may be used by the energy saving cell to update the status database, before switching off, with its

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performance parameters and/or information regarding the Radio Access Stratum (RAS). The compensation cell may then acquire this information by querying it from the status database.

5 As mentioned already before, the energy saving cell may be activated by the compensation cell sending a cell activation request to the energy saving cell. Advantageously, the performance demands of mobile stations located within and/or entering the coverage area of the energy saving cell, in particular QoS or service request information of the mobile stations, may be included in the cell activation request. Upon receiving a cell activation request, the energy saving cell may send a cell activation response in case it can support the performance demands indicated in the cell activation request, and it may send cell activation failure information otherwise.

15 There are several ways how to design and further develop the teaching of the present invention in an advantageous way. To this end it is to be referred to the patent claims subordinate to patent claims 1 and 14 on the one hand and to the following explanation of preferred embodiments of the invention by way of example, illustrated by the drawing on the other hand. In connection with the explanation of the preferred embodiments of the invention by the aid of the drawing, generally preferred embodiments and further developments of the teaching will be explained. In the drawing

25 Fig. 1 is a schematic view illustrating a cellular radio access network scenario with compensation cells and energy saving cells having an overlapping coverage footprint,

Fig. 2 is a schematic view illustrating signaling details for energy saving cell activation according to prior art,

30 Fig. 3 is a schematic view illustrating a switch on scenario for an energy saving cell in accordance with a first embodiment of the invention,

Fig. 4 is a diagram showing signaling details of an energy saving cell activation procedure in accordance with an embodiment of the invention,

Fig. 5 is a flow diagram of an energy saving cell activation procedure in accordance with an embodiment of the invention,

Fig. 6 is a diagram showing signaling details of an energy saving cell activation procedure using a modified cell activation request in accordance with an embodiment of the invention,

Fig. 7 is a schematic view illustrating a switch on scenario for an energy saving cell using an external database entity in accordance with an embodiment of the invention,

Fig. 8 is a diagram showing the signaling details for interaction with an external database entity in accordance with an embodiment of the invention,

Fig. 9 is a schematic view illustrating an application scenario of the present invention with multiple compensation cells and energy saving cells involved, and

Fig. 10 is a flow diagram of a switch on in switch off scenario for an energy saving cell in accordance with an embodiment of the invention.

Before describing in detail the embodiments of the present invention as illustrated in Figs. 3-10, it is first of all noted that hereinafter the terms cell, sector, eNodeB or base station will be used interchangeably. Also, UE (User Equipment) and mobile station are used interchangeably in the context of the following description.

Referring now to Fig. 3, this figure schematically depicts a cellular radio access network scenario considered for an embodiment of the present invention. The network comprises a compensation cell 1 and an energy saving cell 2, wherein the entire coverage footprint of the energy saving (ES) cell 2 (indicated by the dotted

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line circle) is contained within the coverage footprint of the compensation cell 1 (indicated by the solid line circle). In the illustrated embodiment it is assumed that the ES cell 2 is initially in a switched off state and that the mobile station, denoted in 3GPP terminology UE (User Equipment) 3 hereinafter, is connected to the compensation cell 1 (which could be a macro cell).

As can be seen in Fig. 3, UE 3 moves within the range of the switched off ES cell 2. The compensation cell 1 is configured to detect when a mobile station enters the coverage area of the ES cell 2. For the purpose of how the eNodeB of the compensation cell 1 and/or the UE 3 can detect the vicinity of the switched off ES cell 2 different mechanisms may be deployed, e.g. by means of RF fingerprints, UE location reporting, or detection of sparse reference signals from the ES cell 2 which is in a low duty mode. In this scenario, embodiments of the present invention are related to mechanisms for switching on the ES cell 2, as will be described in more detail below.

Assuming the scenario as described in connection with Fig. 3, Fig. 4 shows an embodiment of a signaling diagram used for an ES cell 2 activation procedure in according to the present invention. In a first step, 401, the compensation cell (CS cell) 1, using the X2-interface sends a request to the ES cell 2 for querying the QoS parameters of the ES cell 2. Also via the X2-interface, at step 402, the ES cell 2 sends back a QoS query response. Upon receipt of this response, at step 403, the compensation cell 1 analyzes the QoS parameters of the ES cell 2 and checks whether the QoS demands of the UE 3 that moved into the coverage are of ES cell 2 can be satisfied by ES cell 2. Based on the query result, which in the embodiment of Fig. 4 is assumed to be positive (i.e. the ES cell 2 satisfies the required QoS criteria), the cell activation request as currently defined in 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRAN); Overall description; Stage 2", may be sent, as illustrated at step 404. Thereupon, the ES cell 2 may either send, in the regular case, a cell activation response (step 405) or, exceptionally, a cell activation failure (step 406). It is noted that in the present case this cell activation failure would be unrelated to the executed QoS information exchange operations (i.e. would not be

send due to insufficient support), but only due to some other shortcomings or problems like, e.g., hardware failures.

Fig. 5 shows an embodiment of a flow diagram for an ES cell 2 activation procedure in according to the present invention. At the beginning of the procedure (start 501), the ES cell 2 is assumed to be in a switched off state (502) and the UE 3 is assumed to enter the coverage region of ES cell 2 (503). In a first step, illustrated at 504, the compensation cell 1 checks whether the UE 3 is engaged in heavy data transfer. This check may be performed by analyzing the service requests and BSRs sent by the UE 3 requesting downlink and uplink resources, mobility state of UE 3 and QoS query results from the ES cell 2. If this is not the case, the cell activation procedure is terminated.

Otherwise, as shown at 505, the compensation cell 1 sends a QoS query to the ES cell 2. Based on the response from the ES cell 2, at 506, the compensation cell 1 checks whether the performance parameters of the ES cell 2, in particular the QoS supported by the ES cell 2, satisfy the performance demands of the UE 3. If this is not the case, the cell activation procedure is aborted.

Otherwise, as shown at 507, the compensation cell 1 analyzes the speed or mobility state of the UE 3. If this analysis reveals that the UE 3 is moving too fast (in relation to the size of the ES cell 2), the cell activation procedure is again aborted, since the UE 3 would leave the coverage area of the ES cell 2 too quickly to enable cell activation either with a positive energetic effect from a network perspective or with enhanced QoS experience from UE 3 perspective. On the other hand, if the analysis reveals that the UE 3 is moving not too fast, at 508, the eNB of the compensation cell 1 would send a cell activation request to the eNB of the ES cell 2. Hereupon, shown at 509, the ES cell 2 would turn into a switched on state. Next, at 510, the compensation cell 1 would initiate a handover (HO) procedure to offload traffic to the ES cell 2. After this, the cell activation procedure is completed (end 511).

X2-AP (X2-Application Protocol) message details for 'Load Information' message, as shown in Fig. 4, may be designed following the definition as given in 3GPP TS

36.423: "E-UTRAN: X2 application protocol (X2AP)", which are shown in Table 1 below:

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.13		YES	ignore
Cell Information	M				YES	ignore
>Cell Information Item		<i>1 .. <maxCellineNB></i>			EACH	ignore
>>Cell ID	M		ECGI 9.2.14	Id of the source cell	–	–
>>UL Interference Overload Indication	O		9.2.17		–	–
>>UL High Interference Information		<i>0 .. <maxCellineNB></i>			–	–
>>>Target Cell ID	M		ECGI 9.2.14	Id of the cell for which the HII is meant	–	–
>>>UL High Interference Indication	M		9.2.18		–	–
>>Relative Narrowband Tx Power (RNTP)	O		9.2.19		–	–
>>ABS Information	O		9.2.54		YES	ignore
>>Invoke Indication	O		9.2.55		YES	ignore

Table 1

Here the IE 'Message Type' carries the information regarding the type of X2-AP message. According to a preferred embodiment, based on the definition 3GPP TS 36.423: "E-UTRAN: X2 application protocol (X2AP)", a modified Message Type IE information could be employed by adding the following message type field (indicated by numeral '16'), as shown in Table 2 below:

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IE/Group Name	Presence	Range	IE type and reference	Semantics description
Procedure Code	M		INTEGER (0..255)	"0" = Handover Preparation "1" = Handover Cancel "2" = Load Indication "3" = Error Indication "4" = SN Status Transfer "5" = UE Context Release "6" = X2 Setup "7" = Reset "8" = eNB Configuration Update "9" = Resource Status Reporting Initiation "10" = Resource Status Reporting "11" = Private Message "12" = Mobility Settings Change "13" = Radio Link Failure Indication "14" = Handover Report "15" = Cell Activation "16" = Quality of Service support query (NEW)
Type of Message	M		CHOICE (Initiating Message, Successful Outcome, Unsuccessful Outcome, ...)	

Table 2

In a preferred embodiment, a QoS support request (step 505 in Fig. 5) could be implemented as follows or the request could include a subset of the following information exchanged between the compensation cell and energy saving cell using the X2 interface:

```

-- *****
--
-- QoS SUPPORT REQUEST
--
-- *****

QoSSupportRequest ::= SEQUENCE {
    protocolIEs          ProtocolIE-Container    {{ QoSSupportRequest-
    IEs}},
    ...
}

QoSSupportRequest-IEs X2AP-PROTOCOL-IES ::= {
    { ID id-Old-eNB-UE-X2AP-ID          CRITICALITY reject    TYPE UE-
    X2AP-ID          PRESENCE mandatory}|

```

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```

        { ID id-TargetCell-ID                                CRITICALITY reject      TYPE ECGI
                                                                PRESENCE mandatory}}
        { ID id-UE-ContextInformation                        CRITICALITY reject      TYPE UE-
ContextInformation PRESENCE mandatory}}
5      { ID id-CSGMembershipStatus                            CRITICALITY reject      TYPE
CSGMembershipStatus PRESENCE optional}}
        { ID id-MobilityInformation                          CRITICALITY ignore      TYPE
MobilityInformation PRESENCE optional},
10     ...
}

UE-ContextInformation ::= SEQUENCE {
    mME-UE-SlAP-ID                                UE-SlAP-ID,
15     uESecurityCapabilities                        uESecurityCapabilities,
    aS-SecurityInformation                        AS-SecurityInformation,
    uEAggregateMaximumBitRate                    UEAggregateMaximumBitRate,
    subscriberProfileIDforRFP                    SubscriberProfileIDforRFP
20     OPTIONAL,
    e-RABs-ToBeSetup-List                        E-RABs-ToBeSetup-List,
    rRC-Context                                    RRC-Context,
    handoverRestrictionList                      HandoverRestrictionList
25     OPTIONAL,
    locationReportingInformation                LocationReportingInformation OPTIONAL,
    iE-Extensions                                ProtocolExtensionContainer { {UE-
ContextInformation-ExtIEs} } OPTIONAL,
    ...
}

UE-ContextInformation-ExtIEs X2AP-PROTOCOL-EXTENSION ::= {
30     { ID id-ManagementBasedMDTAllowed    CRITICALITY ignore    EXTENSION
ManagementBasedMDTAllowed PRESENCE optional }}
    { ID id-ManagementBasedMDTPLMNList    CRITICALITY ignore    EXTENSION MDTPLMNList
        PRESENCE optional },
35     ...
}

E-RABs-ToBeSetup-List ::= SEQUENCE (SIZE(1..maxnoofBearers)) OF ProtocolIE-Single-Container {
    {E-RABs-ToBeSetup-ItemIEs} }

40     E-RABs-ToBeSetup-ItemIEs X2AP-PROTOCOL-IES ::= {
        { ID id-E-RABs-ToBeSetup-Item CRITICALITY ignore    TYPE E-RABs-ToBeSetup-Item
        PRESENCE mandatory },
        ...
45     }

E-RABs-ToBeSetup-Item ::= SEQUENCE {
    e-RAB-ID                                E-RAB-ID,
    e-RAB-Level-QoS-Parameters              E-RAB-Level-QoS-Parameters,
50     dL-Forwarding                          DL-Forwarding
        OPTIONAL,
    uL-GTPTunnelEndpoint                    GTPTunnelEndpoint,
    iE-Extensions                          ProtocolExtensionContainer { {E-RABs-
ToBeSetup-ItemExtIEs} } OPTIONAL,
55     ...
}

E-RABs-ToBeSetup-ItemExtIEs X2AP-PROTOCOL-EXTENSION ::= {
    ...
60 }

MobilityInformation ::= BIT STRING (SIZE(32))

```

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From this message the ES cell 2 will get the information regarding the RABs (Radio Bearers), mobility state information, UE Context Information (which consists of the established bearers/traffic information of each UE), etc., based on which the ES cell 2 can take report whether the QoS requirements of the UE 3 can be supported. The response could essentially contain a Boolean element informing the source cell, i.e. the compensation cell 1, whether QoS requirement is supported or not. It could also contain detailed response indicating other information (for e.g. the bearers or traffic flows that could be admitted by the ES cell 2) from the ES cell 2 as well. All of these parameters or a subset of these or even any other parameters which defines the QoS support/Radio resource information or any other parameter which conveys similar information could be used. Here, aggregate information may be sent for all the UEs within the coverage footprint of the switched off ES cell 2. Alternatively, a new UEAggregatedRadioResourceStatus IE could be used to convey the aggregated radio resource utilization done by the UEs within the coverage area of the ES cell 2. This IE could be designed to contain the following:

```

UEAggregatedRadioResourceStatus ::= SEQUENCE {
    dL-GBR-PRB-usage          DL-GBR-PRB-usage,
    uL-GBR-PRB-usage          UL-GBR-PRB-usage,
    dL-non-GBR-PRB-usage      DL-non-GBR-PRB-usage,
    uL-non-GBR-PRB-usage      UL-non-GBR-PRB-usage,
    dL-Total-PRB-usage        DL-Total-PRB-usage,
    uL-Total-PRB-usage        UL-Total-PRB-usage,
    iE-Extensions             ProtocolExtensionContainer {
{RadioResourceStatus-ExtIEs} } OPTIONAL,
    ...
}

UEAggregatedRadioResourceStatus-ExtIEs X2AP-PROTOCOL-EXTENSION ::= {
    ...
},

```

where the information sent to the ES cell 2 is aggregated for all the UEs within switched off ES cell 2 coverage area.

According to an embodiment of the present invention, illustrated in Fig. 6; the QoS requirements could be sent to the ES cell 2 by modifying the Cell Activation Request as currently defined in 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRAN);

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Overall description; Stage 2", and in 3GPP TS 36.423: "E-UTRAN: X2 application protocol (X2AP)". The signaling involved for this implementation is as follows:

In a first step, 601, the compensation cell 1, using the X2-interface sends a cell activation request to the ES cell 2. This request is modified to contain additional QoS support or service request information of the UE(s) within the coverage area of the ES cell 2. Upon receipt of this request, at steps 602a and 602b, the ES cell 2 checks whether its performance parameters satisfy the QoS demands of the UEs in question. Based on this check, the ES cell 2 may either send a cell activation response (step 603) if it can support the requirements, or a cell activation failure (step 604) if it cannot support the requirements.

It is noted that, for a QoS query combined with a cell activation request (CAR), there is no additional signaling load on X2, but optimized handover signaling can be achieved (which in turn reduces the signaling load on X2/S1).

The modified cell activation request employed in connection with the embodiment of Fig. 6 may be designed to contain the following information:

```

-- *****
--
-- Cell Activation Request
--
-- *****

CellActivationRequest ::= SEQUENCE {
    protocolIEs                ProtocolIE-Container    {{CellActivationRequest-IEs}},
    ...
}

CellActivationRequest-IEs X2AP-PROTOCOL-IES ::= {
    { ID id-ServedCellsToActivate    CRITICALITY reject    TYPE ServedCellsToActivate
    PRESENCE mandatory },
    { ID id-UE-ContextInformation    CRITICALITY reject    TYPE UE-
    ContextInformation                PRESENCE mandatory }|
    { ID id-MobilityInformation      CRITICALITY ignore    TYPE
    MobilityInformation                PRESENCE optional },
    ...
}

ServedCellsToActivate ::= SEQUENCE (SIZE (1..maxCellineNB)) OF ServedCellsToActivate-Item

ServedCellsToActivate-Item ::= SEQUENCE {
    ecgi                ECGI,
    iE-Extensions        ProtocolExtensionContainer { { ServedCellsToActivate-
    Item-ExtIEs} } OPTIONAL,
    ...
}

```

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```

}
ServedCellsToActivate-Item-ExtIEs X2AP-PROTOCOL-EXTENSION ::= {
5   ...
}
UE-ContextInformation ::= SEQUENCE {
    mME-UE-S1AP-ID                UE-S1AP-ID,
    uESecurityCapabilities          uESecurityCapabilities,
10   aS-SecurityInformation         AS-SecurityInformation,
    uEAggregateMaximumBitRate      uEAggregateMaximumBitRate,
    subscriberProfileIDforRFP      SubscriberProfileIDforRFP
    OPTIONAL,
    e-RABs-ToBeSetup-List          E-RABs-ToBeSetup-List,
15   rRC-Context                    RRC-Context,
    handoverRestrictionList        HandoverRestrictionList
    OPTIONAL,
    locationReportingInformation    LocationReportingInformation OPTIONAL,
    iE-Extensions                  ProtocolExtensionContainer { {UE-
20   ContextInformation-ExtIEs} } OPTIONAL,
    ...
}

UE-ContextInformation-ExtIEs X2AP-PROTOCOL-EXTENSION ::= {
25   { ID id-ManagementBasedMDTallowed CRITICALITY ignore EXTENSION
    ManagementBasedMDTallowed PRESENCE optional }|
    { ID id-ManagementBasedMDTPLMNList CRITICALITY ignore EXTENSION MDTPLMNList
    PRESENCE optional },
    ...
30   }

E-RABs-ToBeSetup-List ::= SEQUENCE (SIZE(1..maxnoofBearers)) OF ProtocolIE-Single-Container {
    {E-RABs-ToBeSetup-ItemIEs} }

E-RABs-ToBeSetup-ItemIEs X2AP-PROTOCOL-IES ::= {
35   { ID id-E-RABs-ToBeSetup-Item CRITICALITY ignore TYPE E-RABs-ToBeSetup-Item
    PRESENCE mandatory },
    ...
}

E-RABs-ToBeSetup-Item ::= SEQUENCE {
40   e-RAB-ID                      E-RAB-ID,
    e-RAB-Level-QoS-Parameters    E-RAB-Level-QoS-Parameters,
    dL-Forwarding                  DL-Forwarding
                                OPTIONAL,
45   uL-GTPTunnelEndpoint          GTPtunnelEndpoint,
    iE-Extensions                  ProtocolExtensionContainer { {E-RABs-
    ToBeSetup-ItemExtIEs} } OPTIONAL,
    ...
50   }

E-RABs-ToBeSetup-ItemExtIEs X2AP-PROTOCOL-EXTENSION ::= {
    ...
}

55   MobilityInformation ::= BIT STRING (SIZE(32))

```

The fields marked in **bold** (for e.g. UE-ContextInformation, E-RABs-ToBeSetup, UE context information, subscriber profile ID (SPID), etc.) indicate the additions with respect to the definition according to current standards. Using a subset of the information contained in such a message (such as radio access bearers to be setup

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after handover, detailed context information, subscriber profile ID, etc.), CS cell can either inform the ES cell regarding the expected traffic and load conditions, or possible energy saving action that needs to be taken. ES cell could also determine the subscription profile of the UE based on this information, and decide based on pre-configurations or decide autonomously to activate. It is noted that also the cell activation failure message employed in connection with the embodiment of Fig. 6 could be modified adding a new failure cause, as follows:

```

--*****
--
-- CELL ACTIVATION FAILURE
--
-- *****
CellActivationFailure ::= SEQUENCE {
    protocolIEs          ProtocolIE-Container    {{CellActivationFailure-IEs}},
    ...
}
CellActivationFailure-IEs X2AP-PROTOCOL-IES ::= {
    { ID id-Cause          CRITICALITY ignore   TYPE Cause
      PRESENCE mandatory }|
    { ID id-CriticalityDiagnostics CRITICALITY ignore TYPE CriticalityDiagnostics
      PRESENCE optional },
    ...
}

```

where:

```

Cause ::= CHOICE {
    radioNetwork      CauseRadioNetwork,
    transport         CauseTransport,
    protocol          CauseProtocol,
    qosSupport        QoSsupport,
    misc              CauseMisc,
    ...
}

```

where the response QoSSupport would indicate to the compensation cell 1 that the failure reason was lack of QoS support.

Turning now to Fig. 7, this figure is a schematic view illustrating a switch on scenario for an ES cell 2 in accordance with an embodiment of the invention, in which the signaling interaction is between the compensation cell 1 and an external status server/database entity 4. The external status server/database 4 may be implemented as an Operations, Administration, Maintenance and Provisioning

(OAM&P) entity (as described in 3GPP TS 32.551: "Energy Saving Management (ESM); Concepts and requirements") or as any external network operator or other third party deployed entity which provides energy saving configurations to the Radio Access Network or eNBs/cells.

5

This implementation may be used by the ES cell 2 to update the status database 4, before switching off, with its performance parameters and/or information regarding the Radio Access Stratum (RAS). The compensation cell 1 may then acquire this information by querying it from the status database 4. As shown in Fig. 7, the interface between the compensation cell 1 and the ES cell 2 is X2, and between the compensation cell 1 (and the ES cell 2, respectively) and the status database 4 the interface could be proprietary as well.

10

Fig. 8 shows a diagram of an embodiment of the signaling involved. It is assumed that before the ES cell switches off, it updates the database with its Radio Access Stratum (RAS) or QoS related parameters, as illustrated at 801. When the compensation cell 1, at 802, detects that a UE 3 being engaged in heavy data transfer enters the coverage area of the switched off ES cell 2, the compensation cell 1 sends a QoS support status query to the database 4, as illustrated at 803. It is noted that this QoS support status query could be sent over S1 interface as well, using related signaling messages.

15

20

Based on the information retrieved from the status database 4, the compensation cell 1, at 804, evaluates whether the switched off ES cell 2 can support the QoS requirements. Based on the outcome of this evaluation, the cell activation procedure continues according to current standard definitions with signaling steps 805-807, which have already been described in connection with the embodiment of Fig. 4. It is noted that the additional conditions, e.g. for mobility state and service requests, mentioned in connection with the embodiment of Fig. 5, where these conditions particularly include the radio access and backhaul related parameters as well as mobility related parameters, may equally be applied in the present embodiment, although not explicitly shown.

25

30

The above-mentioned embodiments are equally applicable while a compensation cell sends an activation message to an ES cell in dormant mode as well. Basically, the information exchanged should provide energy saving cells and compensation cells to take energy saving actions more efficiently, as mentioned in the distributed decision making approach mentioned earlier. The embodiments are also applicable for all types of cells, and are not limited to the information exchange between small cells and macro cells, and could include information exchange between macro eNBs or cells or base stations as well as small eNBs, cells or base stations. Small cells could include femto cells, pico cells, micro cells, relays or any other cells which provide limited coverage area as compared to the compensation cell.

Generally, UE context information or other resource utilization, service request and other UE QoS related information could be exchanged between the compensation cell 1 and the ES cell 2 before switch ON action, using a newly defined X2 interface message or extending/reusing already defined information elements (IEs) thereby conveying UE/user subscription information (using established bearers, their relative priority information, etc.) to the ES cell 2. In certain embodiments the aggregate information of all UEs within the coverage region of the ES cell 2 is assumed to be communicated. The compensation cell 1 could communicate a subset of this information as well, depending on configured criteria. The ES cell 2 using this information, and based on pre-configurations from external entities (e.g., OAM, etc.), can decide whether to switch on or remain in its current state. When an ES cell 2 wants to switch off (for instance, based on load conditions or any other criteria pre-configured by, e.g., an OAM entity, or due to an autonomous decision made by the ES cell 2 itself), it will exchange the aforementioned information such as aggregated UE load, UE context or UE QoS information with neighboring compensation cell(s) 1 to which UE(s) 3 would be handed over and which could decide whether to allow the ES cell 2 to switch off or not. The compensation cell 1 could take the decision by analyzing the information provided by the ES cell 2 in terms of whether it can handle all (or a subset) of the UEs 3 that would be handed over in terms of load or any other criteria such as GBR/non-GBR (Guaranteed Bit Rate) bearer establishments, backhaul link conditions, etc. The compensation cell 1 could take this decision autonomously, or based on pre-configured semi-static criteria, e.g., from OAM or other external entities out of the network. This gives operators better control over

the state of the network during energy saving state. The transmit power control mechanisms and handover mechanisms could be done based on pre-configurations (for e.g. by OAM) or in distributed autonomous manner where eNBs take such actions.

5

In case multiple CS cells would compensate for an ES cell after entering dormant/deactivated state, the ES cell could exchange the information with the concerned cells, e.g. based on measurement reports from the UEs. The ES cell could exchange aggregated UE QoS related information with the strongest cell in the UE measurement report which could be the potential CS cell to which UE would be handed over when the ES cell enters energy saving state. Information exchange could also be performed with cells configured by OAM, or with all the neighboring cells of an ES cell. As shown in Fig. 9, where ES cells are indicated by dotted lines, while CS cells are indicated by solid lines, since UE-1 is in proximity to CS Cell-1, ES Cell-2 should exchange the UE information with CS Cell-1 while entering energy saving state. For small cells, the coverage macro cell could be the potential target CS cell for information exchange.

An embodiment of ES cell switch ON and OFF actions is illustrated in Fig. 10. In this embodiment optionally OAM 5 or other external entities configure the energy saving state related parameters to the CS/ES cells 1, 2.

The switch ON procedure, as illustrated in the left part of Fig. 10, is implemented as follows:

25

The CS cell(s) 1, based on its/their load conditions, UE proximity to ES cells 2, pre-configured conditions (such as time-of-day, etc.) or due to any other autonomous criteria, decides to activate the ES cell 2 (step 1). The CS cell or cells 1 exchange UE context information with the ES cell 2 in dormant state (step 2). This could contain any of the load, QoS, context information, etc. mentioned earlier, which the ES cell 2 can use to decide whether to activate or not. The information could be exchanged in a modified load information message with new procedure code and reusing existing IEs or defining new IEs (step 2). Based on this information and depending on pre-configurations of UE priority, load conditions for switch ON, etc.,

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the ES cell 2 could decide whether to activate or not (step 3). This information could be informed to CS cell or cells 1 (step 4). Steps 5, 6 and 7 consider actions to be taken once this decision is made and, finally, UEs are handed over to the ES cell 2 once all other actions are completed.

5

The switch OFF procedure, as illustrated in the right part of Fig. 10, is implemented as follows:

10 In step 1, the ES cell 2, based on the OAM 5 or other external entity configurations, decides whether it can handover UEs to neighboring cells and switch off. The ES cell 2 could take this decision based on neighbor cell load information exchange as well. But the ES cell 2 cannot estimate the potential load caused by handed over UEs to CS cell 1, nor whether the CS cell 1 would accept all UEs while doing the handover to enter the dormant state. For this, the ES cell 2 exchanges (the
15 aggregated) UE QoS and related information using a new procedure code in the load information message or any other message (step 2). The CS cell or cells 1 decide whether it/they can allow the ES cell 2 to enter dormant state and whether it/they can accept all the handed over UEs or a subset of them. The decision could be made using OAM configurations, etc. (Step 3). This decision information is
20 exchanged as a (positive/negative) response message or using a new message (step 4). The ES cell 2, based on the reply/replies from CS Cell/cells 1, decides whether to switch off or not (step 5). The decision is informed to the CS cells 1 explicitly or by starting the energy saving state transition procedures (transmit power ramping, handovers, etc.). Due to the proactive UE context exchange in step 2,
25 possible RLF/HOF (Radio Link Failure/Hand Over Failure) recovery could be faster since CS cells 1 are aware of this information (steps 6, 7, 8).

In both cases, i.e. switch on and switch off, by exchanging information between the CS Cell 1 and the ES cell 2, as described above, UEs can be handed over in a
30 controlled manner from CS cell to ES cell, and vice versa, while the ES cell is transitioning from/to energy saving state.

As can be seen from the embodiment of Fig. 10, there could be multiple CS/ES cells involved in the information exchange using aggregated messaging as well. Such

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embodiments basically cover mechanisms described in previous embodiments and generalize the applicability for different scenarios, enabling CS/ES cells entering/leaving energy saving state to make better decisions. This also ensures that during state transitions UEs in connected state are not dropped, or the bearers already established are not torn down due to resource limitations as well. Hence, the method according to the invention in general and this embodiment in particular will ensure that user quality of experience is not affected or is affected at most in a manner that can be controlled by the network operator. The information exchanged as part of UE QoS information exchange could be similar to the Handover Request related messages in 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRAN); Overall description; Stage 2", making it a pre-handover message information exchange for energy saving decision making purpose. The related information elements and messages are documented in the above prior art document, which could be reused or modified.

It is noted that the QoS information exchange or any other related signaling messages could be sent over S1 interface as well. It is further noted that the parameters which could be sent are not restricted to the ones mentioned above. As will be appreciated by those skilled in the art, any information could be exchanged between the energy saving cell and the compensation cell to query its capabilities before switching ON the energy saving cell.

The following is a list of abbreviations, as employed herein:

Term	Description
BSR	Buffer Status Report
CAR	Cell Activation Request
CS Cell	Compensation Cell
eNB	Enhanced NodeB
ES Cell	Energy Saving Cell
E-UTRAN	Evolved Universal Terrestrial Radio Access Network
LTE-A	Long Term Evolution-Advanced

QoS	Quality of Service
RAB	RAudio Bearer
RF	Radio Frequency
RRC	Radio Resource Control
X2-AP	X2-Application Protocol
UE	User Equipment

Many modifications and other embodiments of the invention set forth herein will come to mind the one skilled in the art to which the invention pertains having the benefit of the teachings presented in the foregoing description and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

Claims

1. Method for operating a cellular radio access network, said network comprising a compensation cell (1) and at least one energy saving cell (2), wherein
5 the coverage area of said at least one energy saving cell (2) is at least partly covered by the coverage area of said compensation cell (1),
c h a r a c t e r i z e d i n that said compensation cell (1), while said at least one energy saving cell (2) is either in an energy saving mode or partly or fully in a switched off state, detects when a mobile station (3) enters the coverage area of
10 said at least one energy saving cell (2), and that, prior to deciding on an activation of said at least one energy saving cell (2), performance parameters of said at least one energy saving cell (2) are acquired by said compensation cell (1) and/or exchanged between said compensation cell (1) and said at least one energy saving cell (2).
- 15 2. Method according to claim 1, wherein the performance parameters of said at least one energy saving cell (2) acquired by said compensation cell (1) include at least one of QoS supported by said at least one energy saving cell (2), the amount of radio resources and/or radio access spectrum available at said at least one energy saving cell (2), and/or the operational state and/or capacity of the backhaul
20 interface of said at least one energy saving cell (2).
3. Method according to claim 1 or 2, wherein the process of acquiring and/or exchanging with said at least one energy saving cell (2) the performance parameters of said at least one energy saving cell (2) is triggered according to
25 predefined criteria, preferably by considering the number of mobile stations (3) that enter the coverage area of said at least one energy saving cell (2).
4. Method according to any of claims 1 to 3, wherein said compensation cell (1) analyzes the performance demands, including at least one of QoS, subscription
30 profile or traffic requirements, of the mobile station (3) entering the coverage area of said at least one energy saving cell (2).
5. Method according to any of claim 1 to 4, wherein said compensation cell (1) activates said at least one energy saving cell (2) only in case the performance

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parameters of said at least one energy saving cell (2) satisfy the performance demands of the mobile station (3) entering the coverage area of said at least one energy saving cell (2).

- 5 6. Method according to any of claims 1 to 5, wherein said compensation cell (1) activates said at least one energy saving cell (2) only in case the performance demands of the mobile station (3) entering the coverage area of said at least one energy saving cell (3) exceed a predefined threshold.
- 10 7. Method according to any of claims 1 to 6, wherein said compensation cell (1) analyzes the mobility state of the mobile station (3) entering the coverage area of said at least one energy saving cell (2), and activates said at least one energy saving cell (2) only in case the moving speed of the mobile station (3) is below a predefined threshold.
- 15 8. Method according to any of claims 1 to 7, wherein said compensation cell (1) acquires the performance parameters by querying said at least one energy saving cell (2), preferably by sending a query request via the X2-interface.
- 20 9. Method according to any of claims 1 to 8, wherein said compensation cell (1) acquires the performance parameters by said at least one energy saving cell (2) quickly waking up and sending a short information burst to a mobile station (3) located in the coverage area of said at least one energy saving cell (2).
- 25 10. Method according to any of claims 1 to 9, wherein said compensation cell (1) acquires the performance parameters by retrieving them from a status database (4), where said at least one energy saving cell (2) updates said status database (4) with its Radio Access Stratum and/or its performance parameters prior to entering an energy saving mode or prior to switch off.
- 30 11. Method according to any of claims 1 to 10, wherein said at least one energy saving cell (2) is being activated by said compensation cell (1) sending a cell activation request to said at least one energy saving cell (2).

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12. Method according to any of claims 1 to 11, wherein performance demands of mobile stations (3) located within and/or entering the coverage area of said least one energy saving cell (2) are included in the cell activation request.

13. Method according to any of claims 1 to 12, wherein said least one energy saving cell (2) sends a cell activation response in case it can support the performance demands indicated in the cell activation request, and sends a cell activation failure information otherwise.

14. Cellular radio access network, preferably for executing a method according to any of claims 1 to 13, comprising a compensation cell (1) and at least one energy saving cell (2), wherein the coverage area of said at least one energy saving cell (2) is at least partly covered by the coverage area of said compensation cell (1), characterized in that said compensation cell (1) is configured to detect, while said at least one energy saving cell (2) is either in an energy saving mode or partly or fully in a switched off state, when a mobile station (3) enters the coverage area of said at least one energy saving cell (2), and wherein said compensation cell (1) is further configured, prior to deciding on an activation of said at least one energy saving cell (2), to acquire and/or exchange with said at least one energy saving cell (2) performance parameters of said at least one energy saving cell (2).

15. Network according to claim 14, wherein said at least one energy saving cell (2) is a femto cell, a pico cell, a micro cell, a relay cell or any cell with a limited coverage area as compared to the compensation cell.

16. Network according to claim 14 or 15, further comprising a status database (4) that is configured to store updates received from said at least one energy saving cell (2) regarding the Radio Access Stratum and/or the performance parameters of said at least one energy saving cell (2).

17. Network according to claim 16, wherein said status database (4) is implemented on an OAMP (Operations, Administration, Maintenance and Provisioning) entity.

1/10

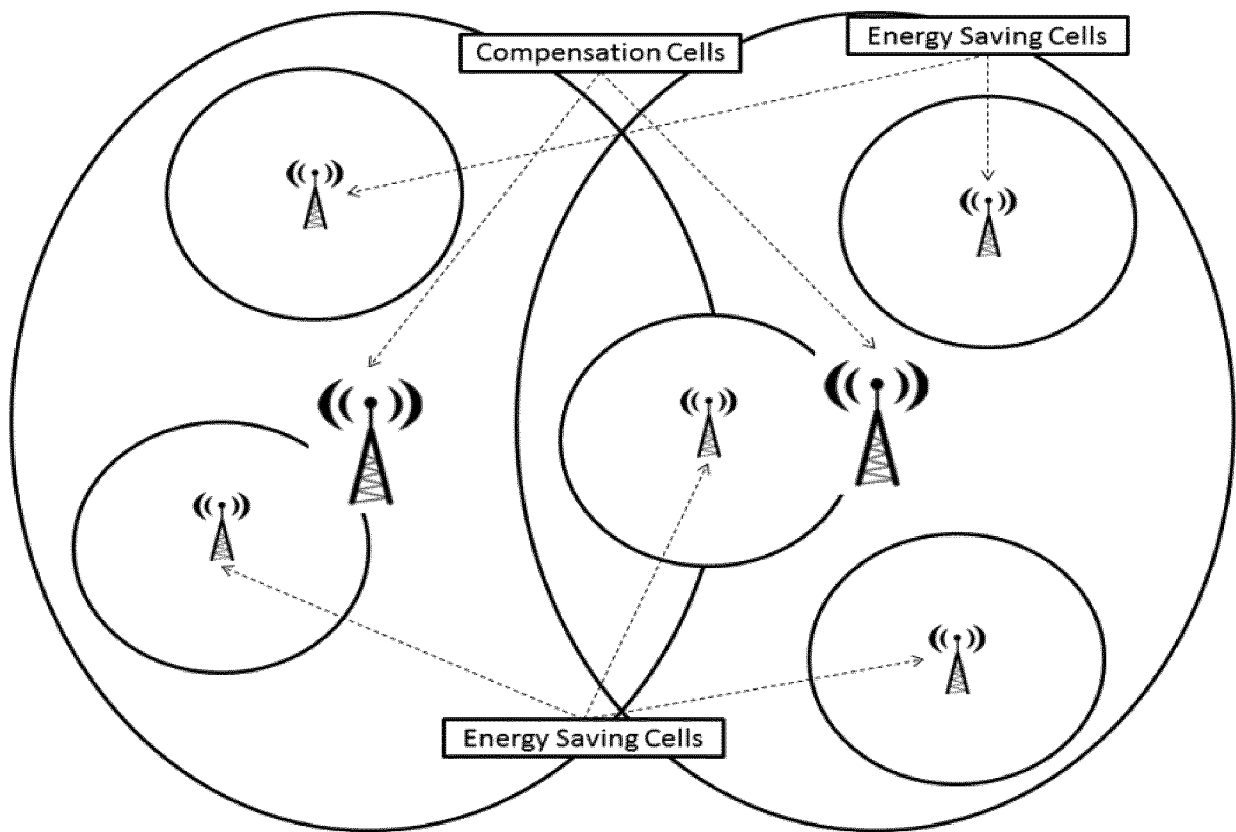


Fig. 1

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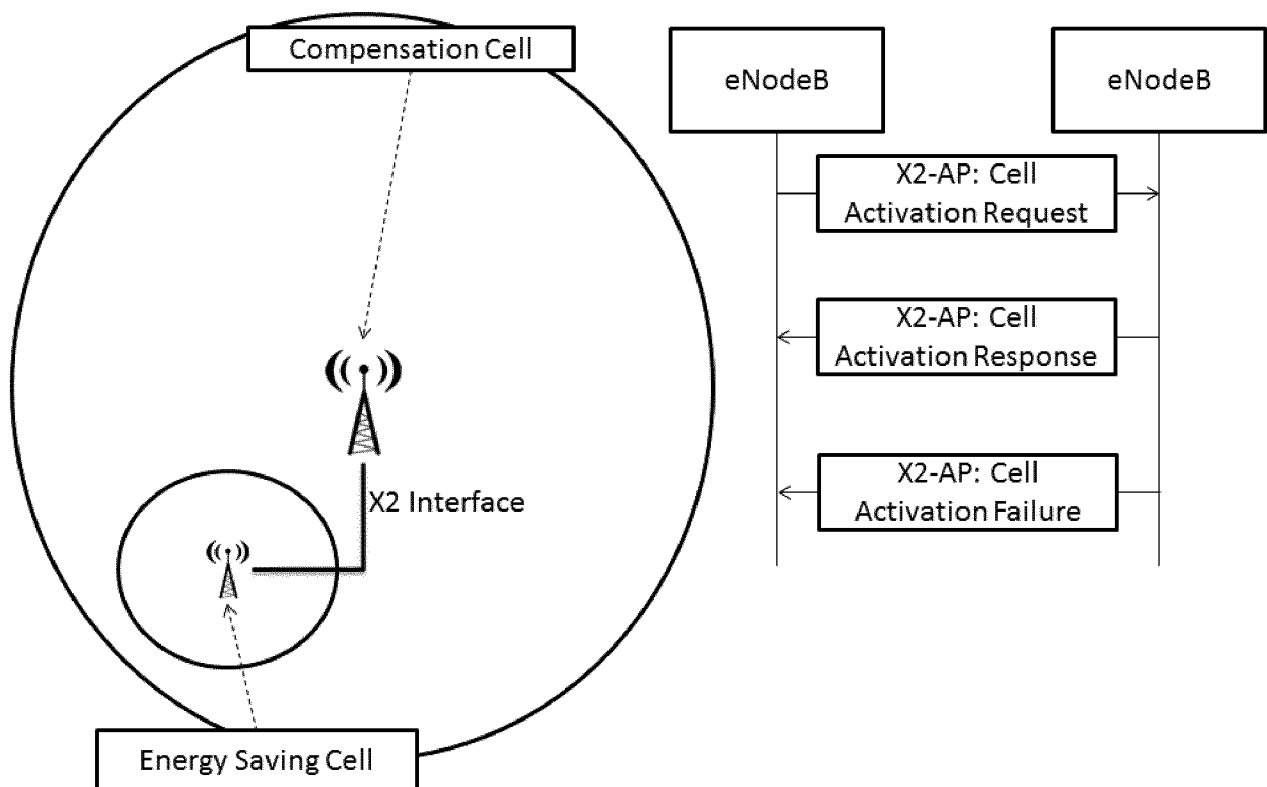


Fig. 2

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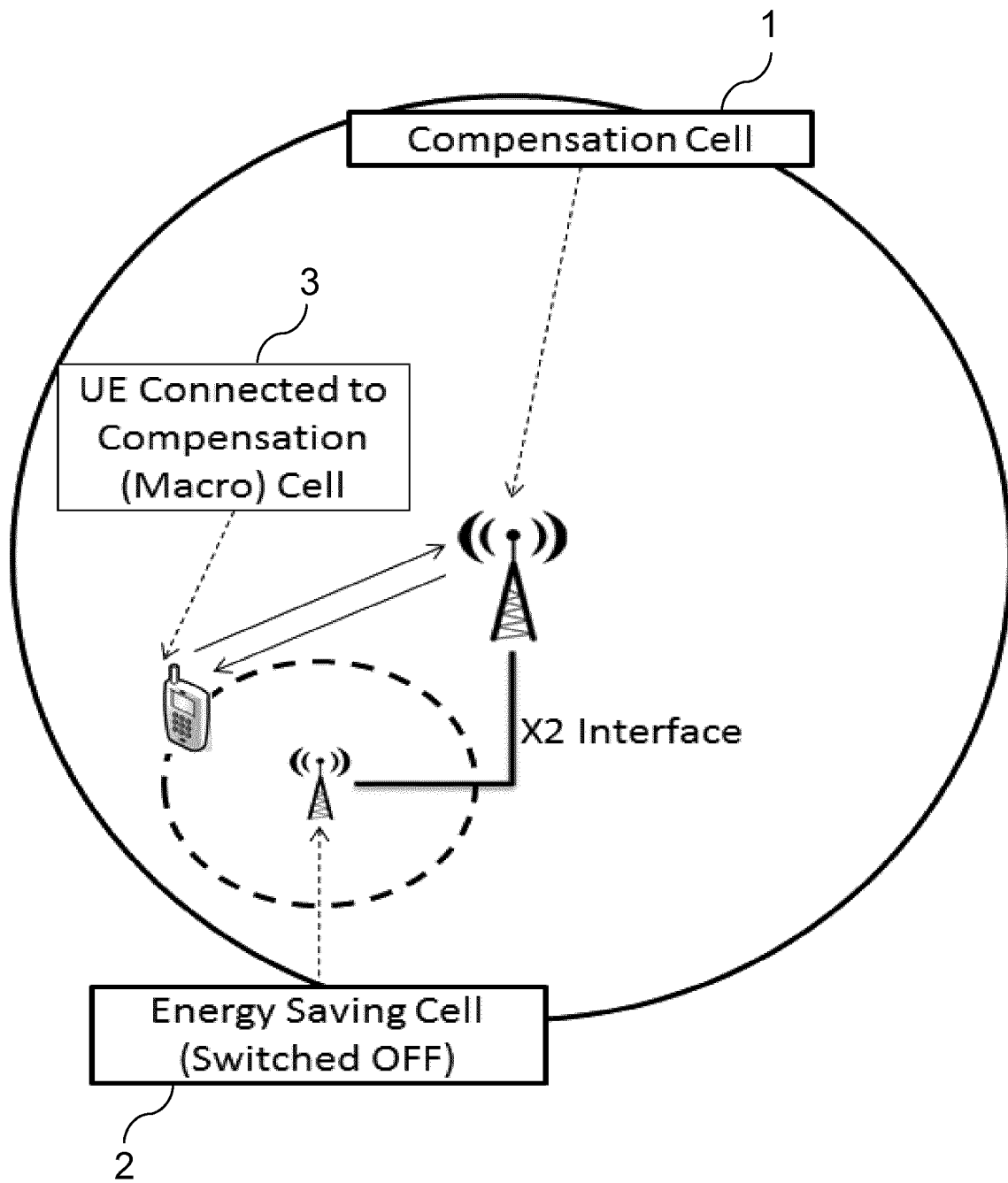


Fig. 3

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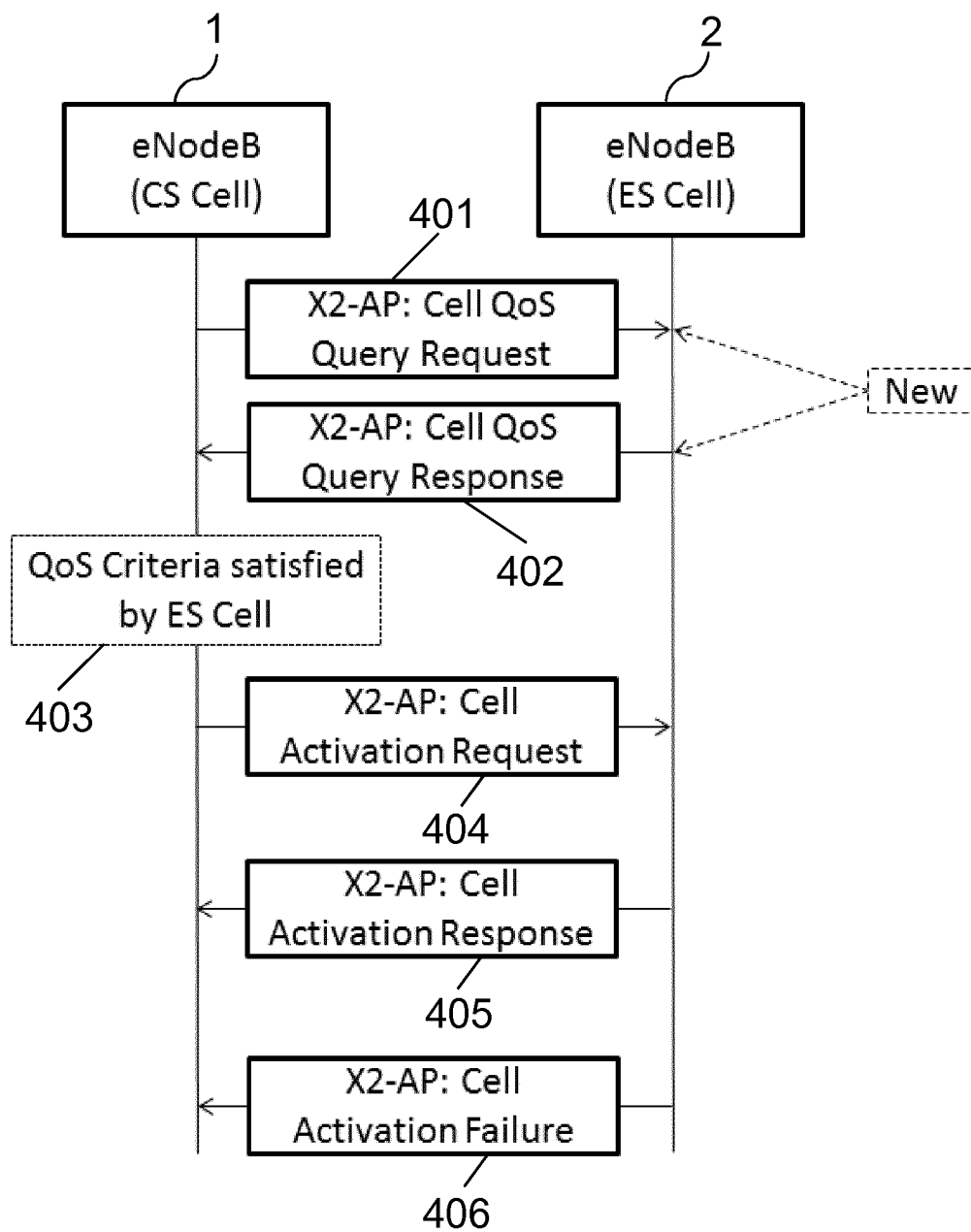


Fig. 4

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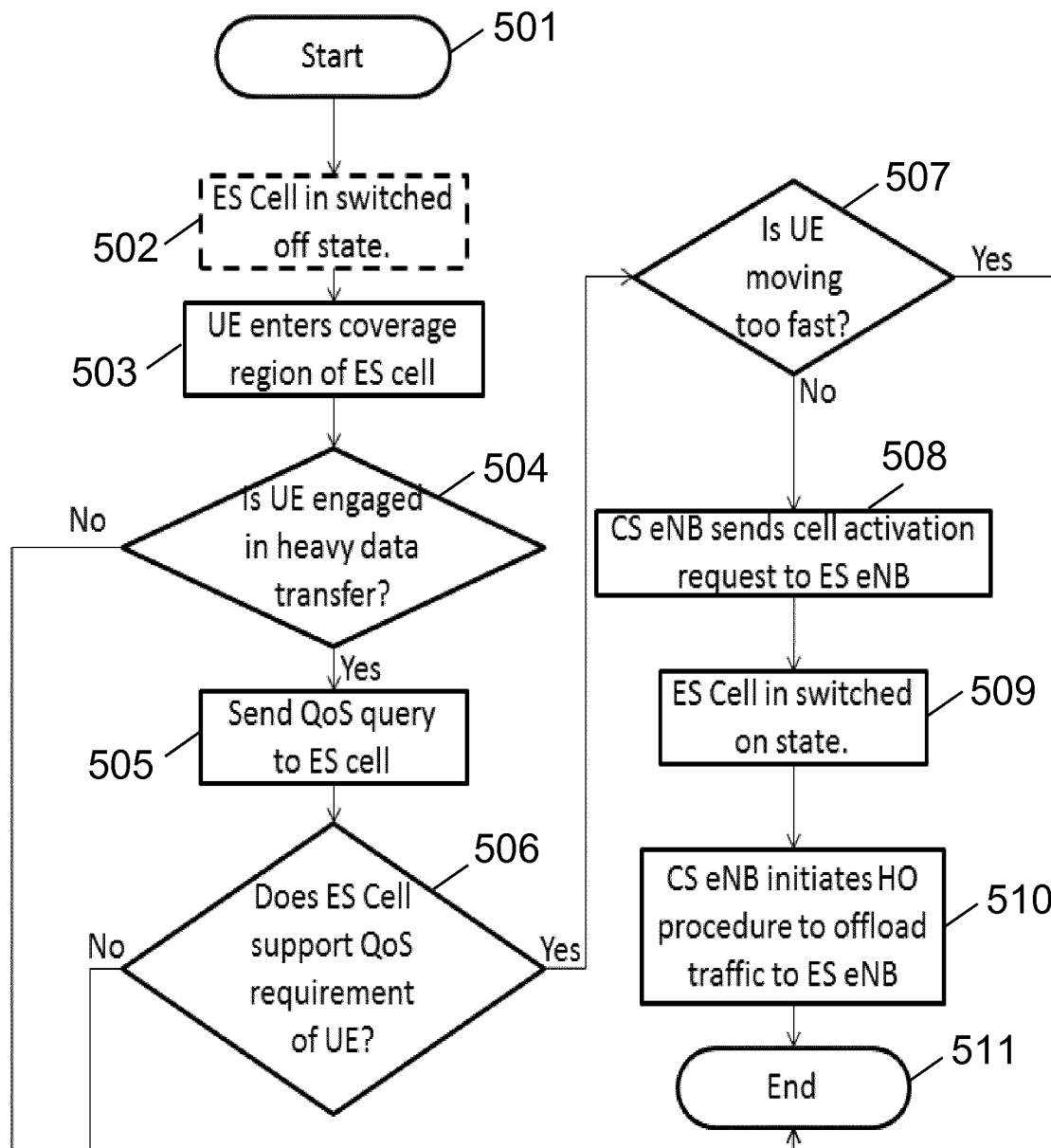


Fig. 5

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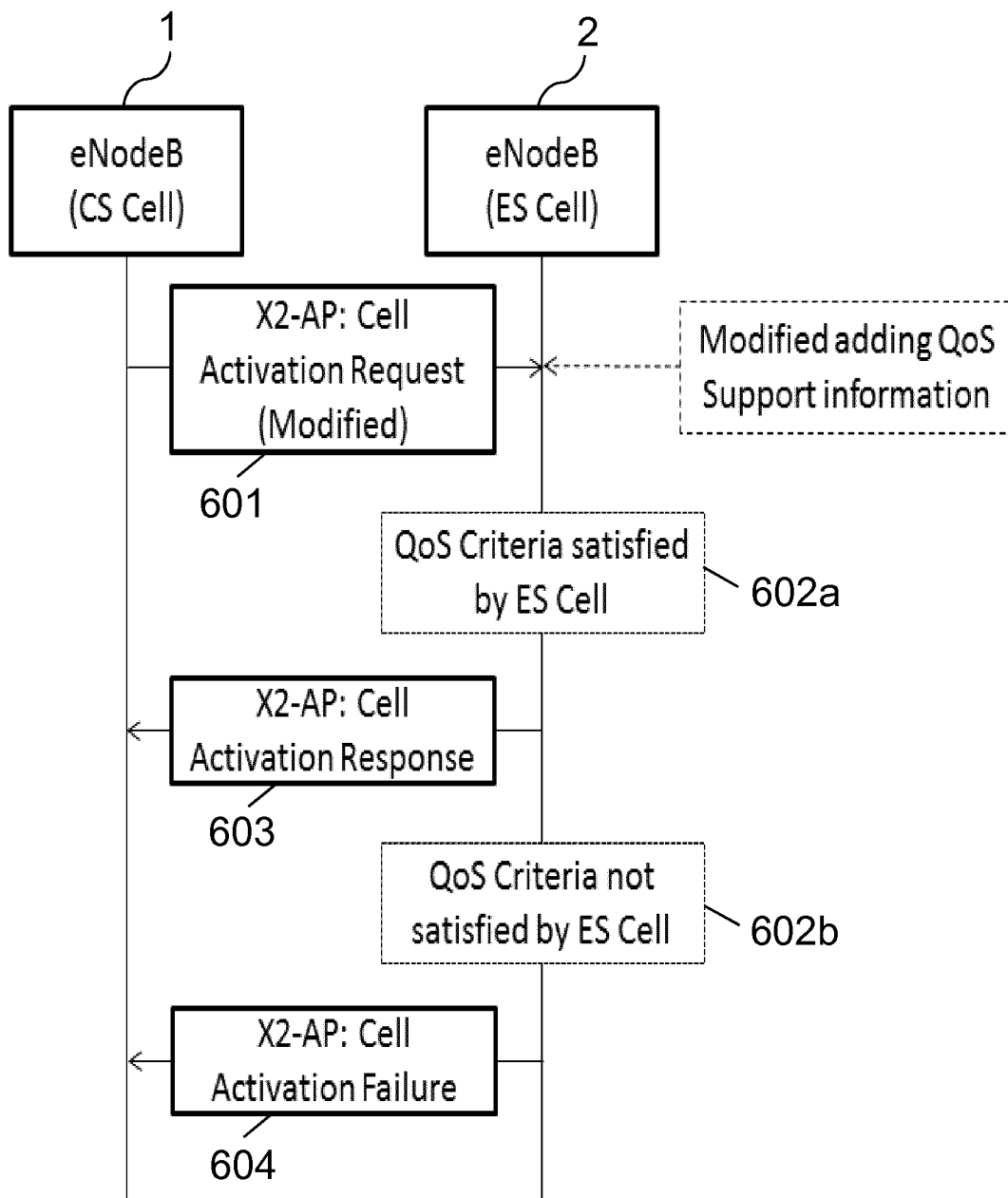


Fig. 6

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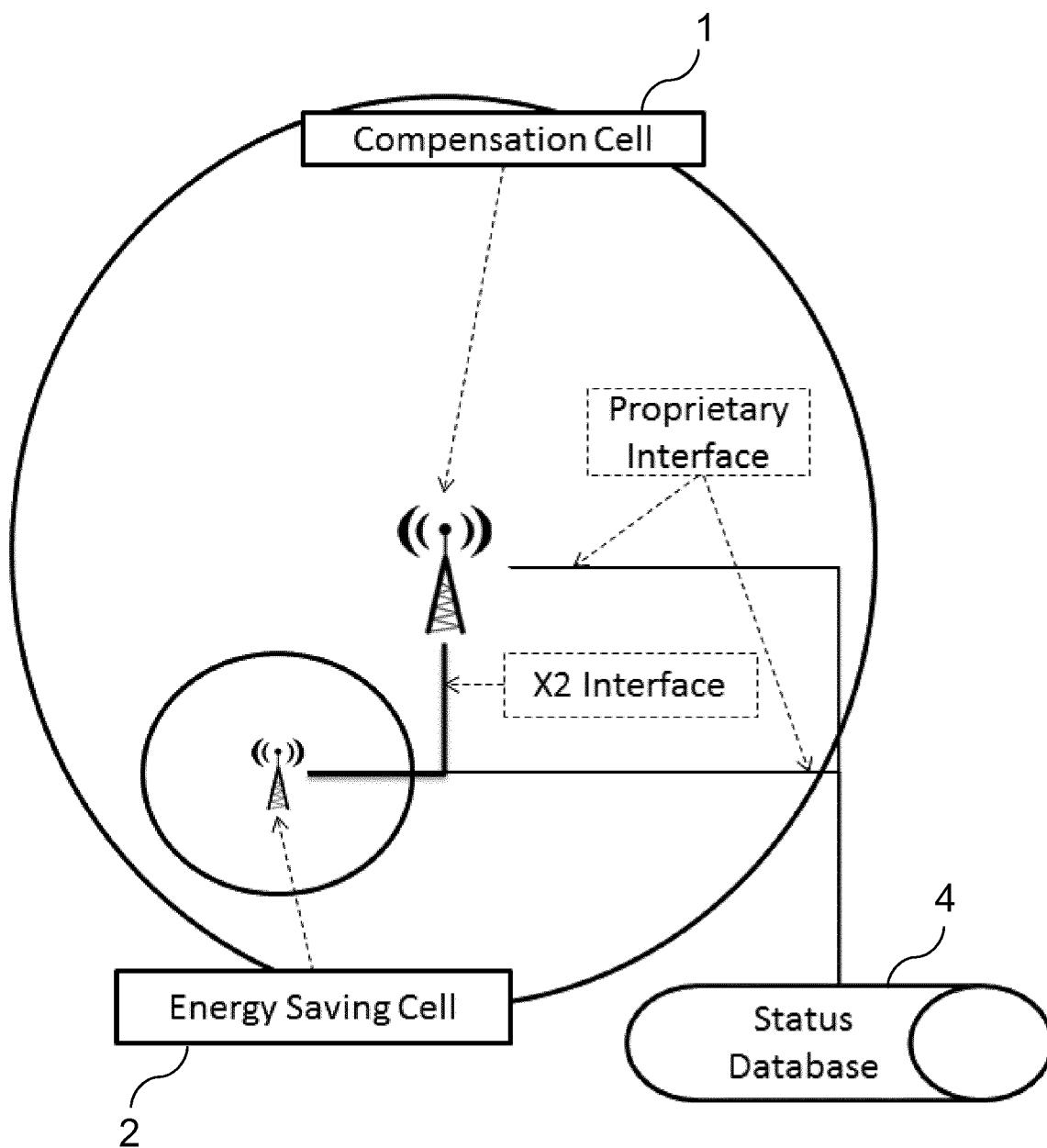


Fig. 7

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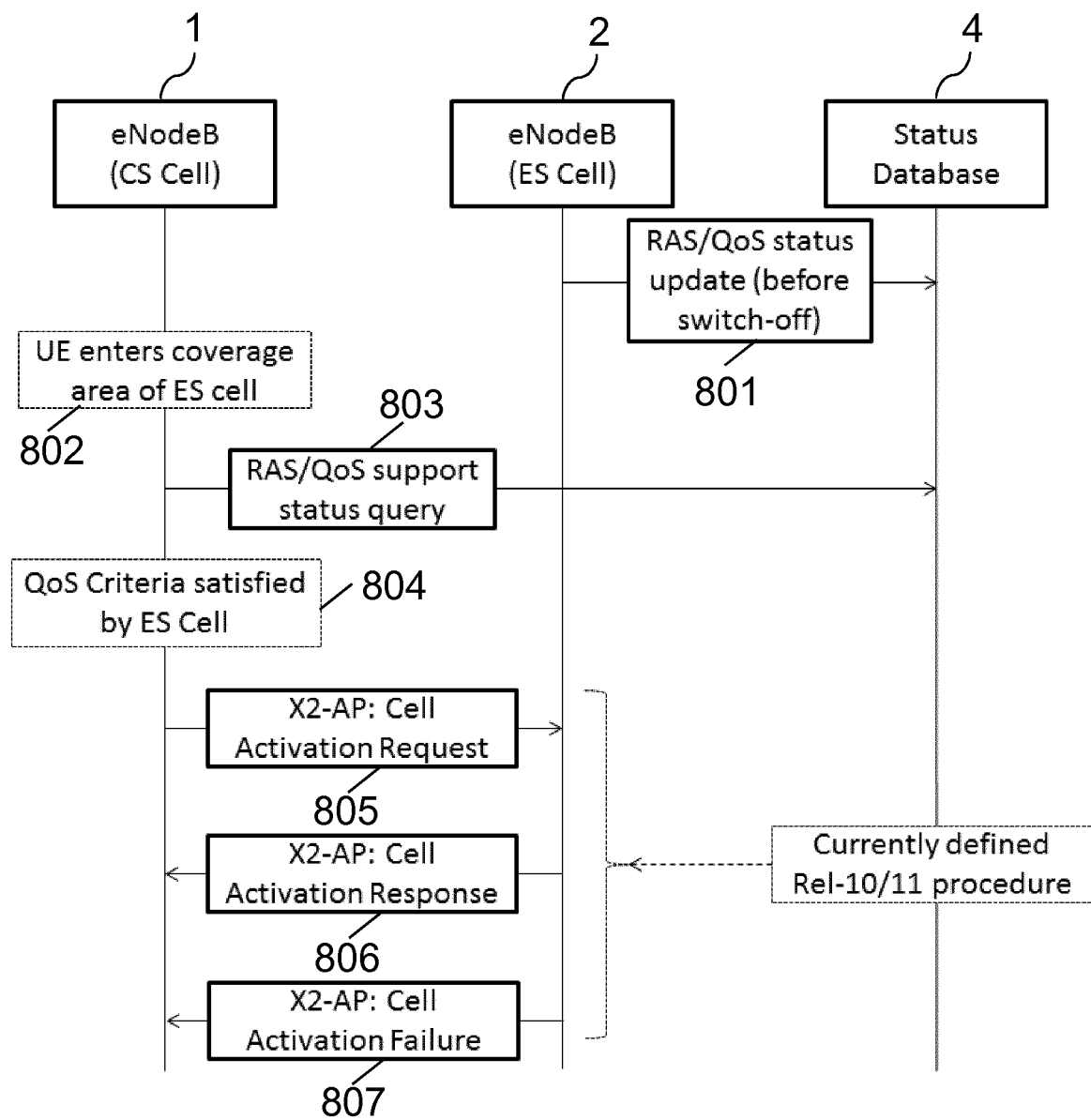


Fig. 8

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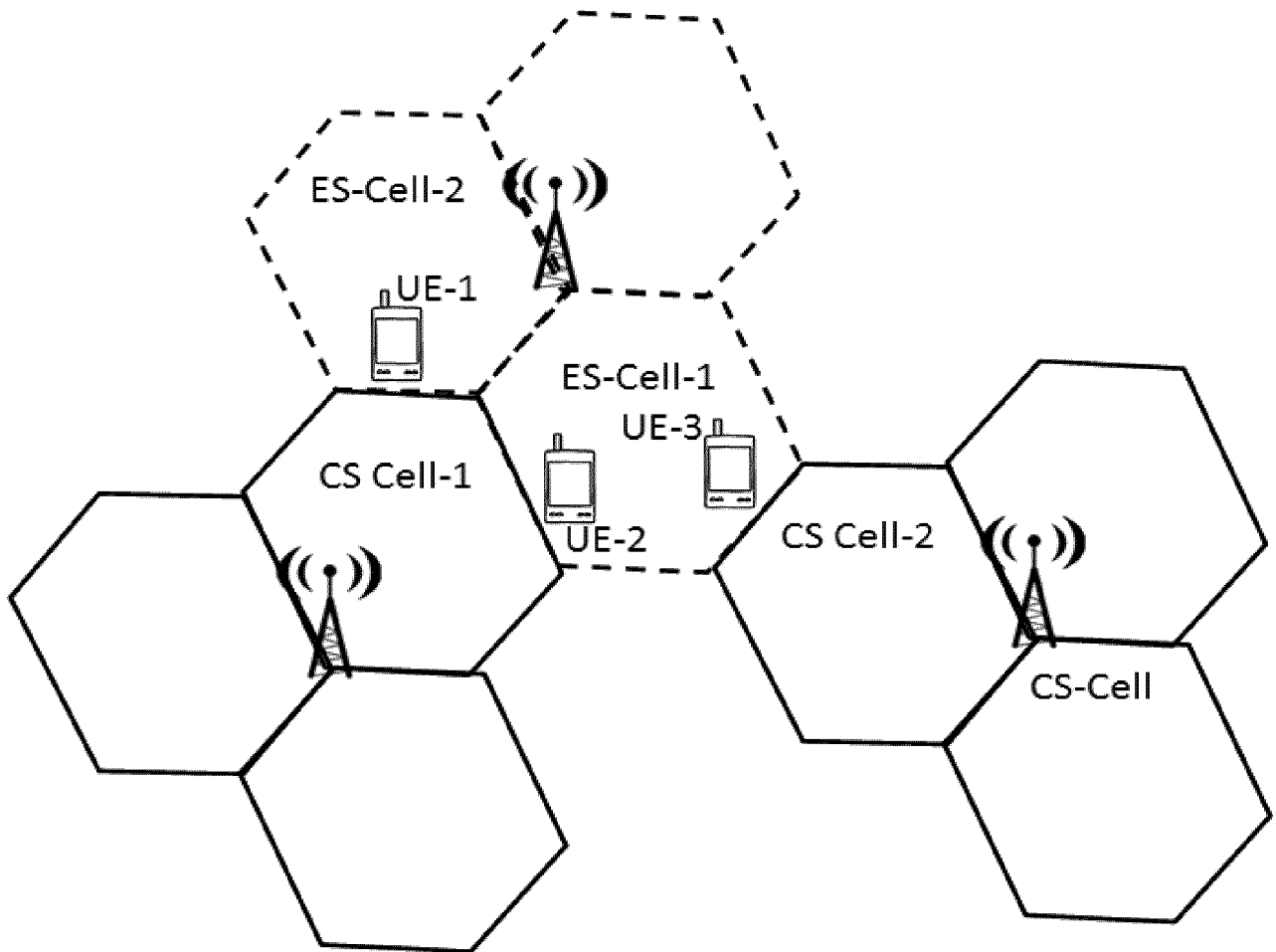


Fig. 9

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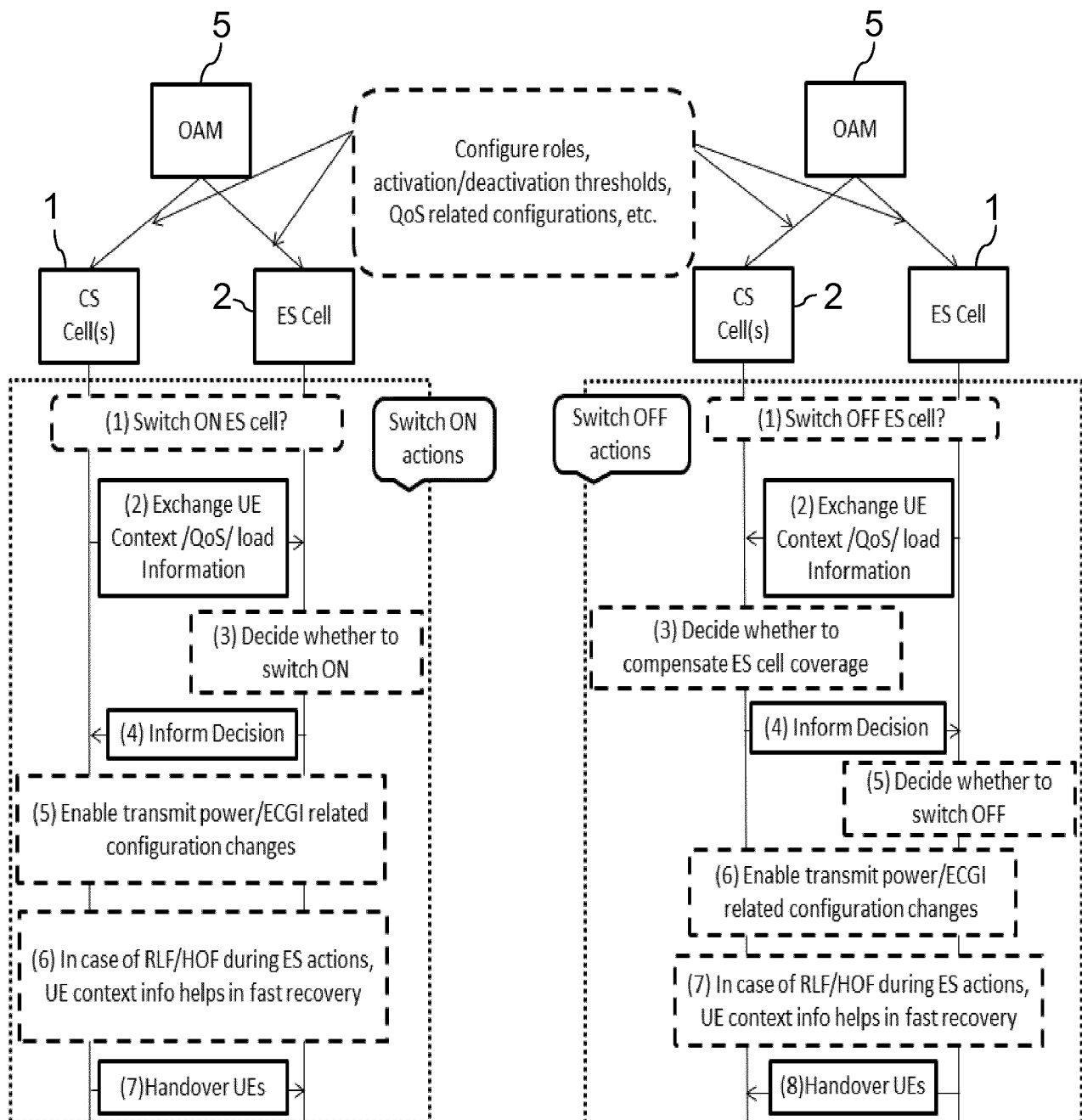


Fig. 10

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2014/056615

A. CLASSIFICATION OF SUBJECT MATTER

INV. 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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/170466 A1 (KWUN JONG-HYUNG [KR]) 14 July 2011 (2011-07-14)	1-6,8-17
A	paragraphs [0014] - [0023] figures 1-7	7
	paragraphs [0038] - [0157] -----	
X	US 2011/044284 A1 (VOLTOLINA ELENA [SE] ET AL) 24 February 2011 (2011-02-24)	1-17
	paragraphs [0008] - [0017] figures 1-14	
	paragraphs [0035] - [0152] -----	
X	EP 2 566 258 A1 (CHINA ACADEMY OF TELECOMM TECH [CN]) 6 March 2013 (2013-03-06)	1-6,8-17
A	paragraphs [0003] - [0019] figures 1-9	7
	paragraphs [0030] - [0115] -----	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"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

30 June 2014

Date of mailing of the international search report

04/07/2014

Name and mailing address of the ISA/

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Fax: (+31-70) 340-3016

Authorized officer

Schmid, Andreas

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2014/056615

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