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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/696,267	12/08/2015	9210590	12-1172-WO-US	9957

20306 7590 11/18/2015

MCDONNELL BOEHNEN HULBERT & BERGHOFF LLP
300 S. WACKER DRIVE
32ND FLOOR
CHICAGO, IL 60606

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 283 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Ljupco Jorguseski, The Hague, NETHERLANDS;
Remco Litjens, Voorschoten, NETHERLANDS;
Haibin Zhang, The Hague, NETHERLANDS;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

20306 7590 08/07/2015
MCDONNELL BOEHNEN HULBERT & BERGHOFF LLP
300 S. WACKER DRIVE
32ND FLOOR
CHICAGO, IL 60606

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/696,267	11/05/2012	Ljupco Jorguseski	12-1172-WO-US	9957

TITLE OF INVENTION: Method and Telecommunications Infrastructure for Activating an Inactive Cell

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	11/09/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
GESESSE, TILAHUN	2649	455-524000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 McDonnell Boehnen Hulbert
2 & Berghoff LLP
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE	(B) RESIDENCE: (CITY and STATE OR COUNTRY)
Koninklijke KPN N.V.	The Hague, Netherlands
Nederlandse Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek TNO	Delft, Netherlands

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
- ☒ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 13-2490 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
  NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
  NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ☐ Applicant changing to regular undiscounted fee status.
  NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /David A. Grabelsky/ Date November 4, 2015

Typed or printed name David A. Grabelsky Registration No. 59,208

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Electronic Patent Application Fee Transmittal

Application Number:	13696267
Filing Date:	05-Nov-2012
Title of Invention:	Method and Telecommunications Infrastructure for Activating an Inactive Cell
First Named Inventor/Applicant Name:	Ljupco Jorguseski
Filer:	David A. Grabelsky/Holly Mueller
Attorney Docket Number:	12-1172-WO-US

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl Issue Fee	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**960**

Electronic Acknowledgement Receipt

EFS ID:	23982023
Application Number:	13696267
International Application Number:	
Confirmation Number:	9957
Title of Invention:	Method and Telecommunications Infrastructure for Activating an Inactive Cell
First Named Inventor/Applicant Name:	Ljupco Jorguseski
Customer Number:	20306
Filer:	David A. Grabelsky
Filer Authorized By:	
Attorney Docket Number:	12-1172-WO-US
Receipt Date:	04-NOV-2015
Filing Date:	05-NOV-2012
Time Stamp:	12:29:04
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$960
RAM confirmation Number	8761
Deposit Account	132490
Authorized User	GRABELSKY, DAVID ANDREW

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. 1.492 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	12_1172_WO_US_IssueFee.pdf	91038 ea693c2beca6443ec49386e61c594fa0faad669b	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30782 5367de4d97997bd0bdcec1a83d4c56cb58f0e6a2	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	121820		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

20306 7590 08/07/2015

MCDONNELL BOEHNEN HULBERT & BERGHOFF LLP
300 S. WACKER DRIVE
32ND FLOOR
CHICAGO, IL 60606

EXAMINER
GESESSE, TILAHUN

ART UNIT	PAPER NUMBER
2649	

DATE MAILED: 08/07/2015

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/696,267	11/05/2012	Ljupco Jorguseski	12-1172-WO-US	9957

TITLE OF INVENTION: Method and Telecommunications Infrastructure for Activating an Inactive Cell

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	11/09/2015

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

20306 7590 08/07/2015
MCDONNELL BOEHNEN HULBERT & BERGHOFF LLP
300 S. WACKER DRIVE
32ND FLOOR
CHICAGO, IL 60606

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Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/696,267	11/05/2012	Ljupco Jorguseski	12-1172-WO-US	9957

TITLE OF INVENTION: Method and Telecommunications Infrastructure for Activating an Inactive Cell

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	11/09/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
GESESSE, TILAHUN	2649	455-524000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

ERICSSON EXHIBIT 1002, Page 8

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/696,267	11/05/2012	Ljupco Jorguseski	12-1172-WO-US	9957

20306 7590 08/07/2015

MCDONNELL BOEHNEN HULBERT & BERGHOFF LLP
300 S. WACKER DRIVE
32ND FLOOR
CHICAGO, IL 60606

EXAMINER	
GESESSE, TILAHUN	

ART UNIT	PAPER NUMBER
2649	

DATE MAILED: 08/07/2015

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 13/696,267	Applicant(s) JORGUSESKI ET AL.	
	Examiner TILAHUN B. GESESSE	Art Unit 2649	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *6/9/15*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-20*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov .
4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☒ All b) ☐ Some *c) ☐ None of the:
   1. ☒ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 3/31/15
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

1. The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Allowable Subject Matter

2. Claims 1-20 are allowed. The following is an examiner's statement of reasons for allowance: The prior art Subrahmanya (US 2010/0002614) does not transmitting a presence signal by, the at least one inactive cell; receiving measurement .reports from the plurality of terminals detecting the presence signal, the measurement reports indicating measurements of the presence signal by the plurality of terminals; processing information contained in the received measurement .reports in a processing system of the wireless access telecommunications infrastructure to provide a processing result; and activating the at least one inactive cell when the processing result fulfills at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the at least one activated cell (see applicant remarks page 8 third paragraph through page 12 dated 6/9/15).

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tilahun B. Gesesse whose telephone number is 571-272-7879. The examiner can normally be reached on flex.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Yuwen Pan can be reached on 571-272-7855. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Tilahun Gesesse/
Primary Examiner, Art Unit 2649

Notice of References Cited	Application/Control No. 13/696,267	Applicant(s)/Patent Under Reexamination JORGUSESKI ET AL.	
	Examiner TILAHUN B. GESESSE	Art Unit 2649	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-8,121,093	02-2012	Chen, Teming	370/331
*	B	US-2010/0093355	04-2010	Voyer et al.	455/436
*	C	US-2012/0094661	04-2012	Frenger et al.	455/434
*	D	US-2014/0302856	10-2014	Nory et al.	455/437
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
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	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
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	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

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BIB DATA SHEET

CONFIRMATION NO. 9957

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/696,267	11/05/2012 RULE	455	2649	12-1172-WO-US

APPLICANTS

INVENTORS

Ljupco Jorguseski, The Hague, NETHERLANDS;
Remco Litjens, Voorschoten, NETHERLANDS;
Haibin Zhang, The Hague, NETHERLANDS;

**** CONTINUING DATA ***************************

This application is a 371 of PCT/EP2011/057093 05/04/2011

**** FOREIGN APPLICATIONS ***************************

EUROPEAN PATENT OFFICE (EPO) 10162192.8 05/06/2010
EUROPEAN PATENT OFFICE (EPO) 10196958.2 12/24/2010
EUROPEAN PATENT OFFICE (EPO) 10187119.2 10/11/2010

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

11/16/2012

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /TILAHUN GESESSE/ Examiner's Signature	☐ Met after Allowance TG Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		NETHERLANDS	6	20	3

ADDRESS

MCDONNELL BOEHNEN HULBERT & BERGHOFF LLP
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32ND FLOOR
CHICAGO, IL 60606
UNITED STATES

TITLE

Method and Telecommunications Infrastructure for Activating an Inactive Cell

FILING FEE RECEIVED		
1140	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13696267	JORGUSESKI ET AL.
	Examiner	**Art Unit**
	TILAHUN B GESESSE	2649

CPC								
Symbol							**Type**	**Version**
H04W		24	/	02			F	2013-01-01
H04W		48	/	12			A	2013-01-01
H04W		52	/	0225			A	2013-01-01
H04W		52	/	0206			I	2013-01-01
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CPC Combination Sets									
Symbol					**Type**	**Set**	**Ranking**	**Version**
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NONE	8/5/15	**Total Claims Allowed:** 20	
(Assistant Examiner)	(Date)		
/TILAHUN B GESESSE/ Primary Examiner.Art Unit 2649	08/05/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13696267	JORGUSESKI ET AL.
	Examiner	**Art Unit**
	TILAHUN B GESESSE	2649

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
455	434	H	0	4	W	4 / 00 (2009.01.01)						
CROSS REFERENCE(S)		H	0	4	W	36 / 00 (2009.01.01)						

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
455	437	436	456.1		

NONE	8/5/15	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/TILAHUN B GESESSE/ Primary Examiner.Art Unit 2649	08/05/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13696267	JORGUSESKI ET AL.
	Examiner	**Art Unit**
	TILAHUN B GESESSE	2649

☒ **Claims renumbered in the same order as presented by applicant** ☐ **CPA** ☐ **T.D.** ☐ **R.1.47**

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NONE	8/5/15	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/TILAHUN B GESESSE/ Primary Examiner.Art Unit 2649	08/05/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13969267
Filing Date	2012-11-05
First Named Inventor	Ljupco JORGUSESKI
Art Unit	2649
Examiner Name	Gesesse, Tilahum
Attorney Docket Number	12-1172-WO-US

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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/T.G./	1	20110092212		2011-04-21	Kubota	

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13969267
	Filing Date	2012-11-05
	First Named Inventor	Ljupco JORGUSESKI
	Art Unit	2649
	Examiner Name	Gesesse, Tilahum
	Attorney Docket Number	12-1172-WO-US

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EXAMINER SIGNATURE

Examiner Signature	/Tilahun Gesesse/	Date Considered	07/31/2015

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13696267	JORGUSESKI ET AL.
	Examiner	**Art Unit**
	TILAHUN B GESESSE	2649

CPC- SEARCHED

Symbol	Date	Examiner
H094J11/0093	12/11/14	TG

CPC COMBINATION SETS - SEARCHED

Symbol	Date	Examiner
H04W48/08, H04W16/32, H04W84/105	12/11/14	TG

US CLASSIFICATION SEARCHED

Class	Subclass	Date	Examiner
455	450.1,550.1,453,452.2	12/11/14	TG

SEARCH NOTES

Search Notes	Date	Examiner
EAST	12/11/14	TG

INTERFERENCE SEARCH

US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
H04W48/12	H04W52/0225, H04W52/0206	8/5/15	TG

/TILAHUN B GESESSE/
Primary Examiner.Art Unit 2649

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
(Docket No. 12-1172-WO-US)

In re the Application of:	)	
	)	
Ljupeo Jorguseski et al.	)	
	)	**Examiner: Gesesse, Tilahun**
Serial No.: 13/696,267	)	
	)	**Art Unit: 2649**
Filed: November 5, 2012	)	
	)	**Confirmation No.: 9957**
	)	
For: Method and Telecommunications Infrastructure for Activating an Inactive Cell	)	

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

RESPONSE TO OFFICE ACTION MAILED DECEMBER 12, 2014

In response to the Office Action mailed December 12, 2014, Applicants submit the following amendments and remarks. In addition, a Petition for Extension of Time under 37 C.F.R. § 1.136(a) (three-month) is enclosed, along with requisite fees.

Amendments to the Claims begin on page 2 of this submission.

Remarks begin on page 8 of this submission.

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Amendments to the Claims

1. (Currently amended) A method for activating at least one inactive cell in a wireless access telecommunications infrastructure, the wireless access telecommunications infrastructure comprising an active cell containing a plurality of terminals, the method comprising:

transmitting a presence signal [[in]] by the at least one inactive cell;

receiving measurement reports from the plurality of terminals detecting the presence signal, the measurement reports indicating measurements of the presence signal by the plurality of terminals;

processing information contained in the received measurement reports in a processing system of the wireless access telecommunications infrastructure to provide a processing result; and

activating the at least one inactive cell when the processing result fulfills at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the at least one activated cell.

2. (Currently amended) The method according to claim 1, further comprising:

terminating transmission of the presence signal [[in]] by the at least one inactive cell when the processed information does not fulfill the at least one activation condition; and

transmitting the presence signal in the at least one inactive cell again at a later time.

3. (Previously presented) The method according to claim 1, further comprising providing the plurality of terminals in the active cell with at least one of measurement

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parameters or reporting parameters to obtain the information regarding the presence signal from the inactive cell.

4. (Previously presented) The method according to claim 1, wherein

the wireless access telecommunications infrastructure comprises a plurality of inactive cells; and

the method further comprises concurrently or sequentially transmitting the presence signal in the plurality of inactive cells.

5. (Previously presented) The method according to claim 1, wherein the at least one activation condition includes at least one of energy reduction for the wireless access telecommunications infrastructure, load reduction for the active cell, or reduction of electromagnetic radiation from the wireless access telecommunications infrastructure or from a particular set of cells in the infrastructure.

6. (Previously presented) The method according to claim 1, further comprising transmitting a reporting identifier in at least one of the active cell or the at least one inactive cell.

7. (Currently amended) The method according to claim 1,

wherein at least one of the plurality of terminals in the active cell is an idle terminal when receiving the measurement report.

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8. (Previously presented) The method according to claim 7, further comprising temporarily decreasing a location area update period in at least one of the active cell or the at least one inactive cell.

9. (Currently amended) The method according to claim 7, wherein the measurement reports are received via the active cell.

10. (Previously presented) The method according to claim 7, further comprising transmitting a paging message in the active cell instructing the at least one idle terminal to obtain or report the information.

11. (Currently amended) A non-transitory computer-readable medium having instructions stored thereon that, ~~computer program comprising software code portions configured,~~ when executed by one or more processing units, cause the one or more processing units to perform functions for activating at least one inactive cell in a wireless access telecommunications infrastructure, the wireless access telecommunications infrastructure comprising an active cell containing a plurality of terminals, the functions comprising:

transmitting a presence signal [[in]] by the at least one inactive cell;

receiving measurement reports from the plurality of terminals detecting the presence signal, wherein the measurement reports indicate measurements of the presence signal by the plurality of terminals;

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processing information contained in the measurement reports received from the plurality of terminals in a processing system of the wireless access telecommunications infrastructure to provide a processing result; and

activating the inactive cell when the processing result fulfills at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

12. (Currently amended) A wireless access telecommunications infrastructure for a wireless access telecommunications system comprising an active cell and at least one inactive cell, the active cell comprising a plurality of terminals, the wireless access telecommunications infrastructure comprising:

a presence signal generator configured for transmitting a presence signal in the at least one inactive cell;

a receiver configured for receiving measurement reports from the plurality of terminals detecting the presence signal, wherein the measurement reports indicate measurements of the presence signal by the plurality of terminals;

a processor system configured for processing information contained in the measurement reports received from the plurality of terminals to provide a processing result; and

an activator configured for activating the inactive cell when the processing result fulfills at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

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13. (Previously presented) The wireless access telecommunications infrastructure according claim 12, wherein the presence signal generator is further configured for:

terminating transmission of the presence signal in the at least one inactive cell when the processed information does not fulfill the at least one activation condition; and

transmitting the presence signal in the at least one inactive cell again at a later time.

14. (Previously presented) The wireless access telecommunications infrastructure according to claim 12, further comprising a signal transmitted in a cell of the wireless access telecommunication system, wherein the signal contains a reporting identifier indicating that the cell is an inactive cell.

15. (Previously presented) The wireless access telecommunications infrastructure according to claim 14, further comprising a terminal configured for processing the signal.

16. (Previously presented) The wireless access telecommunications infrastructure according to claim 12, wherein the presence signal generator is further configured for providing the plurality of terminals in the active cell with at least one of measurement parameters or reporting parameters to obtain the information regarding the presence signal from the inactive cell.

17. (Previously presented) The wireless access telecommunications infrastructure according to claim 12, wherein

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the presence signal generator is further configured for transmitting the presence signal in the plurality of inactive cells, and wherein the wireless access telecommunications infrastructure further comprises a plurality of inactive cells.

18. (Previously presented) The wireless access telecommunications infrastructure according to claim 12, wherein the presence signal generator is further configured for transmitting a reporting identifier in at least one of the active cell or the inactive cell.

19. (Previously presented) The wireless access telecommunications infrastructure according to claim 12, wherein the at least one activation condition includes at least one of energy reduction for the wireless access telecommunications infrastructure, load reduction for the active cell, or reduction of electromagnetic radiation from the wireless access telecommunications infrastructure or from a particular set of cells in the infrastructure.

20. (Currently amended) The wireless access telecommunications infrastructure according to claim 12, wherein at least one of the plurality of terminals in the active cell is an idle terminal when receiving the measurement report.

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Remarks

1. Summary of the Office Action

In the Office Action mailed December 12, 2014 ("Current Office Action," hereinafter), the Examiner rejected claim 11 under 35 U.S.C. § 101 as being allegedly directed to non-statutory subject matter. The Examiner rejected claims 1-7, 9-18, and 20 under pre-AIA 35 U.S.C. § 102(a) as being allegedly anticipated by U.S. Patent Application Pub. No. 2010/0002614 (Subrahmanya). The Examiner also rejected claims 8 and 19 under pre-AIA 35 U.S.C. § 103(a) as being allegedly unpatentable over Subrahmanya in view of U.S. Patent No. 8,467,798 (Lee).

2. Status of the Claims

Claims 1-20 are currently pending in the application. Of these claims, claims 1, 11 and 12 are independent and the remainder are dependent. Applicants have amended various claims as follows.

Applicants have amended each of claims 1, 11, and 12 to describe the recited "transmitting" as being carried out "by the at least one inactive cell." Applicants have also amended these claims to describe the recited "reports" as "measurement reports," where the "measurement reports" indicate "indicating measurements of the presence signal by the plurality of terminals." In addition, Applicants have amended claim 11 to replace the "software" with a "non-transitory computer-readable medium." Support for these amendments can be found generally throughout the original application, and specifically at least at page 6, lines 25-31; page 7, lines 29-32; page 8, lines 21-23; page 17, lines 30-32; page 4, lines 22-25; and page 16, lines 8-20, for example.

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Applicants have amended each of claims 2, 7, 9, and 20 to ensure consistency of antecedent basis with their respective base claims.

No new matter has been introduced by way of any of the above amendments.

3. Response to Rejections under 35 U.S.C. § 101

The Examiner rejected claim 11 under 35 U.S.C. § 101 as being allegedly directed to non-statutory subject matter. Applicants submit that the amendment to claim 11 described above overcomes this rejection, and respectfully request that the Examiner withdraw the rejection of claim 11 under 35 U.S.C. § 101.

4. Response to Rejections under 35 U.S.C. § 102(a)

The Examiner rejected claims 1-7, 9-18, and 20 under pre-AIA 35 U.S.C. § 102(a) as being allegedly anticipated by Subrahmanya. Applicants submit that Subrahmanya fails to teach each and every element set forth in any of claims 1-7, 9-18, or 20, and that these claims are allowable. Applicants first address claim 1, and subsequently address claims 2-7, 9-18, and 20.

Subrahmanya does not teach "transmitting a presence signal by the at least one inactive cell"

and

"receiving measurement reports from the plurality of terminals detecting the presence signal, the measurement reports indicating measurements of the presence signal by the plurality of terminals"

On page 3 of the Current Office Action, the Examiner cited to paragraphs [0072] and [0075] in Subrahmanya as teaching "transmitting a presence signal in the at least one inactive cell." In the cited paragraphs, Subrahmanya discloses "the macro network may transmit a wake-up signal or the like to the AP base station" and "method 800 may involve receiving a wake-up signal transmitted from the macro network," for example. It therefore appears that the Examiner

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has identified the "wake-up signal" in Subrahmanya with the "presence signal" recited in claim 1.

However, Subrahmanya teaches transmitting the "wake-up signal" *to* an "AP base station," while claim 1 recites "transmitting a presence signal *by* the at least one inactive cell" (emphasis added). Thus, even assuming for the sake of argument that the "AP base station" is analogous to the "at least one inactive cell" recited in claim 1, it is clear that the "wake-up signal" in Subrahmanya cannot be the "presence signal" recited in claim 1, since the "wake-up signal" and the "presence signal" are transmitted in opposite directions with respect to the "AP base station"/ "at least one inactive cell."

At most, Subrahmanya discloses (paragraph [0067]) "common channels may be channels that AP base station 502 is required to transmit in order to allow ATs to detect and/or connect to AP base station 502 … common channels may include but are not limited to synchronization channels, pilot or reference signals, and broadcast channels." However, assuming, again for the sake of argument, that the any of these signals or channels can be considered as analogous to the "presence signal" recited in claim 1, Subrahmanya still does not teach or disclose "receiving measurement reports from the plurality of terminals detecting the presence signal, *the measurement reports indicating measurements of the presence signal by the plurality of terminals*" (emphasis added). Indeed, the term "measurement" or "measure" or the like does not appear even once in Subrahmanya. Moreover, to the extent that Subrahmanya discloses anything about a quantity that might be interpreted as measureable, such as a "power level," it is only to teach that an "AP base station" may adjust its power level based on the presence of "access terminals (ATs)" (e.g., paragraphs [0008] and [0066]). But Subrahmanya simply does not teach

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that such a quantity is measured by "a plurality of terminals," much less received in "measurement reports from the plurality of terminals."

Accordingly, Applicants submit that Subrahmanya does not anticipate at least the above-mentioned limitations of claim 1.

Subrahmanya does not teach "processing information contained in the received measurement reports in a processing system of the wireless access telecommunications infrastructure to provide a processing result"

For at least the reason that Subrahmanya does not teach "receiving measurement reports from the plurality of terminals detecting the presence signal, the measurement reports indicating measurements of the presence signal by the plurality of terminals," it follows that Subrahmanya cannot teach "processing information contained in the received measurement reports in a processing system of the wireless access telecommunications infrastructure to provide a processing result." But even beyond this reason, Subrahmanya teaches (paragraph [0065]) that a "presence component 504 may determine the presence of at least one AT associated (e.g. registered) with AP base station 502." However, Subrahmanya provides no details about how such presence is determined. And Subrahmanya certainly does not teach or disclose "processing information contained in" *anything* received from an AT, much less in "measurement reports."

Accordingly, Applicants submit that Subrahmanya does not anticipate at least the above-mentioned limitation of claim 1.

Subrahmanya does not teach "activating the at least one inactive cell when the processing result fulfills at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the at least one activated cell"

For at least the reason that Subrahmanya does not teach "processing information contained in the received measurement reports in a processing system of the wireless access telecommunications infrastructure to provide a processing result," it follows that Subrahmanya

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TELEPHONE (312) 913-0001

cannot teach "activating the at least one inactive cell when the processing result fulfills at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the at least one activated cell."

Accordingly, Applicants submit that Subrahmanya does not anticipate at least the above-mentioned limitation of claim 1.

For at least the reasons above, Applicants respectfully submit that Subrahmanya does not anticipate claim 1, and that claim 1 is therefore allowable.

Each of claims 11 and 12 include, *inter alia*, limitations similar to those of claim 1 discussed above. Applicants therefore submit that each of claims 11 and 12 is allowable for at least the reasons that claim 1 is allowable.

Each of claims 2-7, 9-10, 13-18, and 20 depends from one of claims 1 or 12, both of which are allowable for at least the reasons discussed above. Applicants therefore submit that claims 2-7, 9-10, 13-18, and 20 are allowable for at least the reason that each depends from an allowable claim. Further, Applicants do not concede any of the Examiner's specific assertions with respect to any of claims 2-7, 9-10, 13-18, or 20.

5. Response to Rejections under 35 U.S.C. § 103(a)

The Examiner also rejected claims 8 and 19 under pre-AIA 35 U.S.C. § 103(a) as being allegedly unpatentable over Subrahmanya in view of Lee. Each of claims 8 and 19 depends from one of claims 1 or 12, both of which are allowable for at least the reasons discussed above. Applicants submit that claims 8 and 19 are allowable for at least the reason that each depends from an allowable claim. Further, Applicants do not concede any of the Examiner's specific assertions with respect to either of claims 8 or 19.

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6. Conclusion

For the foregoing reasons, Applicants submit that the claims are allowable. Therefore, Applicants request favorable reconsideration and allowance of the claims.

Applicants do not acquiesce in any assertion in the Current Office Action that is not expressly addressed by these remarks.

Should the Examiner wish to discuss this case with the undersigned, the Examiner is invited to call the undersigned at (312) 913-3353.

Respectfully submitted,

McDONNELL BOEHNEN HULBERT & BERGHOFF LLP

Dated: June 9, 2015

By: /David A. Grabelsky/
David A. Grabelsky
Reg. No. 59,208

McDONNELL BOEHNEN
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PTO/SB/22 (03-13)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): 12-1172-WO-US

Application Number: 13/696,267

Filed: November 5, 2012

For: Method and Telecommunications Infrastructure for Activating an Inactive Cell

Art Unit: 2649

Examiner: Gesesse, Tilahun

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☐ Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$
☑ Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$ 1,400
☐ Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐ Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 132490.

☐ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. 37 CFR 3.73(b) statement is enclosed (Form PTO/SB/96).

☑ attorney or agent of record. Registration number 59,208.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/David A. Grabelsky/ — Signature

June 9, 2015 — Date

David A. Grabelsky — Typed or printed name

312-913-3353 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☑ * Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	13696267
Filing Date:	05-Nov-2012
Title of Invention:	Method and Telecommunications Infrastructure for Activating an Inactive Cell
First Named Inventor/Applicant Name:	Ljupco Jorguseski
Filer:	David A. Grabelsky
Attorney Docket Number:	12-1172-WO-US

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 3 months with $0 paid	1253	1	1400	1400
Miscellaneous:				
			Total in USD ($)	**1400**

Electronic Acknowledgement Receipt

EFS ID:	22574068
Application Number:	13696267
International Application Number:	
Confirmation Number:	9957
Title of Invention:	Method and Telecommunications Infrastructure for Activating an Inactive Cell
First Named Inventor/Applicant Name:	Ljupco Jorguseski
Customer Number:	20306
Filer:	David A. Grabelsky
Filer Authorized By:	
Attorney Docket Number:	12-1172-WO-US
Receipt Date:	09-JUN-2015
Filing Date:	05-NOV-2012
Time Stamp:	12:20:43
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1400
RAM confirmation Number	10219
Deposit Account	132490
Authorized User	GRABELSKY, DAVID ANDREW

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. 1.492 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	12-1172-WO-US_Response_12Dec14_OA.pdf	146921 05d3fdc56e5ee6172e54144899ae374f4083dac1	no	13
Warnings:					
Information:					
2	Extension of Time	12-1172-WO-US_Petition_for_three-month_Extension_of_Time.pdf	187973 71b3ccac6e86cc40d5356b3505c33d21a8758729	no	2
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30967 97be1f7442cbc0d45945980b03cc12ce7bfe9322	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	365861		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/696,267	Filing Date 11/05/2012	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT **06/09/2015**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/EFREM WARREN/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13969267
Filing Date	2012-11-05
First Named Inventor	Ljupco JORGUSESKI
Art Unit	2649
Examiner Name	Gesesse, Tilahum
Attorney Docket Number	12-1172-WO-US

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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If you wish to add additional U.S. Patent citation information please click the Add button. Add

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20110092212		2011-04-21	Kubota	

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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13969267
	Filing Date	2012-11-05
	First Named Inventor	Ljupco JORGUSESKI
	Art Unit	2649
	Examiner Name	Gesesse, Tilahum
	Attorney Docket Number	12-1172-WO-US

	1		☐

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13969267
	Filing Date	2012-11-05
	First Named Inventor	Ljupco JORGUSESKI
	Art Unit	2649
	Examiner Name	Gesesse, Tilahum
	Attorney Docket Number	12-1172-WO-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David A. Grabelsky/	Date (YYYY-MM-DD)	2015-03-31
Name/Print	David A. Grabelsky	Registration Number	59,208

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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Electronic Patent Application Fee Transmittal

Application Number:	13696267
Filing Date:	05-Nov-2012
Title of Invention:	Method and Telecommunications Infrastructure for Activating an Inactive Cell
First Named Inventor/Applicant Name:	Ljupco Jorguseski
Filer:	David A. Grabelsky
Attorney Docket Number:	12-1172-WO-US

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	21933814
Application Number:	13696267
International Application Number:	
Confirmation Number:	9957
Title of Invention:	Method and Telecommunications Infrastructure for Activating an Inactive Cell
First Named Inventor/Applicant Name:	Ljupco Jorguseski
Customer Number:	20306
Filer:	David A. Grabelsky
Filer Authorized By:	
Attorney Docket Number:	12-1172-WO-US
Receipt Date:	31-MAR-2015
Filing Date:	05-NOV-2012
Time Stamp:	17:52:46
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
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Deposit Account	132490
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The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	12-1172-WO-US_Information_Disclosure_Statement_31Mar15.pdf	612099 bc504bbde7c3135c0a24f0d37c5449d5198363e6	no	4
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30757 16042ed69e6abbf33ee2d23ff0e60bbfa258210b	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	642856		

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/696,267	11/05/2012	Ljupco Jorguseski	12-1172-WO-US	9957

20306 7590 12/12/2014

MCDONNELL BOEHNEN HULBERT & BERGHOFF LLP
300 S. WACKER DRIVE
32ND FLOOR
CHICAGO, IL 60606

EXAMINER
GESESSE, TILAHUN

ART UNIT	PAPER NUMBER
2649	

MAIL DATE	DELIVERY MODE
12/12/2014	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 13/696,267	Applicant(s) JORGUSESKI ET AL.	
	Examiner TILAHUN B. GESESSE	Art Unit 2649	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 11/5/12.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) 1-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) 1-20 is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date 11/5/12.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

1. The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Claim Rejections - 35 USC § 101

2. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

3. Claim11 is rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter because the subject matter recited in claim 11 lines 1-2 " A computer program comprising software code portions configured, when executed one or more processing units. The computer program or software code executed one or more processing units is directed to non-statutory subject matter because the program or software code can be executed by the processing unit is only when the program or software code stored in non-transitory storage medium such as RAM or ROM etc. in order to perform the steps, hence claim 11, is rejected 35USC 101.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

5. Claims 1-7,9-18 and 20 are rejected under pre-AIA 35 U.S.C. 102(a) as being anticipated by Subrahmanya (US 2010/0002614).

Claim 1, Subrahmanya teach a method for activating at least one inactive cell in a wireless access telecommunications infrastructure, (see figures 1, 8A , 8B, and abstract where AT not present within coverage area (inactive cell), no response to wake-up signal or enter low power mode , paragraph 0073-0075] . Subrahmanya teach an active cell containing a plurality of terminals, (see paragraph 0072 and 0075] where serving area “active cell” and further Subrahmanya teaches receiving wakeup signal and ceasing operation in the low power mode and increase transmission power in response to receiving wakeup signal macro cell “ activating the inactive cell” (see figure 10B).Subrahmanya teach transmitting a presence signal in the at least one inactive cell (see paragraph 0072 and 0075] where neighboring cell are considered “inactive cell”. Subrahmanya teach receiving reports from the plurality of terminals detecting the presence signal (see fig. 8B flow # 840, 860, 962-866) where AT determined based on received report is within a serving cell. Subrahmanya teach processing information contained in the received reports in a processing system of the wireless access telecommunications infrastructure to provide a processing result (see figure 10A and para 0080-0081]. Subrahmanya teach activating the at least one inactive cell when the processing result fulfills at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the at least one activated cell (see fig. 8B flow # 840, 860, 962-866) where AT determined based on received report is within a serving cell. Claim 2, Subrahmanya teach terminating transmission of the presence

signal in the at least one inactive cell when the processed information does not fulfill the at least one activation condition (see figure 6 where AT present no enter low power mode " terminating transmission wake-up signal since no present signal reported.". Subrahmanya teach transmitting the presence signal in the at least one inactive cell again at a later Time (see figure 6 vary transmission power at function of time. Claim 3, Subrahmanya teach providing the plurality of terminals in the active cell with at least one of measurement parameters or reporting parameters to obtain the information regarding the presence signal from the inactive cell (see figure 1 , and 8A) where wake-up signal transmitted . Claim 4, Subrahmanya teach the wireless access telecommunications infrastructure comprises a plurality of inactive cells (see figure 1) where neighboring cell "in active cells", and the method further comprises concurrently or sequentially transmitting the presence signal in the plurality of inactive cells (see par 0082] where macro network transmit wake up signal. Claim 5. Subrahmanya teach the at least one activation condition includes at least one of energy reduction for the wireless access telecommunications infrastructure, reduction of electromagnetic radiation from the wireless access telecommunications infrastructure or from a particular set of cells in the infrastructure (see figure 6 where AT present no enter low power mode " reduction of electromagnetic radiation. Claim 6, Subrahmanya teach transmitting a reporting identifier in at least one of the active cell or the at least one inactive cell (see figs 8B item 862 and 10B item 1052 identification of at least one serving cell). Claims 7 and 9 Subrahmanya teach at least one of the plurality of terminals in the active cell is an idle terminal when gathering receiving the

report (see abstract) where at least one found idle terminal. Claim 10, Subrahmanya teach transmitting a paging message in the active cell instructing the at least one idle terminal to or report the information (see figure 8B receive broadcast channel or pilot signal to instruct wake up signal idle terminal. Claim 11, Subrahmanya teaches software executed by processor to perform (see figure 10A and 10B where 1008 and 1010 executes and stores the software to perform the steps of activating at least one inactive cell in a wireless access telecommunications infrastructure, (see figures 1, 8A , 8B, and abstract where AT not present within coverage area (inactive cell), no response to wake-up signal or enter low power mode , paragraph 0073-0075] . Subrahmanya teach an active cell containing a plurality of terminals, (see paragraph 0072 and 0075] where serving area “active cell” and further Subrahmanya teaches receiving wakeup signal and ceasing operation in the low power mode and increase transmission power in response to receiving wakeup signal macro cell “ activating the inactive cell” (see figure 10B).Subrahmanya teach transmitting a presence signal in the at least one inactive cell (see paragraph 0072 and 0075] where neighboring cell are considered “inactive cell”. Subrahmanya teach receiving reports from the plurality of terminals detecting the presence signal (see fig. 8B flow # 840, 860, 962-866) where AT determined based on received report is within a serving cell. Subrahmanya teach processing information contained in the received reports in a processing system of the wireless access telecommunications infrastructure to provide a processing result (see figure 10A and para 0080-0081]. Subrahmanya teach activating the at least one inactive cell when the processing result fulfills at least one activation condition such

that at least one of the plurality of terminals is within a coverage area of the at least one activated cell (see fig. 8B flow # 840, 860, 962-866) where AT determined based on received report is within a serving cell. Claims 12-13, 16-17, Subrahmanya teach a system for activating at least one inactive cell in a wireless access telecommunications infrastructure, (see figures 1, 8A , 8B, and abstract where AT not present within coverage area (inactive cell), no response to wake-up signal or enter low power mode , paragraph 0073-0075] . Subrahmanya teach an active cell containing a plurality of terminals, (see paragraph 0072 and 0075] where serving area “active cell” and further Subrahmanya teaches receiving wakeup signal and ceasing operation in the low power mode and increase transmission power in response to receiving wakeup signal macro cell “ activating the inactive cell” (see figure 10B). Subrahmanya teach transmitting a presence signal in the at least one inactive cell (see paragraph 0072 and 0075] where neighboring cell are considered “inactive cell”. Subrahmanya teach receiving reports from the plurality of terminals detecting the presence signal (see fig. 8B flow # 840, 860, 962-866) where AT determined based on received report is within a serving cell. Subrahmanya teach processing information contained in the received reports in a processing system of the wireless access telecommunications infrastructure to provide a processing result (see figure 10A and para 0080-0081]. Subrahmanya teach activating the at least one inactive cell when the processing result fulfills at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the at least one activated cell (see fig. 8B flow # 840, 860, 962-866) where AT determined based on received report is within a serving

cell. Claims 14-15 and 18 Subrahmanya teach transmitting a reporting identifier in at least one of the active cell or the at least one inactive cell (see figs 8B item 862 and 10B item 1052 identified at least one serving cell). Claim 20, Subrahmanya teach at least one of the plurality of terminals in the active cell is an idle terminal when gathering receiving the report (see abstract) where at least one found idle terminal.

Claim Rejections - 35 USC § 103

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 8 and 19 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Subrahmanya in view of Lee et al (US 8,467, 798).

Claims 8, 19 Subrahmanya does not teach load reduction for the active cell. However, Lee et al disclose cell selection and load balancing, reduce number of portable users selected in order to reduce load and changing the cell , when number of idle UEs activated the load balancing technique is to play load reduction in order to avoid from cutting off communication or drop communication due to insufficient resource (see column 5, lines 25-45 and figs 10 and 11). It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify Subrahmanya in load reduction by reducing the size of the cell , as disclosed by Lee,

in order to avoid from cutting off communication or drop communication due to insufficient resource.

Examiner Note: Examiner has cited particular columns and line numbers in the references as applied to the claims above for the convenience of the applicant. Although the specified citations are representative of the teachings of the art and are applied to the specific limitations within the individual claim, other passages and figures may apply as well. It is respectfully requested from the applicant in preparing responses, to fully consider the references in its entirety as potentially teaching of all or part of the claimed invention, as well as the context of the passage as taught by the prior art or disclosed by the examiner.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tilahun B. Gesesse whose telephone number is 571-272-7879. The examiner can normally be reached on flex.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Yuwen Pan can be reached on 571-272-7855. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only.

For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Tilahun Gesesse/
Primary Examiner, Art Unit 2649

Notice of References Cited	Application/Control No. 13/696,267	Applicant(s)/Patent Under Reexamination JORGUSESKI ET AL.	
	Examiner TILAHUN B. GESESSE	Art Unit 2649	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2010/0002614	01-2010	Subrahmanya, Parvathanathan	370/311
*	B	US-8,467,798	06-2013	Lee et al.	455/450
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13696267	JORGUSESKI ET AL.
	Examiner	Art Unit
	TILAHUN B GESESSE	2649

CPC- SEARCHED		
Symbol	Date	Examiner
H094J11/0093	12/11/14	TG

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner
H04W48/08, H04W16/32, H04W84/105	12/11/14	TG

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
455	450.1,550.1,453,452.2	12/11/14	TG

SEARCH NOTES		
Search Notes	Date	Examiner
EAST	12/11/14	TG

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

	/TILAHUN B GESESSE/ Primary Examiner.Art Unit 2649

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2012-11-05
First Named Inventor	Ljupco JORGUSESKI
Art Unit	TBA
Examiner Name	TBA
Attorney Docket Number	12-1172-WO-US

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
/T.G./	1	WO2010/002991	WO	A1	2010-01-07	Qualcomm Incorporated		☐
/T.G./	2	WO2009/140988	WO	A1	2009-11-26	Nokia Siemens Networks OY		☐
/T.G./	3	WO2008131588	WO	A1	2008-11-06	Huawei Technologies Co., Ltd.		☐

Receipt date: 11/05/2012	Application Number	13696267 - GAU: 2649
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	2012-11-05
	First Named Inventor	Ljupco JORGUSESKI
	Art Unit	TBA
	Examiner Name	TBA
	Attorney Docket Number	12-1172-WO-US

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
/T.G./	1	PCT International Search Report and Written Opinion, PCT International Application No. PCT/EP2011/057093 dated June 8, 2011.	☐
/T.G./	2	"Self Organizing Network - NEC's Proposals for Next-Generation Radio Network Management", White Paper, February 2009, NEC Corporation, pp. 1-5.	☐
/T.G./	3	"3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Universal Terrestrial Radio Access (UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Measurement Collection for Minimization of Drive Tests (MDT); Overall Description; Stage 2 (Release 10)", 3GPP TS 37.320, V10.0.0, December 2010, pp. 1-17.	☐
/T.G./	4	"3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Self-Configuring and Self-Optimizing Network (SON) Use Cases and Solutions (Release 9)", 3GPP TR 36.902 V9.1.0 (March 2010), pp. 1-23.	☐
/T.G./	5	European Search Report, European Patent Application No. 10162192.8, dated December 15, 2010.	☐
/T.G./	6	Mitsubishi Electric, "Dynamic Setup of HNBs for Energy Savings and Interference Reduction", 3GPP TSG RAN WG3 Meeting #61, Jeju Island, Korea, 18th-22nd August 2008, 7 pages.	☐
/T.G./	7	Ericsson, "Sustainable Energy for Mobile Communications", White Paper, June 2007, pp. 1-23.	☐

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EXAMINER SIGNATURE

Examiner Signature	/Tilahun Gesesse/	Date Considered	12/11/2014

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13696267	JORGUSESKI ET AL.
	Examiner	**Art Unit**
	TILAHUN B GESESSE	2649

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/11/2014								
	1	✓								
	2	✓								
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BIB DATA SHEET

CONFIRMATION NO. 9957

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/696,267	11/05/2012 RULE	455	2649	12-1172-WO-US

APPLICANTS

INVENTORS

Ljupco Jorguseski, The Hague, NETHERLANDS;
Remco Litjens, Voorschoten, NETHERLANDS;
Haibin Zhang, The Hague, NETHERLANDS;

**** CONTINUING DATA ***************************

This application is a 371 of PCT/EP2011/057093 05/04/2011

**** FOREIGN APPLICATIONS ***************************

EUROPEAN PATENT OFFICE (EPO) 10162192.8 05/06/2010
EUROPEAN PATENT OFFICE (EPO) 10196958.2 12/24/2010
EUROPEAN PATENT OFFICE (EPO) 10187119.2 10/11/2010

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

11/16/2012

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /TILAHUN GESESSE/ Examiner's Signature	☐ Met after Allowance TG Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		NETHERLANDS	6	20	3

ADDRESS

MCDONNELL BOEHNEN HULBERT & BERGHOFF LLP
300 S. WACKER DRIVE
32ND FLOOR
CHICAGO, IL 60606
UNITED STATES

TITLE

Method and Telecommunications Infrastructure for Activating an Inactive Cell

FILING FEE RECEIVED		
1140	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/696,267	11/05/2012	Ljupco Jorguseski	12-1172-WO-US

CONFIRMATION NO. 9957

20306
MCDONNELL BOEHNEN HULBERT & BERGHOFF LLP
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CHICAGO, IL 60606

PUBLICATION NOTICE

OC000000059581358

Title: Method and Telecommunications Infrastructure for Activating an Inactive Cell

Publication No.US-2013-0053091-A1
Publication Date:02/28/2013

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

U.S. APPLICATION NUMBER NO.	FIRST NAMED APPLICANT	ATTY. DOCKET NO.
13/696,267	Ljupco Jorguseski	12-1172-WO-US

20306
MCDONNELL BOEHNEN HULBERT & BERGHOFF LLP
300 S. WACKER DRIVE
32ND FLOOR
CHICAGO, IL 60606

INTERNATIONAL APPLICATION NO.	
PCT/EP2011/057093	
I.A. FILING DATE	PRIORITY DATE
05/04/2011	05/06/2010

CONFIRMATION NO. 9957
371 ACCEPTANCE LETTER

OC000000057678249

Date Mailed: 11/21/2012

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office in its capacity as a Designated / Elected Office (37 CFR 1.495), has determined that the above identified international application has met the requirements of 35 U.S.C. 371, and is ACCEPTED for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above and the relevant dates are:

11/05/2012	11/06/2012
DATE OF RECEIPT OF 35 U.S.C. 371(c)(1), (c)(2) and (c)(4) REQUIREMENTS	DATE OF COMPLETION OF ALL 35 U.S.C. 371 REQUIREMENTS

A Filing Receipt (PTO-103X) will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE " FILING DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1), (c)(2) and (c)(4) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN ABOVE.** *The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363).* Once the Filing Receipt has been received, send all correspondence to the Group Art Unit designated thereon.

The following items have been received:

- Copy of the International Application filed on 11/05/2012
- Copy of the International Search Report filed on 11/05/2012
- Copy of IPE Report filed on 11/05/2012
- Preliminary Amendments filed on 11/05/2012
- Information Disclosure Statements filed on 11/05/2012
- Oath or Declaration filed on 11/05/2012
- U.S. Basic National Fees filed on 11/05/2012
- Priority Documents filed on 11/05/2012

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

CHARITTA A SHELTON

Telephone: (571) 272-3926

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET

Substitute for Form PTO-1360
(For use with Form PTO/SB/06)

Application Number	Filing Date
13696267	

Applicant(s) Ljupco Jorguseski

* May be used for additional claims or amendments

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
1	1		1			
2		1		1		
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Total Indep	2		3		0	
Total Depend	14	↵	17	↵	0	↵
Total Claims	16		20		0	

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/696,267	11/05/2012		1140	12-1172-WO-US	20	3

CONFIRMATION NO. 9957

20306
MCDONNELL BOEHNEN HULBERT & BERGHOFF LLP
300 S. WACKER DRIVE
32ND FLOOR
CHICAGO, IL 60606

FILING RECEIPT

Date Mailed: 11/21/2012

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Ljupco Jorguseski, The Hague, NETHERLANDS;
Remco Litjens, Voorschoten, NETHERLANDS;
Haibin Zhang, The Hague, NETHERLANDS;

Applicant(s)

Ljupco Jorguseski, The Hague, NETHERLANDS;
Remco Litjens, Voorschoten, NETHERLANDS;
Haibin Zhang, The Hague, NETHERLANDS;

Assignment For Published Patent Application

KONINKLIJKE KPN N.V., The Hague, NL
Nederlandse Organisatie voor Toegepast- Natuurwetenschappelijk Onderzoek TNO, delft, NETHERLANDS

Power of Attorney: The patent practitioners associated with Customer Number 20306

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/EP2011/057093 05/04/2011

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
EUROPEAN PATENT OFFICE (EPO) 10162192.8 05/06/2010
EUROPEAN PATENT OFFICE (EPO) 10196958.2 12/24/2010
EUROPEAN PATENT OFFICE (EPO) 10187119.2 10/11/2010

If Required, Foreign Filing License Granted: 11/16/2012

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/696,267**

Projected Publication Date: 02/28/2013

Non-Publication Request: No

Early Publication Request: No
Title

Method and Telecommunications Infrastructure for Activating an Inactive Cell

Preliminary Class

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage, facilitate, and accelerate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/696,267

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	390
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	500
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 62 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 250 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1140

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Method and telecommunications infrastructure for activating an inactive cell

the specification of which is attached hereto unless the following space is checked:

X was filed on 5 November 2012 as United States Application Serial Number 13/696,267

hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 (including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application).

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT international application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s):

	Number	Country	Day/Month/Year Filed
1.	10162192.8	EP	06/05/2010
2.	10187119.2	EP	11/10/2010
3.	10196958.2	EP	24/12/2010
4.	PCT/EP2011/057093	WO	04/05/2011

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

	Application Number	Filing Date
1.		

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or § 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

I hereby appoint the practitioners associated with the Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and I direct that all correspondence be addressed to that Customer Number.

ERICSSON EXHIBIT 1002, Page 75

Customer Number: **020306**
Principal attorney or agent: Bradley Hulbert
Telephone number: 312-913-0001

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

The undersigned hereby authorize and request the attorneys of record in said application to insert in this declaration and power of attorney the filing date and serial number of said application when officially known, if the specification is not attached hereto.

Full name of first inventor: Ljupco Jorguseski

Inventor's signature: _____ Date: 13-11-202

Residence: Jozef Israellaan 234, 2282 TR The Hague, The Netherlands
Citizenship: The Netherlands
Post Office Address: Jozef Israellaan 234, 2282 TR The Hague, The Netherlands

Full name of second inventor: Remco Litjens

Inventor's signature: _____ Date: 7-11-12

Residence: Van Kempenstraat 22, 2352 VH Voorschoten, The Netherlands
Citizenship: The Netherlands
Post Office Address: Van Kempenstraat 22, 2352 VH Voorschoten, The Netherlands

Full name of third inventor: Haibin Zhang

Inventor's signature: _____ Date: 07-11-12

Residence: Usselincxstraat 142, 2593 VP The Hague, The Netherlands
Citizenship: China
Post Office Address: Usselincxstraat 142, 2593 VP The Hague, The Netherlands

ERICSSON EXHIBIT 1002, Page 76

Electronic Acknowledgement Receipt

EFS ID:	14263554
Application Number:	13696267
International Application Number:	
Confirmation Number:	9957
Title of Invention:	Method and Telecommunications Infrastructure for Activating an Inactive Cell
First Named Inventor/Applicant Name:	Ljupco Jorguseski
Customer Number:	20306
Filer:	Christian Hines
Filer Authorized By:	
Attorney Docket Number:	12-1172-WO-US
Receipt Date:	19-NOV-2012
Filing Date:	05-NOV-2012
Time Stamp:	15:01:26
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	12_1172_WO_US_Power.pdf	112046 ef5f2e5b61fa63636cdce9080046bf1118acaeff	no	2

Warnings:	
Information:	

Total Files Size (in bytes):	112046

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO-1390 (09-11)
Approved for use through 4/30/2013. OMB 0651-0021
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	U.S. APPLICATION NO. (If known, see 37 CFR 1.5)
12-1172-WO-US	

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP2011/057093	May 4, 2011	May 6, 2010

TITLE OF INVENTION
Method and Telecommunications Infrastructure for Activating an Inactive Cell

APPLICANT(S) FOR DO/EO/US
JORGUSESKI, Ljupco; LITJENS, Remco; ZHANG, Haibin

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☑ This is a **FIRST** submission of items concerning a submission under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a submission under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☑ The US has been elected (Article 31).
5. ☑ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☑ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☑ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☑ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☑ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☑ A preliminary amendment.
14. ☑ An Application Data Sheet under 37 CFR 1.76.
15. ☐ A substitute specification.
16. ☐ A power of attorney and/or change of address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13*ter*.3 and 37 CFR 1.821- 1.825.
18. ☑ A second copy of the published International Application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).

This collection of information is required by 37 CFR 1.414 and 1.491-1 .492. The information is required to obtain or retain a b enefit by the public, w hich is to file (and by the USPTO to pro cess) an application . Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 15 minutes to complete, including gathering information, preparing, and submitting the completed form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEE S OR COMPLE TED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ERICSSON EXHIBIT 1002, Page 79

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
	PCT/EP2011/057093	12-1172-WO-US

20. Other items or information:
PCT International Search Report (PCT/ISA/210) and Written Opinion (PCT/ISA/237)
Form PCT/IB/304

The following fees have been submitted	CALCULATIONS	PTO USE ONLY
21. ☑ Basic national fee (37 CFR 1.492(a))..... **$380**	$ 390.00	
22. ☑ Examination fee (37 CFR 1.492(c)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4)..... **$0** All other situations..... **$250**	$ 250.00	
23. ☑ Search fee (37 CFR 1.492(b)) If the written opinion of the ISA/US or the International preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4)..... **$0** Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority..... **$120** International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB..... **$490** All other situations..... **$620**	$ 500.00	
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CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
				$	
Total claims	- 20 =		x $ **60**	$	
Independent claims	- 3 =		x **$250**	$	
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			TOTAL OF ABOVE CALCULATIONS =	$1,140.00	
☐ Applicant claims small entity status. See 37 CFR 1.27. Fees above are reduced by ½.					
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Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
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SEND ALL CORRESPONDENCE TO:

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Dated: November 5, 2012

/Christian B. Hines/
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REGISTRATION NUMBER

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Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Method and Telecommunications Infrastructure for Activating an Inactive Cell
First Named Inventor/Applicant Name:	Ljupco Jorguseski
Filer:	Christian Hines/Holly Mueller
Attorney Docket Number:	12-1172-WO-US

Filed as Large Entity

U.S. National Stage under 35 USC 371 Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
National Stage Fee	1631	1	390	390
Natl Stage Search Fee - Report provided	1642	1	500	500
National Stage Exam - all other cases	1633	1	250	250
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1140**

Electronic Acknowledgement Receipt

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Application Number:	13696267
International Application Number:	PCT/EP11/57093
Confirmation Number:	9957
Title of Invention:	Method and Telecommunications Infrastructure for Activating an Inactive Cell
First Named Inventor/Applicant Name:	Ljupco Jorguseski
Customer Number:	20306
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Payment Type	Deposit Account
Payment was successfully received in RAM	$1140
RAM confirmation Number	5358
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Documents submitted with 371 Applications	PCTEP2011057093.pdf	2249584 af11cbcb1931a88191d647ce230d43643b709231	no	53
Warnings:					
Information:					
2		12_1172_WO_US_Preliminary_Amendment_Final.pdf	104658 f2496053a934b0bd345b44a5901dfde3cc121380	yes	9

Multipart Description/PDF files in .zip description

Document Description	Start	End
Preliminary Amendment	1	1
Specification	2	2
Claims	3	8
Applicant Arguments/Remarks Made in an Amendment	9	9

Warnings:					
Information:					
3	Application Data Sheet	12_1172_WO_US_ADS.pdf	899996 a165b4567c06555172806847c639f6b2aaf0e0a8	no	5
Warnings:					
Information:					
4	Documents submitted with 371 Applications	12_1172_WO_US_Search_Report.pdf	612703 4b63dd97c8415f9cc21d8e60e465dd9867465562	no	15
Warnings:					
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5	Documents submitted with 371 Applications	12_1172_WO_US_IB304.pdf	72566 63ce90b5afb5a03b830bd88c8a6046c3d0c8032e	no	1
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6	Foreign Reference	WO2010002991A1.pdf	2106376 a33719d9331ab81f5f0d986c7c27567ff77e048e	no	54
Warnings:					
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7	Foreign Reference	WO2009140988A1.pdf	2082235 146cc7a3dd4da42e36de65312d4c9ece97489543	no	47
Warnings:					
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8	Foreign Reference	WO2008131588A1.pdf	1408177 0e5631898a411f40996f33467818bc60f77e5494	no	27
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9	Non Patent Literature	NPL_1.pdf	612703 281155b49823c1673eb19019c3fadb4cd3519fa6	no	15
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10	Non Patent Literature	NPL_2.pdf	539369 2eff80e89628f5f68f017c14143a674d7c30d988	no	5
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11	Non Patent Literature	NPL_3.pdf	304564 01c0cb2bf6880ece134ef228fc9902e2f09c57f4	no	17
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13	Non Patent Literature	NPL_5.pdf	377304 a6688478f0092289014411b1cb1acea0f0104fe50	no	10
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14	Non Patent Literature	NPL_6.pdf	328715 5681cb3cedce382d16d039e5929d34974ef1a83c	no	8
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15	Non Patent Literature	NPL_7.pdf	2838140 031d509bda7c06c2c4795ef5273f76f00bf5e6d9	no	23
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16	Information Disclosure Statement (IDS) Form (SB08)	12_1172_WO_US_IDS.pdf	613160 24e3270395f56e87ea2d11ab9fe472ffdfcbbe82	no	5
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A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
17	Transmittal of New Application	12_1172_WO_US_Transmittal_Letter.pdf	246204 04511637849532c7f18f1d84200522f72942bdd1	no	4
Warnings:					
Information:					
18	Fee Worksheet (SB06)	fee-info.pdf	33027 140c249c6e552e49881c3a88368bc2833e5db897	no	2
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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

[Continued on next page]

(54) Title: METHOD AND TELECOMMUNICATIONS INFRASTRUCTURE FOR ACTIVATING AN INACTIVE CELL

(57) Abstract: The invention relates to a method for activating at least one inactive cell in a wireless telecommunications infrastructure. The telecommunications infrastructure comprises an active cell containing a plurality of terminals. A presence signal is transmitted in the at least one inactive cell. The plurality of terminals in the active cell detect the presence signal (s) of the one or more inactive cells to gather information from the inactive cell. The information is reported to and received at the telecommunications infrastructure. The information received from the plurality of terminals is processed in a processing system of the telecommunications infrastructure to provide a processing result. The inactive cell is activated when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

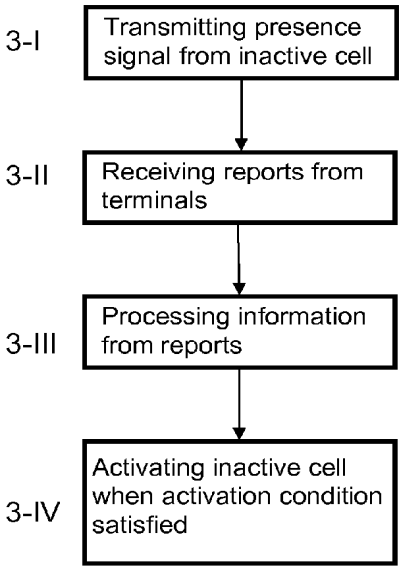

FIG. 3

WO 2011/138351 A1

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

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— *of inventorship (Rule 4.17(iv))*

Published:

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

Method and telecommunications infrastructure for activating an inactive cell

FIELD OF THE INVENTION

The invention relates to the field of telecommunications infrastructures. More specifically, the invention relates to the field of activating inactive cells of a telecommunications infrastructure for purposes such as controlling energy consumption and electromagnetic radiation, particularly reducing energy consumption or electromagnetic radiation.

BACKGROUND OF THE INVENTION

The operation of wireless access networks for enabling wireless communication is highly energy consuming. In view of current environmental concerns, increased attention is paid recently to the energy consumption of telecommunications networks.

Various studies have been performed to reduce conventional energy consumption in wireless access networks, e.g. by exploring the option of using sustainable energy sources (Ericsson AB White Paper "Sustainable energy use in mobile communications, June 2007).

With the development of the 3GGP Long Term Evolution (LTE) network, energy saving for the network is also approached in the context of self organizing networks (SON). In a White Paper of NEC, dated February 2009, "NEC's proposals for next-generation radio network management", energy is considered as a significant part of the operation expenses of a cellular network. It is recognized that the main saving potential resides in using variations in load over time, that allows to switch off parts of the resources, for example during the night. When a complete base station is switched off, other base stations of the access network need to make up for the reduction in coverage area and capacity. This requires coordination between the nodes. A similar use case is described in 3GGP TR 36.902 v9.1.0 "Self-

configuring and self-optimizing network(SON) use cases and solutions".

Once base stations (or one or more cells thereof) have been deactivated, at some point in time these base stations (or cells) may have to be reactivated again. Thus, a decision is required when and/or which base stations or cells need to be activated.

A first solution would be to activate the base stations or cells at a predetermined time. As an example, it can be imagined that fewer base stations need to be active during night time and more base stations need to be active during the day.

Another solution would be to activate all inactive cells adjacent to (i.e. relevant for) a currently active cell when the currently active cell detects a certain traffic load exceeding a threshold or detects a rising traffic load.

There is a need in the art to improve these solutions by determining more accurately which base stations and/or cells should be activated.

SUMMARY OF THE INVENTION

A method for activating at least one inactive cell in a wireless telecommunications infrastructure is disclosed. The telecommunications infrastructure comprises an active cell containing a plurality of terminals. A presence signal is transmitted in the at least one inactive cell. The plurality of terminals in the active cell (which are not necessarily all terminals in the active cell) detect the presence signal(s) of the one or more inactive cells to gather information about the inactive cell. The information is reported to and received at the telecommunications infrastructure. The information received from the plurality of terminals is processed in a processing system of the telecommunications infrastructure to provide a processing result. It should be appreciated that the information contained in some reports from some terminals need not necessarily be processed. The inactive cell is activated when the processing result fulfils at least one activation condition such that at

least one of the plurality of terminals is within a coverage area of the activated cell.

Capabilities of terminals to gather information about a cell (e.g. to measure a signal transmitted by a cell) and to report such information are known in the art, for example to gather information about a neighbour cell in order to consider a handover to a neighbour cell. Examples for LTE include measuring and reporting Reference Signal Received Power (RSRP) and Reference Signal Received Quality (RSRQ). Also see 3GPP TS 37.320 "Radio measurement collection for Minimization of Drive Tests (MDT)". Examples for UMTS include measuring and reporting Received Signal Code Power (RSCP) and a quantity indicated as Ec/Io. For other technologies comparable quantities have been defined.

Processing information received from terminals may also include combining the received information with other information available to the infrastructure, such as the number of (failed) handover requests to an inactive cell, the number of (rejected) session requests from terminals trying to connect to an inactive cell, the positions of (some of) the terminals, the current load in an active cell, history or statistics of the history of the load in a cell, the location of a cell and the typical coverage area of a cell when active.

Receiving and processing information may continue e.g. until an activation condition has been fulfilled, or until a predetermined time has elapsed (e.g. since commencing to transmit a presence signal in an inactive cell) while an activation condition is not fulfilled, or until substantially no more additional information is received in relation to the transmission of a presence signal while an activation condition is not fulfilled. It should be appreciated that gathering adequate information about an inactive cell transmitting a presence signal may take some time, depending for example on how quickly a terminal may be informed about the measurements to be performed, on the type and duration of measurements to be performed (which may include performing signal strength and/or signal quality measurements on an inactive cell's presence signal, performing

handover evaluations, cell reselections and location area updates), on the way a terminal is able to perform the requested functions, on the complexity and number of reports a terminal may prepare, on the way the telecommunication infrastructure may receive the reports, on the type and number of reports and/or events to be received, on the fraction of the reports that include location information and on the accuracy of the location information, etc. The time period from commencing to transmit a presence signal in an inactive cell to the moment a decision is taken on whether or not to activate the inactive cell may be referred to as a 'probing period'.

Fulfilling an activation condition may be that the processing result indicates, for example, that the number of terminals which are estimated to be in the best server area of an inactive cell, when activated, is above a predetermined number of terminals or is above a predetermined fraction of the terminals currently served by one or more active cells, or that the load (expressed e.g. in the number of calls or in an aggregated bit rate or in another load measure) that is estimated to be absorbed by an inactive cell, when activated, is above a predetermined load measure.

A computer program containing software code portions (possibly distributed over several components in the telecommunications infrastructure) for performing the method when executed by a processing system is also disclosed.

A wireless access telecommunications infrastructure comprising an active cell and at least one inactive cell is also disclosed. The active cell can contain a plurality of terminals is also disclosed. The infrastructure comprises a presence signal generator configured for generating a presence signal to be transmitted in the at least one inactive cell. The infrastructure further comprises a receiver configured for receiving reports from the plurality of terminals detecting the presence signal and a processor system configured for processing information contained in the reports received from the plurality of terminals to provide a processing result. The processing system may be part of the telecommunications infrastructure or be

(partly) connected to the telecommunications infrastructure in which case the processing system is considered part of the telecommunications infrastructure. The infrastructure further comprises an activator configured for activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell. By using the (partly) existing capabilities of terminals to measure and report information received from neighbouring cells (typically applied for e.g. handover operations), the transmission of the presence signal in the currently inactive cell enables the telecommunications infrastructure to assess whether the terminals recognize this cell as an appropriate target, i.e. whether the terminals currently connected to or camping on the active cell are likely able to be connected to or camp on a currently inactive cell. The telecommunications infrastructure is configured to receive and process the information relating to the inactive cell(s) from the reports of various terminals within the active cell (possibly, but not necessarily, all terminals in the active cell). The reported information, possibly combined with other information available to the infrastructure, forms the basis to decide whether or not to actually activate the currently inactive cell (i.e. to change the network configuration of the telecommunications infrastructure) in order for the terminal to connect to or camp on the activated cell via a handover operation or cell reselection, respectively.

The information can be used by an energy evaluation algorithm for determining whether energy consumption of the telecommunications infrastructure can be reduced or used in an efficient manner, e.g. by efficiently controlling activation of cells in the telecommunications infrastructure if required.

The method and telecommunications infrastructure may, in addition or alternatively, also be applied for other purposes. As an example, similar considerations apply to the reduction of electromagnetic radiation produced by a base station. For example, for health reasons it is advisable to limit the amount and duration of electromagnetic radiation to a level

that is strictly necessary for the operation of the base station. When the level of electromagnetic radiation can be reduced or when a base station can be switched off, this may be well-appreciated by the population in the vicinity of the base station. Considerations may either apply to the complete telecommunications infrastructure or to a part of the infrastructure, e.g. for a plurality of cells. For example, heavily populated areas may be selected to have low electromagnetic radiation density, whereas in less densely populated areas, the electromagnetic radiation levels can be higher. In addition to health concerns, there may also be technical reasons to restrict the electromagnetic radiation, and therewith the possibility and level of interference experienced in adjacent areas.

It should be appreciated that the active cell and inactive cell may relate to any type of radio access technology (RAT) including, but not limited to GSM, UMTS, LTE, Wimax etc.

It should further be appreciated that the measurements for information on the inactive cell(s) of terminals in the active cell may relate to a single radio access technology (intra-RAT) or multiple different radio access technologies (inter-RAT). An example of inter-RAT includes a terminal in an active UMTS cell performing measurements on an inactive GSM cell.

The method and telecommunications infrastructure also allow taking account of the distribution of terminals in the active cell. For example, if the analysis reveals that a considerable number of terminals served by the active cell finds themselves near the edge of the active cell (i.e. the reported measurement information indicates a high signal level or signal quality for the presence signal of neighbouring inactive cells and much lower levels for the active cell for a considerable number of terminals), the total energy for the telecommunications infrastructure may be reduced by activating one or more inactive cells and hand over these terminals to these cells.

In the present application, an active cell is considered a cell enabling connection of a terminal to the base station responsible for the cell. In other words, the cell is fully operational.

An inactive cell is considered a cell that is not intended to carry any voice or data traffic but may transmit a presence signal during particular time intervals or continuously. A presence signal may comprise a beacon signal, such as BCCH in GSM network, CPICH in UMTS network or reference symbols in LTE in order to indicate the presence of the cell. In addition, the inactive cell may at least transmit some system information (e.g. cell identity, power level of its beacon signal, etc.), for example on a broadcast signal (BCH) containing system information blocks (MIB, SIB, etc.), depending on its level of functionality. A presence signal may also include a synchronization channel (SCH), commonly used in mobile communication systems such as GSM, UMTS and LTE, for cell search, for identifying a cell and for synchronization with a cell. An inactive cell may, during a probing period transmit a presence signal, for example reference symbols in LTE or CPICH in UMTS, synchronisation signal (SCH) and broadcast signal (BCH) containing system information blocks (MIB, SIB, etc) while not accepting any 'normal' traffic, such as voice or data connections.

The inactive cell can become an active cell by applying the method disclosed herein. The inactive cell may be an inactive cell because it does not accept handover for active terminals to the inactive cell or because it redirects connections to an active cell once a connection is requested from a terminal in the inactive cell. Such methods are known in the art and may for example be realised by settings a call admission control function (CAC) to block any handover request or any request for setting up a new session.

The main purpose of the inactive cells to transmit the presence signal is to allow the terminals in the active cell to perform measurements on these inactive cells and to report such measurements to the network. Terminals in the active cell can be distinguished between terminals in the active mode (active terminals) and terminals in the idle mode (idle terminals). A terminal with an active connection (e.g. a voice call or data being exchanged) is said to be in 'active mode' or 'connected mode'. When the terminal is in active mode (active terminal),

the network has detailed knowledge about the terminal and knows by which cell it is served. A terminal which is powered on but without an active connection is said to be in 'idle mode'. When the terminal is in idle mode (idle terminal), the network has limited knowledge about the mobile station and only knows in which paging or location area the terminal may be paged. In idle mode the terminal listens to e.g. a broadcast channel or a paging channel of a particular cell. It is said that the terminal 'camps on' that cell. Consequently, a decision as to activate an inactive cell (or which active cell(s) from a set of inactive cells) can thus be based on information gathered from terminals in different states, i.e. from active terminals (terminals which have an active connection with the network for conveying traffic) and possibly from idle terminals (terminals which do not have an active connection with the network).

As a first example, a decision to activate an inactive cell may be based on the information gathered only from active terminals, for example by one or more of the following:

1. Counting requests for handover from active terminals with the inactive cell as target/destination.

2. Receiving and processing reported measurements from active terminals, e.g. signal strength and/or quality of the presence signal transmitted in an inactive cell, location information (e.g. determined by GPS or by the mobile network), etc.

3. Counting requests for a new session from active terminals that attempted to set up a connection with the inactive cell (and were refused and/or redirected towards an active cell because the inactive cell does not accept 'normal' traffic).

4. Any other measurements by active terminals that would be useful in deciding whether or not to activate an inactive cell.

As a second example, a decision to activate an inactive cell may be based on the information gathered both from active terminals and from idle terminals. In addition to the possibilities listed above for active terminals, from the idle terminals one or more of the following could be used:

1. Counting events of cell reselection by an idle terminal from an active cell to an inactive cell. This may in particular be relevant to an inter-RAT case. For example, an idle terminal that was originally camped on an active cell reselects to an inactive cell and then camps on the inactive cell.

2. Counting events of a location area update (e.g. as a result of a cell reselection).

3. Receiving an processing measurements performed by idle terminals, e.g. about signal strength and/or quality of the presence signal transmitted in an inactive cell, location information (e.g. determined by GPS or by the mobile network), etc.

4. Any other measurements by idle terminals that would be useful in deciding whether or not to activate an inactive cell.

As a third example, a decision to activate an inactive cell may be based on the information gathered only from idle terminals. However, this is not preferred, because the information from currently active terminals is considered to be highly relevant and relatively easy to obtain.

As indicate above, an inactive cell is considered a cell that is not intended to carry any voice or data traffic but may transmit a presence signal. That leaves a whole spectrum of additional capabilities which may or may not be available in an inactive cell while transmitting a presence signal during a probing period. Two examples will be provided towards the ends of that spectrum; a first example of an inactive cell with close to full functionality and a second example of an inactive cell with close to minimum functionality. It may be noted that the functionality of an inactive cell also has some impact on the role the inactive cell may have in gathering information about the inactive cell.

A first example of an inactive cell is a cell which does not accept any ‘normal’ data or voice traffic from a terminal (realised, for example, by proper settings of the connection admission function, which blocks any handover towards the or session set-up to the inactive cell) but is otherwise close to fully functional. For example, the Tx and Rx chains may be fully

functional, the interfacing with the core network (in LTE the for example X2 or S1 interface, in UMTS for example the Iub interface with the RNC) may be activated, etc. Consequently, the inactive cell may be able to receive measurement reports from active and/or idle terminals, may be able to process or forward these reports, may be able to receive location area updates from idle terminals, etc. Also, requests for handover towards the inactive cell and requests for setting up a session to the inactive cell may be received and properly responded to, i.e. be refused or redirected towards an active cell. It is expected that with a close to full functionality during a probing period, a noticeable energy consumption is unavoidable but that still a major energy saving is achieved by not allowing 'normal' data or voice traffic.

A second example of an inactive cell is a cell which only performs close to the minimum of functions, i.e. the transmission of a presence signal. For example, only the downlink signalling (such as pilot channel/reference symbol, SCH, BCH, etc.) are active to indicate the presence and the identity of the inactive cell and to allow the terminals to perform measurements on the presence signal of the inactive cell. The inactive cell may be configured to not receive any signalling messages (e.g. related to handover, to session set-up, to location area updates, to measurement reports, etc.) during the probing interval. Communication with the core network may likewise be restricted to, for example, receiving management commands related to the transmission of the presence signal (including any associated information), to the activation of the inactive cell and to transmitting some status information. It is expected that with a close to minimum functionality during a probing period, a very high energy saving is achieved.

Between the ends of the spectrum a trade-off may be made between the energy consumption and the functionality provided by (and associated therewith the ease of information gathering) an inactive cell during its probing period.

The method for assessing whether activation of the inactive cell is possible or required can be performed during

subsequent time intervals (e.g. periodic time intervals), as defined in claim 2 in order to not bother the terminals (battery saving) and the network (reduction of network load) continuously. However, (semi-) continuous performance of the method when one or more cells are currently inactive may be an attractive alternative for rapid assessment of opportunities to change the configuration of the telecommunications infrastructure.

In an embodiment of the invention, defined in claim 3, the terminals may be provided with measurement and/or reporting parameters in order to control measurement and reporting operations by the terminals in the active cell. The parameters may e.g. be provided over a connection via the active cell to a terminal that is in the active mode or broadcasted in the active cells to terminals in the active or idle mode. The measurement parameters trigger terminals to perform measurements. The reporting parameters instruct terminals (when) to report measurements to the network.

In existing wireless access telecommunications networks, terminals usually already perform measurements in certain conditions and may report measurement results in certain other conditions. For example, active terminals in handover regions between adjacent cells usually already report measurement information from the adjacent cells to the network in order for the network to perform a handover decision for each individual terminal. The measurement parameters provided to the terminals as defined in claim 3 not only allow to obtain measurement information from active terminals in the handover region but also allow to obtain information about neighbour inactive cells from active terminals outside the handover region and from idle terminals within the active cell. These terminals may report that information to the telecommunications infrastructure.

As a first example, a reporting threshold usually applied in the terminal to prevent reporting measurements about neighbour signals with a signal level which is insufficient compared to the signal from the serving cell to be relevant for a possible handover may be adjusted temporarily to allow also reporting signal levels which would otherwise be considered

insufficient. As a second example, a signal level threshold usually applied in the idle terminals to prevent performing measurements on neighbour cells when the signal level from the serving cell is more than adequate, may be adjusted (e.g. increased) temporarily to allow measurements on neighbour cells. Providing the measurement and/or reporting parameters to the terminals in the active cell enables more terminals and enables terminals at more locations in the active cell (e.g. not only in what would normally be considered the handover region between two cells) to perform measurements and/or to provide reports to the network.

The telecommunications infrastructure may comprise several inactive cells that may concurrently or sequentially transmit the presence signal, enabling the terminals to measure signals from a plurality of cells concurrently or sequentially to allow the network to obtain a more complete picture of the possibilities for a network configuration change (claim 4). The inactive cells may be located in the active cells (e.g. micro cells), may be adjacent to the active cell or may be located further away from the active cell. The plurality of inactive cells may have an aggregated estimated coverage area that at least partially overlaps the coverage area of the active cell.

Concurrent transmission of a presence signal by several inactive cells may be time efficient and may provide a slightly different picture of the network situation. For example, in a situation with overlapping inactive cells, a sequential transmission of the presence signal could indicate that a particular user device would select more than one inactive cell if only a single of these inactive cells would be activated, whereas concurrent transmission of the presence signal would indicate which of these inactive cells the same user device would select if all these inactive cells would be activated. Sequential transmission of a presence signal may be work load efficient as it allows to refrain from completing the entire envisaged sequence, for example if the thus far collected information appears to be satisfactory. Sequential transmission of a presence signal may involve the sequential transmission in groups of inactive cells

to assess the best combination. The sequential variant may use history information to first transmit a presence signal in inactive cells that previously turned out successful candidates for activation.

In the embodiment of claim 6, a reporting identifier is transmitted in the inactive cell. The present application also discloses a signal transmitted in a cell of the infrastructure, wherein the signal comprises the reporting identifier.

Active terminals in the active cell may receive the reporting identifier and transmit the reporting identifier with the report in order to enable the telecommunications infrastructure to distinguish between reports from terminals related to normal handover (to an active cell) and reports from terminals reporting information about the inactive cells for assessing whether the inactive cell should be activated.

Idle terminals detecting the reporting identifier from the inactive cell may be configured to use this identifier to prevent cell reselection by the idle terminal to the inactive cell, to report the information about the inactive cell to the telecommunications infrastructure via the active cell before reselection to the inactive cell, or to report information about the inactive cell to the inactive cell when the inactive cell is configured to receive such reports.

The embodiment defined in claim 7 is advantageous for the reason that the number of idle terminals is normally much greater than the number of active terminals. Having a plurality of idle terminals reporting information on the presence signal(s) from the inactive cell(s) may greatly contribute to the complete picture of opportunities for reconfiguration of the telecommunications infrastructure and also may indicate possible traffic load in the near future. For the idle terminals to transmit reports to the telecommunications infrastructure, these terminals should temporarily become active.

Apart from the mechanism for idle terminals as described above in relation to claim 6, the embodiments of claims 8-10 provide several other mechanisms for participation of idle terminals in the method according to the invention. These em-

bodiments are described in further detail in the detailed description.

Briefly, the embodiment of claim 8 comprises temporarily decreasing a location area update period (or a similar period) in at least one of the active cell and the inactive cell. The embodiment is advantageous as it may require no or only few modifications to currently existing networks.

The embodiment of claim 9 comprises the idle terminals to report measurement information to the telecommunications infrastructure via the active cell, whereas these terminals would otherwise reselect to the inactive cell and attempt reporting to the inactive cell. This embodiment allows the inactive cells to maintain a status wherein these cells are not able or are configured not to be able to receive reports.

The embodiment of claim 10 comprises transmitting a paging message in the active cell instructing the idle terminals to obtain and/or report the information. The idle terminals listen to broadcast and paging channels and can be triggered to detect information from inactive cells using these channels. Using such paging message, less need exists to temporarily reconfigure the system information of the active cell different from the normal operation. This is particularly true if the paging messages carry configuration parameters for the idle terminals, such as the measurement and/or reporting parameters defined in claim 3.

The embodiments of claims 6 and 10 require modifications to the processing capabilities of currently existing wireless terminals. The present application discloses a wireless terminal for use in these embodiments.

Hereinafter, embodiments of the invention will be described in further detail. It should be appreciated, however, that these embodiments may not be construed as limiting the scope of protection for the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIGS. 1A and 1B are schematic illustrations of base stations in a wireless access telecommunications infrastructure providing active cells and inactive cells;

FIG. 2 is a schematic illustration of a telecommunications infrastructure comprising a base station defining an active cell containing a plurality of terminals and a base station providing an inactive cell transmitting a presence signal;

FIG. 3 is a flow chart illustrating various steps of a method according to an embodiment of the invention;

FIG. 4 is a flow chart illustrating the information processing step in further detail;

FIGS. 5-8 are flow chart illustrating steps of a method for participation of idle terminals and

FIG. 9 is a schematic illustration of a wireless terminal configured for being operable in the telecommunication infrastructure of FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1A is a schematic illustration of base stations BS A – BS G in a wireless access telecommunications infrastructure providing a plurality of active cells. Each base station location comprises three sectors, thus covering an area around the base station location. For example, cell A1 of base station location BS A serves its best server area marked ‘a1’. Similarly, cell A2 and A3 of the same location serve their best server area marked ‘a2’ and ‘a3’ respectively. A same set-up is shown for the other base station locations BS B to BS G. In FIG. 1A, the regular pattern of base stations and sectors leads to the commonly known hexagonal pattern of coverage areas.

FIG. 1B shows the same areas in a light grey colour. For example for energy saving reasons, some cells at base station locations B and C have been switched off and cell A1, together with some other cells (not shown) now provides service to some of BS B and BS C’s best server areas. In FIG. 1B, a darker gray shading illustrates that cell A1 provides service not only in its ‘own’ or ‘native’ area a1, but also in areas b2 and c3 and in part of the areas b3 and c2. Other cells may simi-

larly have been switched off and service in their ('native') areas may be provided by one or more of the surrounding cells.

FIG. 2 is a schematic illustration of a wireless access telecommunications infrastructure 1 comprising a base station BS A defining an active cell A1 containing a plurality of active terminals Ta and idle terminals Ti. Base station BS B provides an inactive cell B1 wherein it transmits a presence signal P.

Telecommunications infrastructure 1 comprises a presence signal generator 2 for generating the presence signal P via interface 3. The telecommunications infrastructure 1 further comprises a receiver 4 configured for receiving reports from the plurality of terminals Ta, Ti detecting the presence signal P. A processor system 5 is configured for processing information contained in the reports received from the plurality of terminals Ta, Ti to provide a processing result. The processor system 5 has an activation module 6 configured for activating the inactive cell of BS B when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals Ta, Ti is within a coverage area of the activated cell B1 of base station BS B.

Various events may trigger the telecommunications system 1 to operate the method as illustrated in the flow chart of FIG. 3. The method may be performed periodically or continuously, wherein generator 2 periodically or continuously generates the presence signal P in inactive cell B1. In at least some situations, it is advantageous to transmit the presence signal P concurrently by several related cells (rather than transmitting the presence signal P for separate cells, e.g. one-by-one). For example, in FIG. 1B, it may be advantageous to perform the method and evaluation concurrently for cells B3, B2, C3 and C2. A same or similar advantage may apply to cells which otherwise provide mutual coverage or are in close proximity of each other. Alternatively or in addition, the transmission of the presence signal P may be initiated by a predetermined condition in an active cell A1 verified by processing system 5, e.g. a traffic load exceeding a threshold or a traffic load showing a substantial increase.

The method as illustrated in the flow chart of FIG. 3 may be performed as follows. In step 3-I, a presence signal P is generated by generator 2 and transmitted in the at least one inactive cell of base station BS B. The plurality of terminals Ta, Ti in the active cell A1 (which are not necessarily all terminals in the active cell) detect and measure the presence signal P of the inactive cell B1 and gather information about the inactive cell (e.g. signal level/quality of presence signal P and cell identity of inactive cell B1). The information is reported to and received at the telecommunications network via the active cell A1 and receiver 4 (step 3-II). Alternatively, some of the information, in particular from idle terminals Ti, may be also reported via inactive cells, presuming these are configured for at least receiving such reports. The information received from the plurality of terminals Ta, Ti is processed in processing system 5 to provide a processing result (step 3-III). It should be appreciated that the information contained in some reports from some terminals need not be processed by processing system 5 and that processing system 5 may use additional information not received from the terminals (e.g. information typically available from a management system such as the location and configuration of the base stations etc.). The inactive cell B1 is activated in step 3-IV when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals Ta, Ti is within a coverage area of the activated cell B1.

FIG. 4 shows a flow chart exemplifying some steps of processing step 3-III in further detail. The telecommunications infrastructure 1 allows to take account of the distribution of terminals Ta and Ti in the active cell A1. The information obtained from the terminals Ta (such as measured signal level/quality or path loss) can be applied for energy reduction purposes. For example, if the analysis (e.g. based on the reported signal level measurements) reveals that a considerable number of active terminals Ta served by the active cell A1 finds themselves near the edge of the active cell A1 as shown in FIG. 2 and is transferable to inactive cell B1 (step 4-I), a recon-

figuration of the network can be analysed (step 4-II) wherein the inactive cell B1 is activated (step 4-II). The activation condition wherein the total energy for the telecommunications infrastructure 1 can be reduced (step 4-III) may be fulfilled since the power reduction estimated to be obtained by transferring these terminals away from active cell A1 may be more than the power estimated to be required for an activated cell B1 and for serving these terminals by cell B1.

The analysis as depicted in FIG. 4 may also be used for increasing the energy consumption of the telecommunications network in an efficient manner. As an example, if the load in active cell A1 increases, at some point in time additional cells need to be activated. Reports from the active terminals Ta may indicate (e.g. from the signal levels / signal quality reported about the presence signal P of cell B1) that cell B1 is a suitable candidate for activation.

As an alternative or in addition, triggered reports from idle terminals Ti may be considered in the decision which cell is most suitably reactivated to alleviate the effects of the local traffic overload. Note that the number of idle terminals in a cell is usually much larger than the number of active terminals. Reports from such idle terminal typically indicate the best cell as selected by each triggered idle terminal, choosing from both active and inactive cells that transmit a presence signal P. Counting for each inactive cell transmitting presence signal P how many idle terminals Ti (optionally: how many idle terminals that currently camp on the overloaded active cell) would prefer that inactive cell, provides an indication of the near-future traffic load that can be absorbed by the inactive cell when fully reactivated, thus relaxing the currently overloaded active cell from that (potential) ‘burden’. Instead or along with the information on the active terminals Ta, the information on the idle terminals Ti can be considered in the decision process regarding which inactive cell to activate.

Several methods of triggering active user terminals Ta and idle terminals Ti to obtain information on the inactive

cell(s) and to report this information will now be discussed in further detail.

Generally, the terminals may be provided with measurement and/or reporting parameters in order to control measurement and reporting operations by the terminals in the active cell A1. The parameters may e.g. be provided over a connection via the active cell to an active terminal Ta or broadcasted in the active cell A1 to active and idle terminals Ta, Ti using e.g. system information blocks SIB.

An active terminal Ta receives instructions from the network about which measurements to perform and which events to report to the network (e.g. the event that a neighbour inactive cell B1 is detected with a signal strength/quality that is better by x dB than that of the currently serving active cell A1). When a measurement leads to one of the specified events, the terminal Ta reports the relevant information (e.g. an identification of the detected neighbour inactive cell B1, its measured present signal level/quality and the measured signal level/quality of the active cell A1) over the existing connection to the telecommunications infrastructure 1. Either in response to a report from a terminal Ta or autonomously, the telecommunications infrastructure 1 may instruct the terminal Ta to perform additional measurements of a same or different kind and to report the results.

Base station BS B may transmit a reporting identifier, hereinafter also referred to as 'probing flag', in the inactive cell B1. Active terminals Ta in the active cell A1 may receive the reporting identifier and transmit the reporting identifier with the report containing information regarding inactive cell B1. The active terminal Ta is thus configured to recognize the reporting identifier and to include this reporting identifier in the report containing the information on the inactive cell B1. This facilitates the processing system 5 of telecommunications infrastructure 1 to more easily distinguish between terminals Ta-ho (see FIG. 2) reporting in the context of a normal handover to another active cell (not shown in FIG. 2) and terminals Ta reporting information from the inactive cell B for assessing

whether the inactive cell should be activated. An alternative for enabling the telecommunications infrastructure 1 to distinguish between reports relating to normal handovers and reports to be analyzed towards a decision whether to activate an inactive cell is to inform the base station BS A (or at least the associated entity normally handling the handover-related reports) of the identity of the inactive cells transmitting presence signals, such that reports related to an identity of an inactive cell can be excluded from being processed towards a handover decision and can be forwarded to processing system 5.

In order for idle terminals in active cell A1 to be triggered to obtain information about inactive neighbour cell B1, various parameters may be broadcasted in the active cell A1 in the system information block SIB for cell reselection. One example of such a parameter is an absolute signal level threshold Ts,search. This threshold is used by idle terminals as a reference for the received signal level Srxlev, measured by the terminals, from the active cell A1 and to decide if neighbour measurements for cell reselection are needed. Different values might be assigned to Ts,search for the measurement of intra-frequency, inter-frequency and inter-RAT neighbours. If Srxlev < Ts,search, the terminal will search for corresponding (intra-frequency, inter-frequency or inter-RAT) neighbour cells and measure the received signal level Nrxlev and/or Nqual. Nrxlev is the received signal level of the presence signal from a neighbour cell, e.g. from the inactive cell B1. Nqual is the received signal quality from a neighbour cell, e.g. from inactive cell B1 (e.g. E_c/I_0 of the CPICH for UMTS cells or RSRQ of the reference symbols for LTE cells). Hysteresis parameter Qhyst for the active cell A1 and offset parameters Qoffset,n to be applied to each neighbour *n* specifically, can also be broadcasted in the active cell A1.

Next, exemplary methods will be discussed for instructing idle terminals Ti to perform measurements on inactive cells and to report this information to the telecommunications infrastructure 1.

In a first method, illustrated in the flow chart of FIG. 5, a location area update period (or a similar period) is decreased in the active cell A1 and the inactive cell B1. The embodiment is advantageous as it requires no modifications to currently existing networks.

In the active cell A1, in the system information (SIB) to be broadcast on the broadcast channel of the active cell A1, a relatively short value (e.g. 30 s, 1 min) is set for the periodic location area (LA) update (instead of a nominal value, e.g. 30 min, 1 hour, infinite). This is illustrated in step 5-I. A paging message may be issued in the cell A1 indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1.

As a consequence, an idle terminal Ti camping on the active cell A1 reads the modified SIB and starts providing frequent (e.g. every 30 s, 1 min) periodic LA updates. An LA Update message also includes information about the identity of the terminal. The telecommunications infrastructure 1 (more particularly processing system 5) receives the LA Update messages and may derive (e.g. every 30 s, 1 min) how many and which terminals Ti are currently camping on the active cell A1. This provides information about the initial situation regarding idle terminals in the active cell.

In step 5-II, the inactive cell(s) B1 set a periodic LA update value to a similarly short (e.g. 30 s, 1 min) value as used for the active cell A1. The presence signal P is transmitted in the inactive cell B1.

In the active cell A1, in the system information (SIB) to be broadcast on the broadcast channel of the cell, the absolute signal level threshold parameter Ts,search is set higher than nominal (e.g. nominal value +[5,10] dBm), step 5-III. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells B1. In the cell, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselec-

tion evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal Ti for which the received signal level of the active cell A1 is below the adjusted (increased) threshold Ts,search measures the neighbour cells, for example including inactive neighbour B1. For some RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active) neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell. The ranking mechanism may be dependent on the radio access technologies of the involved cells and possibly also on other conditions like environment characteristics. In the existing art it is for instance known that cell reselection in a network consisting of cells with different radio access technologies may be organised in a 2-step manner: For instance in a network consisting of both UMTS (UTRAN) and GSM (GERAN) cells, first a ranking based on received signal level (Srxlev for the serving cell and Nrxlev for the neighbour cells) may be performed, taking account of corresponding Qhyst and Qoffset,n (noted as Qhyst(1) and Qoffset,n(1)). If the highest ranked cell is a GSM cell, the terminal will reselect to this cell. However, for the ranking of the UMTS cells, received signal quality (e.g. E_c/I_0) is a better indicator of the suitability of a cell for cell reselection. Therefore, if a UMTS cell is the highest ranked in the first step, a second step follows, in which the UMTS cells are ranked based on received signal quality, still taking Qhyst and Qoffset,n (noted as Qhyst(2) and Qoffset,n(2)) into account. The terminal then reselects to the highest ranked UMTS cell in this second ranking.

Similarly, for different combinations of RATs different ranking methods may be devised.

It is also known from the existing art that differences in certain geographical environments may be used to select a ranking mechanism form a set of implemented ranking mechanisms.

The remainder of this text is based on applying the example of cell-ranking based on received signal level. It should however be understood that also other cell ranking mechanisms can be applied.

An idle terminal Ti persisting to camping on the active cell A1 continues providing frequent LA Updates messages to the active cell A1. An idle terminal Ti which has reselected to an inactive cell B1 (which is assumed to be configured for frequent LA Updates as indicated above) will provide its frequent LA Update messages to the relevant inactive cell B1. An idle terminal Ti which has reselected another active cell will adhere to the LA Update regime as broadcast by that cell (which may be a nominal value, e.g. 30 min, 1 hour, etc.)

After a transitional period (whose length may depend on the duration of the cell reselection procedure and the LA Update period), the processing system 5 may derive in step 5-IV from the received LA Update messages how many and which idle terminals remain camped on the active cell, how many and which idle terminals have reselected an inactive cell (and which cell) and how many and, possibly, which idle terminals have reselected from the active cell to other cells. This analysis provides an estimate about the situation regarding idle terminals Ti when each of the inactive cells B1 would be activated.

The information obtained from step 5-IV may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 5-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions. A paging message may be issued indicating modified system information. This pag-

ing message is also received by idle terminals still camping on the active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision obtained from the processing of step 5-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions. In these cells, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on any of the cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 5-V in FIG. 5 for both the active cell A1 and the activated cell B1.

Still further, after the decision obtained from the processing of step 5-IV, the inactive cells that are decided to be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped on such a cell will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read modified system information is RAT dependent.

In a second method, illustrated in the flow chart of FIG. 6, a location area update period (or a similar period) is decreased in the active cell A1 and a reporting identifier, also referred to here below as probing flag, is broadcast in the inactive cell B1 during a time interval.

The first step, indicated by 6-I, is equivalent to step 5-I in FIG. 5.

Different from the first method, the LA update period is not changed in the inactive cells B1. A reporting identifier is transmitted in the inactive cells B1 (step 6-II). The presence signal P, possibly including the probing flag, is transmitted in the inactive cells B1.

In the active cell A1, the absolute signal level threshold parameter Ts,search is set higher than nominal (e.g. nominal value +[5,10] dBm) in step 6-III and is broadcasted in the system information (SIB) on the broadcast channel of the cell. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells. A paging message may be issued indicating modified system information. This paging message is also received by idle terminals Ti camping on the cell. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselection evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal Ti for which the absolute received signal level of the active cell A1 is below the adjusted threshold Ts,search measures the neighbours. For some RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active) neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell.

An idle terminal Ti persisting to camping on the active cell A1 continues providing frequent LA Updates messages to the active cell A1. An idle terminal Ti which reselects to an inactive cell B1 (the terminal Ti may detect this from the probing flag in the inactive cell's broadcast channel) is configured to, shortly after performing the reselection, send a LA Update message to the selected inactive cell B1. This first LA Update message is sent, regardless the setting of the LA Update period in the inactive cell B1. An idle terminal reporting a cell reselection to an inactive neighbour cell may be further configured to also report the presence of the probing flag in its LA Update

message. This could ease bookkeeping at the processing system 5 regarding the neighbour state (inactive or active).

Different from the first method, the inactive cells B1 are configured with a nominal period for LA Updates. Consequently an idle terminal camping on an inactive cell provides (subsequent to the first LA Update message sent shortly after camping on a cell with its probing flag set) only nominal LA Update messages (e.g. 30 min, 1 hour, etc.) to the cell. An idle terminal Ti which has reselected another active cell will adhere to the LA Update regime as broadcast by that cell (which may be a nominal value, e.g. 30 min, 1 hour, etc.).

After of transitional period (whose length may depend on the duration of the cell reselection procedure and the selected LA Update period in the cell A1), the telecommunications infrastructure 1 (more specifically, the processing system 5) may derive from the received LA Update messages how many and which idle terminals remain camped on the active cell A1, how many and which idle terminals Ti have reselected an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals have reselected from the active cell A1 to other cells. This provides an estimate about the situation regarding idle terminals when each of the inactive cells B1 will be activated (step 6-IV).

It should be noted that in the second method, the LA area update messages used to obtain the processing result are reported to the inactive cell B1 (and then via interface 3 to processing system 5, see FIG. 2).

In order to decrease the burden on the inactive cell B1, a first alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, does not perform cell reselection to that cell as long as it has its probing flag set; it sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on (see the box beside 6-IV in FIG. 6). Different from the first method illustrated in FIG. 5, and

different from the second method's basis described above, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, an inactive cell in this first alternative needs not to support reception of LA Update messages as described above. Also different from the first method illustrated in FIG. 5, an idle terminal Ti in this first alternative of the second method does not reselect to an inactive cell (comparable to active terminals Ta not being handed over to inactive cell B1).

A second alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, first sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on and only subsequently performs cell reselection to the best cell (see the box beside 6-IV in FIG. 6). Different from the first method illustrated in FIG. 5, and different from the second method's basis described above, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, again, an inactive cell needs not to support reception of LA Update messages.

Different from the first method, the inactive cells are configured with a nominal period for LA Updates. In this case, to prevent that LA Updates are sent to the inactive cell, the inactive cell may be configured with an infinite LA Update period during the period(s) wherein the presence signal P is transmitted in the inactive cell.

The information obtained from step 6-IV (and possibly step 6-I) may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 6-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions. A paging message

may be issued indicating modified system information. This paging message is also received by idle terminals still camping on the original active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision in step 6-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions including removal of the probing flag. This system information modification may, but not necessarily needs be announced in the activated cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 6-V, including a reset to the nominal LA update value for cell A1 and to remove the probing flag in activated cell(s) B1 in FIG. 6.

Still further, after the decision obtained from the processing of step 6-IV, the inactive cells that are decided to be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped on such a cell will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read system information is RAT dependent.

In a third method, illustrated in the flow chart of FIG. 7, the reporting identifier, also referred to as probing flag, is broadcasted in both the active cell A1 and the inactive cell B1. This third method does not rely on frequent periodic LA updates.

In step 7-I, the system information (SIB) to be broadcasted on the broadcast channel of the active cell A1 comprises a probing flag. In the active cell, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1.

An idle terminal Ti, detecting the probing flag, is configured (see FIG. 9) to report information about its identity (e.g. IMSI) and best cell (in this case, likely the active cell A1) to the cell it camps on. The information about the cell identity is not necessarily included in the report but may be added by the cell via which the report is sent. The report is sent once, on first detection of the probing flag being set. It is an option that an idle terminal Ti which has reselected another active cell will not send a report, which would prevent unnecessary reports to be received in other active cells. The telecommunications infrastructure (more precisely the processing system 5) receives the reports and may derive how many and which terminals Ti are currently camping on the active cell. This provides the information about the situation regarding idle terminals before the probing period starts.

Then, in step 7-II, a probing flag is also transmitted in the inactive cell(s) B1 and the presence signal P is transmitted as well.

In the active cell A1, the absolute signal level threshold Ts,search parameter is set higher than nominal (e.g. nominal value +[5,10] dBm) and in step 7-III is broadcast in the system information (SIB) on the broadcast channel of the cell. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells. A paging message may be issued indicating modified system information. This paging message is also received by idle terminals Ti camping on the cell. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselection evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal for which the absolute received signal level of the active cell A1 is below the adjusted threshold Ts,search measures the neighbours. For some RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active) neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell.

An idle terminal persisting to camping on the active cell A1 sends a report as described above for step 7-I regarding the active cell A1 to the active cell A1. An idle terminal Ti which reselects to an inactive cell (the terminal may detect this from the probing flag in the inactive cell's broadcast channel) is configured to, shortly after performing the reselection, send a report as described for step 7-I to the selected inactive cell (see FIG. 9). The report is sent once, on first detection of the probing flag being set in the cell it is camped on and to the cell it is camped on. It is an option that an idle terminal which has reselected another active cell will not send a report, which would prevent unnecessary reports to be received in other active cells. An idle terminal reporting a cell reselection to an inactive neighbour cell may be further configured to also report the presence of the probing flag in its report. This could ease bookkeeping at the processing system 5 regarding the neighbour state (probing or nominal).

After a transitional period (whose length may depend on the duration of the cell reselection procedure and time to send the associated reports), the telecommunications infrastructure 1 (more precisely, the processing system 5) may derive from the received reports how many and which idle terminals remain camped on the active cell A1, how many and which idle terminals have reselected an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals have reselected from the active cell to other cells. This provides an estimate about the situation regarding idle terminals when each of the inactive cells B1 will be activated.

Again, in order to decrease the burden on the inactive cell B1, a first alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, does not perform cell reselection to that cell as long as it has its probing flag set, yet may remain camping on such a cell; it sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on (see the box beside 7-IV in FIG. 7). Comparable to the second method's first alternative, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, an inactive cell in this first alternative needs not to support reception of reports as described above.

A second alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, first sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on and only subsequently performs cell reselection to the best cell (see the box beside 7-IV in FIG. 7). Comparable to the second method's second alternative, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, again, an inactive cell B1 needs not to support reception of reports as described above.

The information obtained from step 7-IV (and possibly step 7-I) may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 7-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions (which also includes removal of the probing flag). A paging message may be issued indicating modified system information. This paging mes-

sage is also received by idle terminals still camping on the original active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision in step 7-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions including removal of the probing flag. This system information modification may, but not necessarily needs be announced in the activated cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 7-V including a removal of the probing flags in active cell A1 and activated cell(s) B1.

Still further, after the decision obtained from the processing of step 7-IV, the inactive cells that are decided to be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped on such a cell will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read system information is RAT dependent.

Finally, in a fourth method, illustrated in the flow chart of FIG. 8, a measurement-and-report paging message, hereinafter denoted as paging message, is transmitted in the active cell A1 instructing the idle terminals Ti to obtain and report information on the inactive cells B1. The idle terminals Ti listen to broadcast and paging channels and can be triggered, using these channel(s), to obtain information on the inactive cells B1. The method may be combined with probing flags transmitted in the inactive cells.

In a first optional step 8-I, a paging message is transmitted in the active cell A1. The paging message may optionally comprise configuration parameters (see below), which

configuration parameters are to be applied by the idle terminal Ti.

In response to step 8-I, an idle terminal receiving the paging message is configured (see FIG. 9) to perform measurements on the serving cell (in this case the active cell A1) and on its neighbour cells, regardless the criterion settings for initiating a search (such as parameter Ts,search), and to subsequently send a report, by default to the cell that issued the paging message (in this case the active cell A1). After sending the report, a cell reselection may be performed. The idle terminal can be configured to not performing cell reselection as long as the highest-ranked cell has the probing flag set (comparable to the first alternative of the second or third method).

As indicated above, the paging message may optionally comprise configuration parameters. Examples are parameters that further specify the measurements to be made (which terminals should measure, which cell(s) to be measured, which RAT to be measured, which characteristics, etc.), parameters that further specify the subsequent reselection (such as offset or hysteresis parameters) and parameters that further specify the report to be provided (whether or not to provide a report, how many of the best cells to be reported, which quantities – e.g. signal level/quality, path loss estimates – to be reported, destination of the report, etc.). The paging parameters may alternatively or in addition, include a reference where the (further) parameters may be obtained, e.g. a reference (link) to a broadcast channel or the like, for example when the set of parameters is impractically large to be sent in the paging message itself.

A terminal receiving configuration parameter values in (or associated with) the paging message applies the received values when performing the measurements, the cell reselection procedure and the reporting as commanded by the paging message. It may be that in case of a conflict with an existing parameter having been assigned a value, the value received in the paging message is only applied for the measurements etc. related to the present method. Other procedures continue to apply the already

assigned value and are not affected by the value in the paging message.

The reported information includes at least an indication about the terminal identity (e.g. IMSI) and about the identity of the best cell. The report is sent once, on detection of the paging message, and by default (unless instructed otherwise) to the cell that issued the paging message, regardless the cell reselection that may be the result of the search.

The telecommunications infrastructure 1 (more precisely, the processing system 5) receives the reports and may derive how many and which terminals were camping on the active cell A1 and received the paging message and also may derive how many and which terminals are likely to remain camping on the active cell A1 after the paging message. This provides the information about the situation regarding idle terminals before the probing period starts.

Step 8-I is an optional step that may e.g. be omitted if the processing system 5 has no particular interest in obtaining information about the situation regarding idle terminals Ti in the active cell A1 before the start of transmitting the presence signal P in the inactive cell(s) B1.

Step 8-II involves the transmission of the presence signal P in the inactive cell(s). A probing flag may also be transmitted. Optionally, one or more of the inactive cells may be configured with system information parameters different from the normal operating conditions, e.g. values set specifically for the method.

Optionally, as described for previous methods illustrated in FIGS. 5-7, the active cell A1 may be configured with system information parameters different from the normal operating conditions, e.g. values set specifically for the probing phase. It is, however, envisaged that the possibility to specify configuration parameters in (or associated with) the paging message, has advantages over making temporary modifications to system information parameters.

In step 8-III, again a paging message is transmitted in the active cell A1. The paging message may optionally comprise

configuration parameters as described above. The values of these parameters may be different from those in the paging message optionally transmitted in step 8-I in active cell A1.

In order to decrease the load of reports, the paging message may also instruct only a fraction f of the idle terminals Ti in the active cell A1 to perform measurements and to provide a report. Mechanisms, such a paging groups, can be used to address or to instruct a particular fraction f (subset) of the idle terminals Ti. A fraction f of the idle terminals may also be established by configuring the idle terminal Ti to, randomly or deterministically determined, only provide the requested reports for a fraction f of the requests.

In response to step 8-III, an idle terminal receiving a paging message is configured to perform measurements on the serving cell (in this case the active cell A1) and on its neighbour cells, regardless the criterion settings for initiating a search, and to subsequently send a report (in this case to the default which is the cell that issued the paging message, i.e. active cell A1). The report is sent once, on detection of the paging message. After sending the report a cell reselection may be performed. The idle terminal can be configured to not performing cell reselection as long as the highest-ranked cell has the probing flag set.

The report includes at least an indication about the identity of the best cell and preferably an indication about the terminal identity (e.g. IMSI). The report may additionally include the status of the probing flag, if any, of the reported best cell.

The telecommunications infrastructure 1 (or more precisely, the processing system 5) receives the reports and may derive from the received reports how many and which idle terminals are likely to remain camped on the active cell, how many and which idle terminals are likely to reselect to an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals are likely to reselect to another cell (and which other cell). This provides an estimate about the situation re-

garding idle terminals when each of the inactive cells will be activated (step 8-IV).

The information obtained from step 8-IV (and possibly step 8-I, when performed) may be taken into account in the evaluation by the telecommunications infrastructure 1 (more precisely processing system 5) about which of the inactive cells to activate and which not.

If the system information of the active cell A1 has been set differently for the execution of the method than during normal operating conditions, then the system information for the active cell may be reverted back to normal operating conditions (not shown in FIG. 8).

If the inactive cell B1 is activated the following applies. If a probing flag was set, the probing flag may be removed. This system information change need not be announced by a paging message in the relevant cell(s). If the system information of the inactive cell has been set differently for the probing phase than during normal operating conditions, then the system information for the cell may be reverted back to normal operating conditions. If a probing flag was not set, an idle terminal camped there, will remain camped there.

If the inactive cell B1 is decided to not be activated, it may be switched off. If a probing flag was not set in the cell, an idle terminal camped there will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells, possibly reselecting another neighbour cell).

A paging message may be transmitted again after activating inactive cells wherein a probing flag was transmitted. In this case a primary objective is to actually let an idle terminal camped on the active cell A1 perform a reselection to one of the activated neighbour cells B1, when such reselection is still applicable. The processing system 5 may choose to either ignore the reports or to process the reports to assess the final configuration or to have it confirmed. If the system has no interest in assessing / confirming the final configuration, this

paging message may advantageously specify a configuration parameter indicating that no reports are to be sent.

It should be appreciated that 3GPP already specified functions for information gathering by a terminal such as described in 3GPP TS 37.320 "Radio Measurement collection for Minimization of Drive Tests (MDT)", which allows to configuring active terminals and/or idle terminals to perform measurements and to report the result to the network. With the described approaches, the responsiveness of the MDT measurements may be greatly improved and be made better suited to also gather information for the purpose of deciding which inactive cell(s) to activate.

In some of the methods and alternatives for triggering idle terminals Ti as described above, it may occur that an idle terminal Ti which camps on an inactive cell B1 initiates a session (e.g. initiates a voice or a data call). There are various ways to handle this situation.

When the inactive cell, despite its 'inactive' status, is to a sufficiently large extent operational, it may choose to accept the request and to support the call in the normal way, at least temporarily. Subsequently, the inactive cell may attempt to handover the call to an active cell; alternatively it may continue serving the call until a decision has been taken about the activation (or not) of that cell. If activated, it may continue to serve the call as an active cell; if not activated, it may handover the call to an active cell before the inactive cell is switched off.

When the inactive cell has insufficient capabilities to accept and/or support a call, or when it is otherwise undesirable to do so, the inactive cell may deny the call request. Various wireless access technologies provide a mechanism to elegantly and quickly refer a refused caller to an alternative, e.g. 'directed retry'. In that case, the inactive cell only needs to support the corresponding signalling.

Finally, note that by using a probing flag in an inactive cell and by using an idle terminal configured to not actually reselect to or camp on a cell which has its probing

flag set (also see the first alternative of the second and third method and see the fourth method), it can be prevented that idle terminals actually camp on an inactive cell.

In each of the above methods, the process of counting how many idle terminals will perform cell reselection may use a hysteresis Qhyst in the terminal for the measurement result.

Similarly, a neighbour-specific offset Qoffset,n can be applied to (e.g. added to) the measurement result in the terminal. By means of these cell-specific offsets a cell may be either be promoted or demoted in the ranking of cells for cell reselection.

In the above-described methods, conditions for cell reselection have been frequently addressed. In addition to these conditions, there may be various other conditions that determine whether a cell is suitable to be camped on by the idle terminal. It is assumed that all inactive neighbours are classified as a 'suitable cell', e.g. their Nrxlev and Nqual are sufficiently high to consider them for camping. It is also assumed that suitable averaging is applied to the measurements. Additionally, it is assumed that a (minimum) period is taken into account for which a highest-ranked cell has to be different from the current (active) cell before actually performing a cell reselection. This minimum period (timer) may also broadcasted via the broadcast channel of the cell in the same SIB.

For the measurement of inter-frequency or inter-RAT neighbour cells, active terminals Ta need some (measurement) time gaps to carry out the measurement. This might be managed by using the idle period provided by discontinuous reception (DRX) or radio resource scheduling. One example is the so called "compressed mode" in UMTS networks, where the data rate (and also transmit power) is temporarily doubled, so the data can be sent twice as fast and the resulting time gap could be used for inter-frequency of inter-RAT measurement.

Whereas the disclosed method and telecommunications infrastructure use existing measurement and reporting capabilities of wireless terminals, in at least some of the above-described embodiments the capabilities of wireless terminals should be

adapted to participate in these embodiments. Examples have been indicated above and include the recognition, processing and actions performed for cell reselection, in response to the reporting identifier (probing flag) and/or the measurement-and-reporting paging message of the above-described fourth method. Most of these enhanced capabilities will be obtained by software modifications in the wireless terminals. Therefore, FIG. 9 is a highly schematic illustration of a wireless terminal T comprising storage S and processor uP configured for storing and operating the modified software. For a base station BS A, BS B similar considerations apply.

Other network elements and signalling may also be affected, depending on how and where the modules 2~6 (as shown in Fig. 2) are deployed. One option is that the modules are deployed in a centralized fashion in the operation and management centre (OMC), the main impact may then be to the signalling messages that are carried between the OMC and base stations BS A and BS B.

Another option is that the modules are deployed in a distributed fashion in the radio network, e.g. in RNC (Radio Network Controller) of UMTS or eNodeB (LTE term for base station) of LTE. Then, additional signalling between these network nodes is required. For example, if BS A is an UMTS base station and BS B is an LTE base station, additional signalling between RNC and eNodeB is required for the purpose of this invention.

CLAIMS

1. A method for activating at least one inactive cell in a wireless telecommunications infrastructure, the telecommunications infrastructure comprising an active cell containing a plurality of terminals, the method comprising the steps of:

- transmitting a presence signal in the at least one inactive cell;
- receiving reports from the plurality of terminals detecting the presence signal;
- processing information contained in the reports received from the plurality of terminals in a processing system of the telecommunications infrastructure to provide a processing result; and
- activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

2. The method according to claim 1, further comprising the steps of:

- terminating transmission of the presence signal in the at least one inactive cell when the processed information does not fulfil the at least one activation condition
- transmitting the presence signal in the at least one inactive cell again at a later time.

3. The method according to claim 1 or 2, further comprising the step of providing the terminals in the active cell with measurement parameters and/or reporting parameters to obtain the information regarding the presence signal from the inactive cell.

4. The method according to one or more of the preceding claims, wherein the telecommunications infrastructure contains a plurality of inactive cells, the method comprising

the step of concurrently or sequentially transmitting the presence signal in the plurality of inactive cells

5. The method according to one or more of the preceding claims, wherein the at least one activation condition includes at least one of energy reduction for the telecommunications infrastructure, load reduction for the active cell or reduction of electromagnetic radiation from the telecommunications infrastructure or from a particular set of cells in the infrastructure.

6. The method according to one or more of the preceding claims, comprising the step of transmitting a reporting identifier in at least one of the active cell and the inactive cell.

7. The method according to one or more of the preceding claims, wherein at least some of the plurality of terminals in the active cell are idle terminals when gathering information for the report.

8. The method according to claim 7, further comprising the step of temporarily decreasing a location area update period in at least one of the active cell and the inactive cell.

9. The method according to claim 7 or 8, wherein the reports are received via the active cell.

10. The method according to claim 7, further comprising the step of transmitting a paging message in the active cell instructing the idle terminals to obtain and/or report the information.

11. A computer program comprising software code portions configured, when executed on one or more processing units, to perform the method according to one more of the claims 1-10.

12. A wireless access telecommunications infrastructure comprising an active cell and at least one inactive cell,

the active cell containing a plurality of terminals, wherein the infrastructure comprises:

- a presence signal generator configured for transmitting a presence signal in the at least one inactive cell;
- a receiver configured for receiving reports from the plurality of terminals detecting the presence signal;
- a processor system configured for processing information contained in the reports received from the plurality of terminals to provide a processing result; and
- an activator configured for activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

13. The wireless access telecommunications infrastructure configured for performing the method according to one or more of the claims 1-10.

14. A signal transmitted in a cell of the wireless access telecommunication of claim 12 or 13, wherein the signal contains a reporting identifier indicating that the cell is an inactive cell.

15. A terminal configured for operating in the wireless access telecommunications infrastructure of claim 12 or 13 and for processing the signal according to claim 14 or operating in the method according to claim 10.

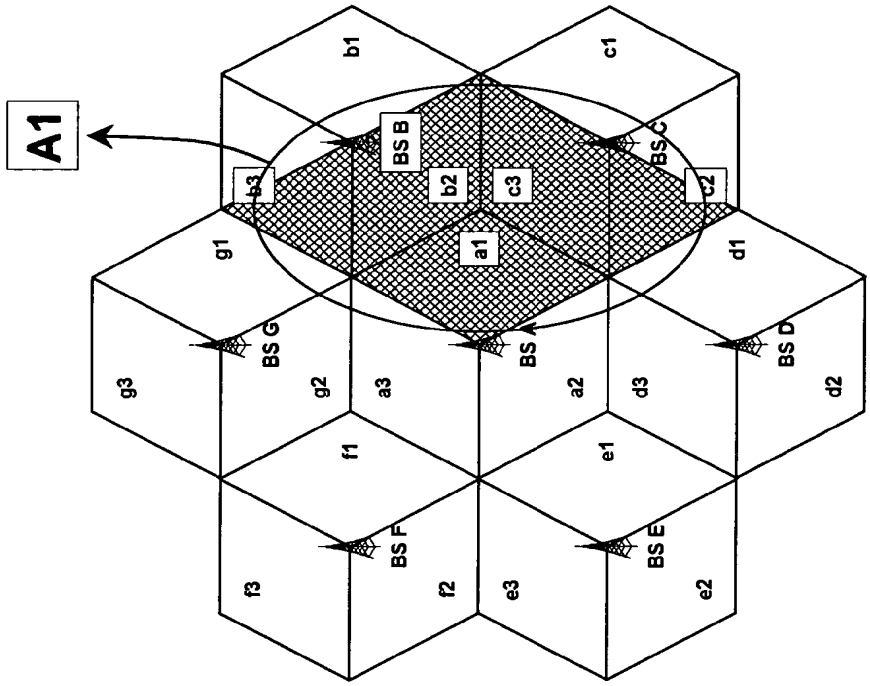
A1
b1
c1
BS B
BS C
b3
b2
c3
c2
a1
g1
d1
BS G
BS A
BS D
g3
g2
a3
a2
d3
d2
f1
e1
BS F
BS E
f3
f2
e3
e2

FIG. 1B

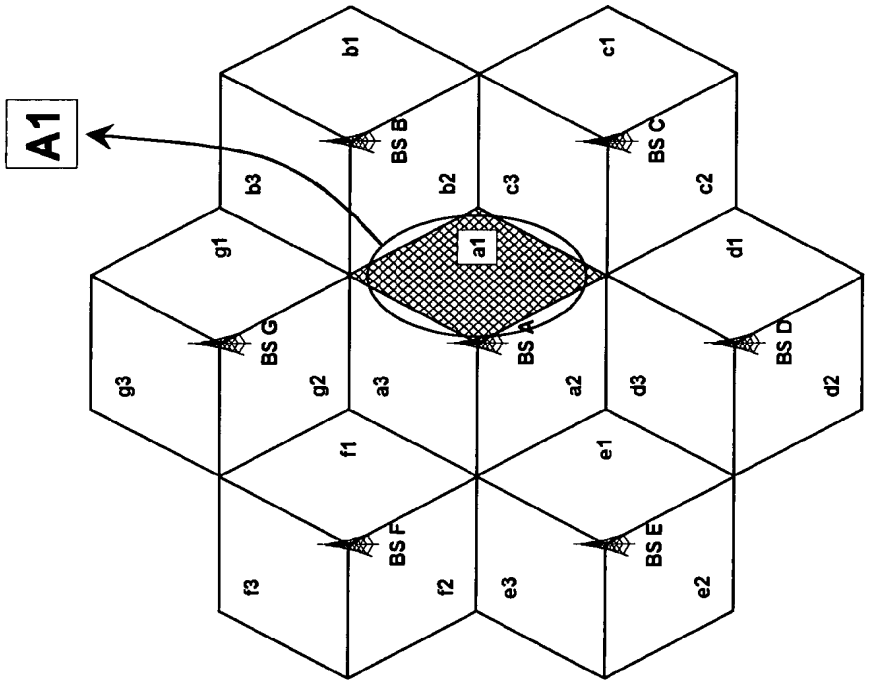
A1
b1
c1
BS B
BS C
b3
b2
c3
c2
a1
g1
d1
BS G
BS A
BS D
g3
g2
a3
a2
d3
d2
f1
e1
BS F
BS E
f3
f2
e3
e2

FIG. 1A

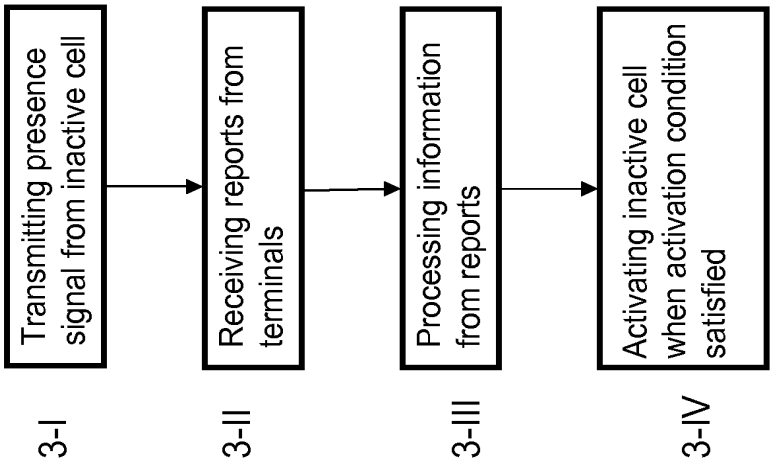
Transmitting presence signal from inactive cell
Receiving reports from terminals
Processing information from reports
Activating inactive cell when activation condition satisfied
3-I
3-II
3-III
3-IV

FIG. 3

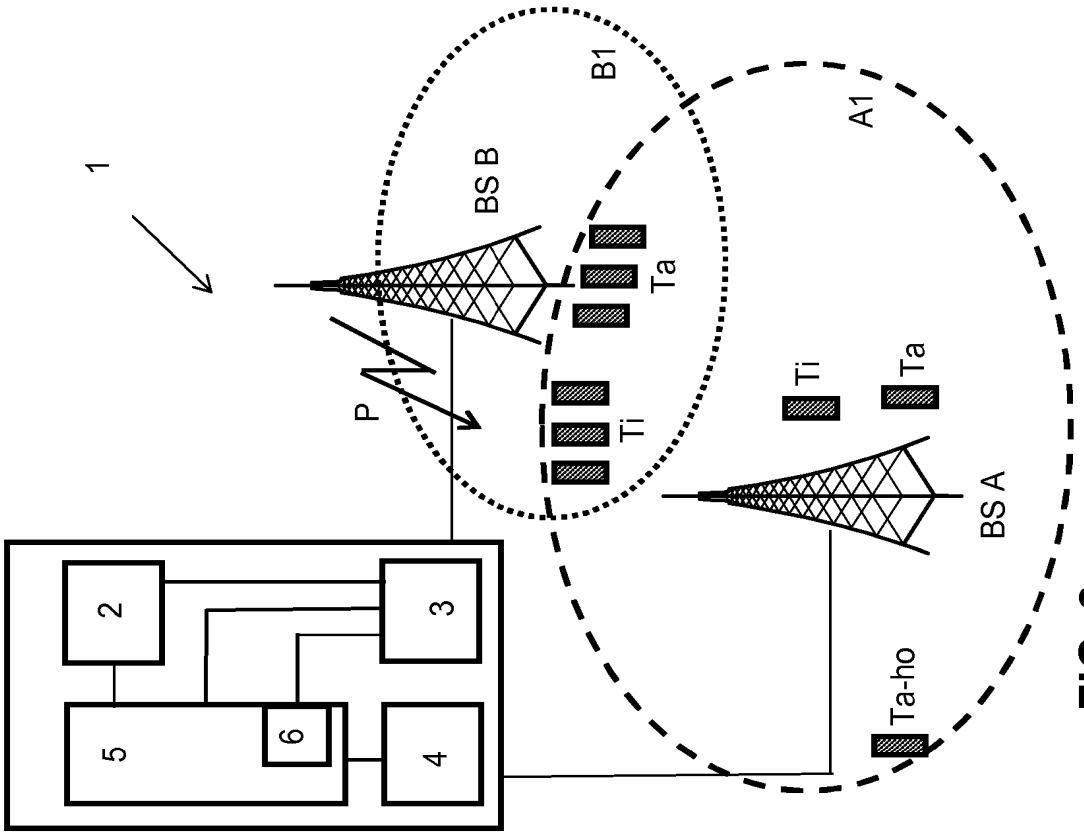
1
BS B
B1
Ta
Ti
P
A1
Ti
Ta
BS A
Ta-ho
2
3
4
5
6

FIG. 2

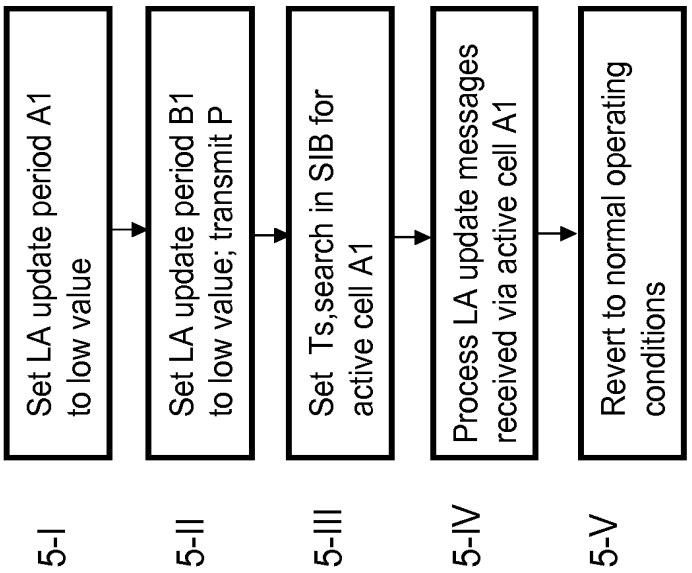
Set LA update period A1 to low value
Set LA update period B1 to low value; transmit P
Set Ts,search in SIB for active cell A1
Process LA update messages received via active cell A1
Revert to normal operating conditions
5-I
5-II
5-III
5-IV
5-V

FIG. 5

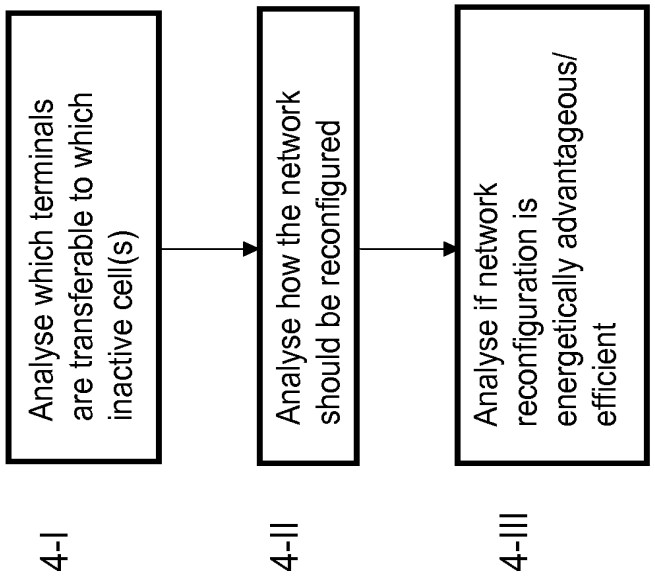
Analyse which terminals are transferable to which inactive cell(s)
Analyse how the network should be reconfigured
Analyse if network reconfiguration is energetically advantageous/ efficient
4-I
4-II
4-III

FIG. 4

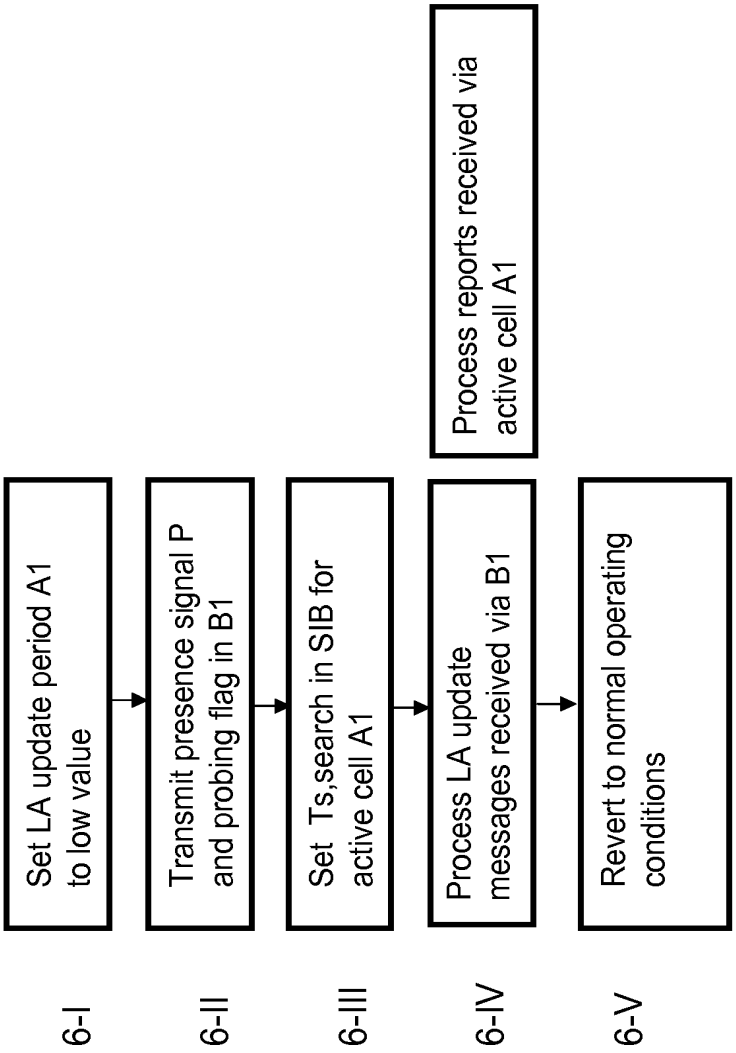
Set LA update period A1 to low value
Transmit presence signal P and probing flag in B1
Set Ts,search in SIB for active cell A1
Process LA update messages received via B1
Process reports received via active cell A1
Revert to normal operating conditions
6-I
6-II
6-III
6-IV
6-V

FIG. 6

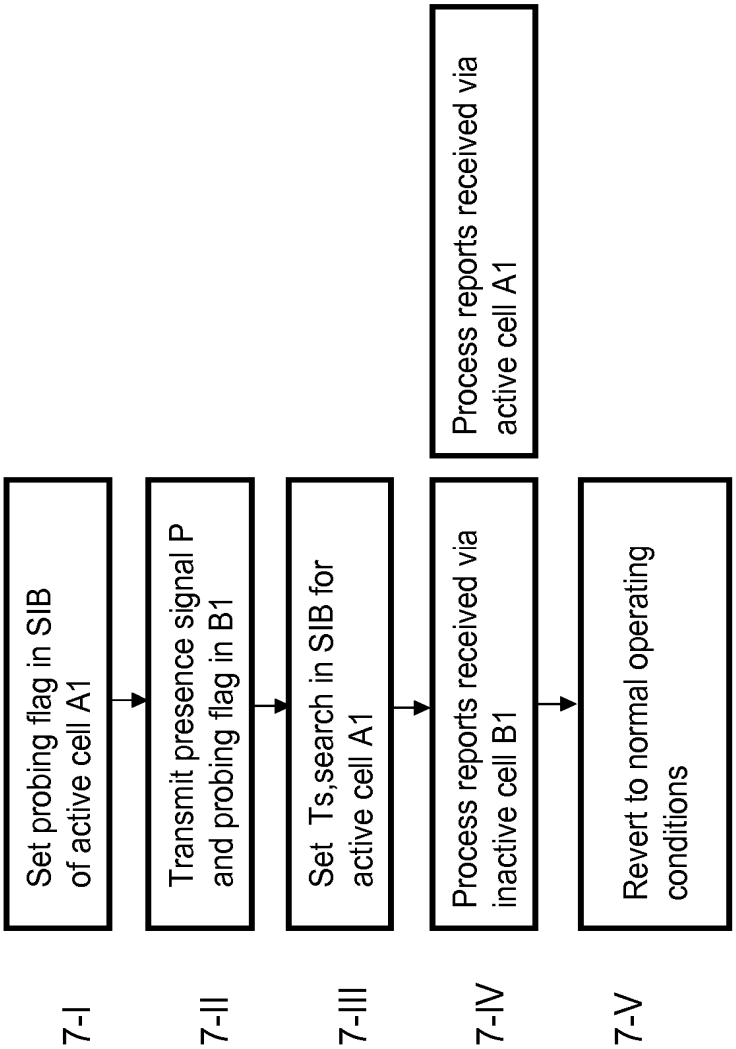
Set probing flag in SIB of active cell A1
Transmit presence signal P and probing flag in B1
Set Ts,search in SIB for active cell A1
Process reports received via inactive cell B1
Process reports received via active cell A1
Revert to normal operating conditions
7-I
7-II
7-III
7-IV
7-V

FIG. 7

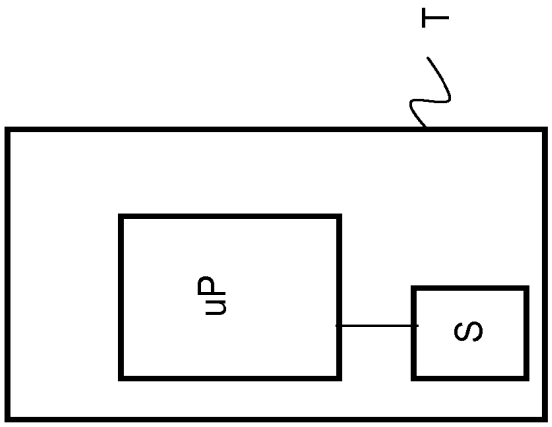
T
uP
S

FIG. 9

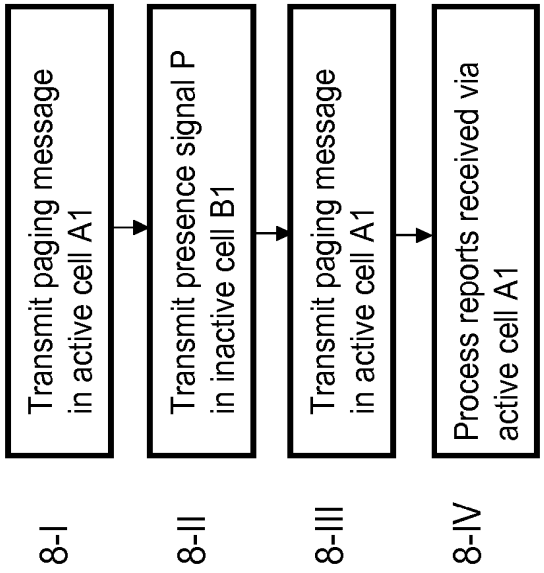
Transmit paging message in active cell A1
Transmit presence signal P in inactive cell B1
Transmit paging message in active cell A1
Process reports received via active cell A1
8-I
8-II
8-III
8-IV

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/057093

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W24/02
ADD. H04W52/02 H04W48/20

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 practical, 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	WO 2008/131588 A1 (HUAWEI TECH CO LTD [CN]; QVARFORDT CHRISTER [SE]; OLOFSSON HENRIK [SE]) 6 November 2008 (2008-11-06) page 4 - page 12	1-3, 11-13,15
X	WO 2010/002991 A1 (QUALCOMM INC [US]; SUBRAHMANYA PARVATHANATHAN [US]) 7 January 2010 (2010-01-07) figure 7 paragraphs [0006], [0060] - paragraph [0070]	1,11-13, 15

-/--

[X] Further documents are listed in the continuation of Box C.

[X] 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 document 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	Date of mailing of the international search report
27 May 2011	08/06/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Tozlovanu, Ana-Delia

1

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MITSUBISHI ELECTRIC: "Dynamic Setup of HNBs for Energy Savings and Interference Reduction", 3GPP DRAFT; R3-081949 (DYNAMIC SETUP HNBS), 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG3, no. Jeju Island; 20080813, 13 August 2008 (2008-08-13), XP050165010, section 1, 2.1 scenario 5, 2.2.B --- WO 2009/140988 A1 (NOKIA SIEMENS NETWORKS OY [FI]; DOETTLING MARTIN [DE]; FAERBER MICHAEL) 26 November 2009 (2009-11-26) page 7, line 30 - page 10, line 15 ---	1,4,5, 7-13,15 1,6, 11-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2011/057093

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2008131588 A1	06-11-2008	CN 101395935 A	25-03-2009
		EP 2149272 A1	03-02-2010
		US 2010061356 A1	11-03-2010
WO 2010002991 A1	07-01-2010	AU 2009266922 A1	07-01-2010
		CA 2728310 A1	07-01-2010
		CN 102077659 A	25-05-2011
		EP 2301282 A1	30-03-2011
		KR 20110039329 A	15-04-2011
		US 2010002614 A1	07-01-2010
WO 2009140988 A1	26-11-2009	EP 2316238 A1	04-05-2011
		US 2011076964 A1	31-03-2011

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US)
(Case No. 12-1172-WO-US)

In re Application of:	)	
	)	
Ljupco Jorguseski et al.	)	
	)	**Examiner: TBA**
Serial No.: Not yet assigned	)	
Int'l Appln. No.: PCT/EP2011/057093	)	**Art Unit: TBA**
	)	
Int'l. Filing Date: 4 May 2011	)	
	)	
For: METHOD AND	)	
TELECOMMUNICATIONS	)	
INFRASTRUCTURE FOR	)	
ACTIVATING AN INACTIVE CELL	)	

PRELIMINARY AMENDMENT

Mail Stop PCT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Prior to examination of the concurrently filed United States National application corresponding to PCT/EP2011/057093, Applicants respectfully request entry of the attached amendments to the specification beginning on page 2 and the claims beginning on page 3, as well as consideration of the attached Remarks beginning on page 9.

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AMENDMENT TO THE SPECIFICATION

In the first page, after the Title of the Invention, please insert the following:

"CROSS REFERENCE TO RELATED APPLICATIONS

The present application is a national stage entry of PCT/EP2011/057093, filed May 4, 2011, and claims priority to EP 10162192.8, filed May 6, 2010; EP 10187119.2, filed October 11, 2010; and EP 10196958.2, filed December 24, 2010. The full disclosures of EP 10162192.8, EP 10187119.2, EP 10196958.2, and PCT/EP2011/057093 are incorporated herein by reference."

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AMENDMENTS TO THE CLAIMS

1. (Currently Amended) A method for activating at least one inactive cell in a wireless access telecommunications infrastructure, the wireless access telecommunications infrastructure comprising an active cell containing a plurality of terminals, the method comprising ~~the steps of~~:

[[-]] transmitting a presence signal in the at least one inactive cell;

[[-]] receiving reports from the plurality of terminals detecting the presence signal;

[[-]] processing information contained in the received reports ~~received from the plurality of terminals~~ in a processing system of the wireless access telecommunications infrastructure to provide a processing result; and

[[-]] activating the at least one inactive cell when the processing result ~~fulfils~~ fulfills at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the at least one activated cell.

2. (Currently Amended) The method according to claim 1, further comprising ~~the steps of~~:

[[-]] terminating transmission of the presence signal in the at least one inactive cell when the processed information does not ~~fulfil~~ fulfill the at least one activation condition; and

[[-]] transmitting the presence signal in the at least one inactive cell again at a later time.

3. (Currently Amended) The method according to claim 1 ~~or 2~~, further comprising ~~the step of~~ providing the plurality of terminals in the active cell with at least one of measurement

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parameters or reporting parameters to obtain the information regarding the presence signal from the inactive cell.

4. (Currently Amended) The method according to ~~one or more of the preceding claims~~ claim 1, wherein:

the wireless access telecommunications infrastructure ~~further contains~~ comprises a plurality of inactive cells[[,]]; and

the method further comprises[[ing]] ~~the step of~~ concurrently or sequentially transmitting the presence signal in the plurality of inactive cells.

5. (Currently Amended) The method according to ~~one or more of the preceding claims~~ claim 1, wherein the at least one activation condition includes at least one of energy reduction for the wireless access telecommunications infrastructure, load reduction for the active cell, or reduction of electromagnetic radiation from the wireless access telecommunications infrastructure or from a particular set of cells in the infrastructure.

6. (Currently Amended) The method according to ~~one or more of the preceding claims~~ claim 1, further comprising ~~the step of~~ transmitting a reporting identifier in at least one of the active cell or [[and]] the at least one inactive cell.

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7. (Currently Amended) The method according to ~~one or more of the preceding claims~~ claim 1, wherein at least [[some]] one of the plurality of terminals in the active cell is an [[are]] idle terminal[[s]] when ~~gathering information~~ receiving [[for]] the report.

8. (Currently Amended) The method according to claim 7, further comprising ~~the step of~~ temporarily decreasing a location area update period in at least one of the active cell [[and]] or the at least one inactive cell.

9. (Currently Amended) The method according to claim 7 [[or 8]], wherein the reports are received via the active cell.

10. (Currently Amended) The method according to claim 7, further comprising ~~the step of~~ transmitting a paging message in the active cell instructing the at least one idle terminal[[s]] to obtain [[and/]]or report the information.

11. (Currently Amended) A computer program comprising software code portions configured, when executed by [[on]] one or more processing units, to perform ~~the method according to one more of the claims 1-10~~ functions for activating at least one inactive cell in a wireless access telecommunications infrastructure, the wireless access telecommunications infrastructure comprising an active cell containing a plurality of terminals, the functions comprising:

transmitting a presence signal in the at least one inactive cell;

receiving reports from the plurality of terminals detecting the presence signal;

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processing information contained in the reports received from the plurality of terminals in a processing system of the wireless access telecommunications infrastructure to provide a processing result; and

activating the inactive cell when the processing result fulfills at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

12. (Currently Amended) A wireless access telecommunications infrastructure for a wireless access telecommunications system comprising an active cell and at least one inactive cell, the active cell ~~containing~~ comprising a plurality of terminals, ~~wherein~~ the wireless access telecommunications infrastructure compris[[es]]ing:

[[-]] a presence signal generator configured for transmitting a presence signal in the at least one inactive cell;

[[-]] a receiver configured for receiving reports from the plurality of terminals detecting the presence signal;

[[-]] a processor system configured for processing information contained in the reports received from the plurality of terminals to provide a processing result; and

[[-]] an activator configured for activating the inactive cell when the processing result ~~fulfils~~ fulfills at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

13. (Currently Amended) The wireless access telecommunications infrastructure ~~configured for~~

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~~performing the method~~ according to ~~one or more of the claims 1-10~~claim 12, wherein the presence signal generator is further configured for:

terminating transmission of the presence signal in the at least one inactive cell when the processed information does not fulfill the at least one activation condition; and

transmitting the presence signal in the at least one inactive cell again at a later time.

14. (Currently Amended) The wireless access telecommunications infrastructure according to claim 12, further comprising a[[A]] signal transmitted in a cell of the wireless access telecommunication system ~~of claim 12 or 13~~, wherein the signal contains a reporting identifier indicating that the cell is an inactive cell.

15. (Currently Amended) The wireless access telecommunications infrastructure according to claim 14, further comprising a[[A]] terminal configured ~~for operating in the wireless access telecommunications infrastructure of claim 12 or 13 and~~ for processing the signal ~~according to claim 14 or operating in the method according to claim 10~~.

16. (New) The wireless access telecommunications infrastructure according to claim 12, wherein the presence signal generator is further configured for providing the plurality of terminals in the active cell with at least one of measurement parameters or reporting parameters to obtain the information regarding the presence signal from the inactive cell.

17. (New) The wireless access telecommunications infrastructure according to claim 12, wherein

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the presence signal generator is further configured for transmitting the presence signal in the plurality of inactive cells, and wherein the wireless access telecommunications infrastructure further comprises a plurality of inactive cells.

18. (New) The wireless access telecommunications infrastructure according to claim 12, wherein the presence signal generator is further configured for transmitting a reporting identifier in at least one of the active cell or the inactive cell.

19. (New) The wireless access telecommunications infrastructure according to claim 12, wherein the at least one activation condition includes at least one of energy reduction for the wireless access telecommunications infrastructure, load reduction for the active cell, or reduction of electromagnetic radiation from the wireless access telecommunications infrastructure or from a particular set of cells in the infrastructure.

20. (New) The wireless access telecommunications infrastructure according to claim 12, wherein at least one of the plurality of terminals in the active cell is an idle terminal when receiving the report.

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REMARKS

No new matter has been introduced into the present application as a result of the above amendments.

Applicant submits this preliminary amendment to put the claims in better condition for examination. Prompt consideration and entry of this amendment prior to examination is respectfully requested. If there are any questions or comments regarding this Amendment or application, the Examiner is encouraged to contact the undersigned attorney as indicated below.

Respectfully submitted,

Date: November 5, 2012

/Christian B.E. Hines/
Christian B.E. Hines
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PTO/SB/14 (11-08)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	12-1172-WO-US
	Application Number	
Title of Invention	Method and Telecommunications Infrastructure for Activating an Inactive Cell	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Ljupco		Jorguseski	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	The Hague	Country Of Residence[i]	NL
Citizenship under 37 CFR 1.41(b)[i]	NL		

Mailing Address of Applicant:

Address 1	Jozef Israellaan 234		
Address 2			
City	The Hague	State/Province	
Postal Code	2282 TR	Country[i]	NL

Applicant 2 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Remco		Litjens	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Voorschoten	Country Of Residence[i]	NL
Citizenship under 37 CFR 1.41(b)[i]	NL		

Mailing Address of Applicant:

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Address 2			
City	Voorschoten	State/Province	
Postal Code	2352 VH	Country[i]	NL

Applicant 3 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Haibin		Zhang	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	The Hague	Country Of Residence[i]	NL

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	12-1172-WO-US
	Application Number	
Title of Invention	Method and Telecommunications Infrastructure for Activating an Inactive Cell	

Citizenship under 37 CFR 1.41(b) [i]	CN		
Mailing Address of Applicant:			
Address 1	Usselincxstraat 142		
Address 2			
City	The Hague	**State/Province**	
Postal Code	2593 VP	**Country**[i]	NL

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	20306		
Email Address	docketing@mbhb.com	Add Email	Remove Email

Application Information:

Title of the Invention	Method and Telecommunications Infrastructure for Activating an Inactive Cell		
Attorney Docket Number	12-1172-WO-US	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		**Sub Class (if any)**	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	6	**Suggested Figure for Publication (if any)**	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S. C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	12-1172-WO-US
	Application Number	
Title of Invention	Method and Telecommunications Infrastructure for Activating an Inactive Cell	

Customer Number	20306

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	a 371 of international	PCT/EP2011/057093	2011-05-04

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Remove

Application Number	Country [i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
10162192.8	EP	2010-05-06	(•) Yes ( ) No

Remove

Application Number	Country [i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
10187119.2	EP	2010-10-11	(•) Yes ( ) No

Remove

Application Number	Country [i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
10196958.2	EP	2010-12-24	(•) Yes ( ) No

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To:
Wuyts, Koenraad
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P.O. Box 95321
NL-2509 CH The Hague
PAYS-BAS

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 403543WO	Date of mailing *(day/month/year)* 8 June 2011 (08-06-2011)
International application No. PCT/EP2011/057093	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
Applicant KONINKLIJKE KPN N.V.	International filing date *(day/month/year)* 4 May 2011 (04-05-2011)

1. [X] The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
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   When? The time limit for filing such amendments is normally two months from the date of transmittal of the International Search Report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Fascimile No.: (41-22) 338.82.70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 - 9.011.

2. [ ] The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. [ ] **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   [ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

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Name and mailing address of the International Searching Authority	Authorized officer
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Date of mailing *(day/month/year)* 09 June 2011 (09.06.2011)	
Applicant's or agent's file reference 403543WO	**IMPORTANT NOTIFICATION**
International application No. PCT/EP2011/057093	International filing date *(day/month/year)* 04 May 2011 (04.05.2011)
International publication date *(day/month/year)* **Not yet published**	Priority date *(day/month/year)* 06 May 2010 (06.05.2010)
Applicant KONINKLIJKE KPN N.V. et al	

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Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
06 May 2010 (06.05.2010)	10162192.8	EP	06 June 2011 (06.06.2011)
11 October 2010 (11.10.2010)	10187119.2	EP	06 June 2011 (06.06.2011)
24 December 2010 (24.12.2010)	10196958.2	EP	06 June 2011 (06.06.2011)

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— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

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

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) **Title**: LOW POWER MODES FOR FEMTO CELLS

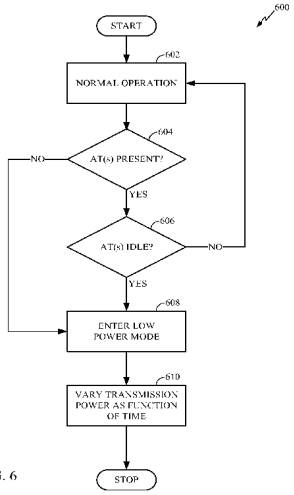


FIG. 6

(57) **Abstract**: Devices and methods are provided for deploying and/or implementing a low power mode in an access point (AP) base station. The low power mode may be implemented based on the presence and/or status of access terminals (ATs). In one embodiment, the method may involve determining whether any ATs are present within at least one defined coverage area. In another embodiment, the method may involve determining whether the ATs are in an idle or active state.

WO 2010/002991 A1

LOW POWER MODES FOR FEMTO CELLS

Claim of Priority under 35 U.S.C. §119

[0001] The present Application for Patent claims priority to Provisional Application No. 61/077,533 entitled "LOW POWER MODES FOR FEMTOCELLS" filed July 2, 2008, and assigned to the assignee hereof and hereby expressly incorporated by reference herein.

BACKGROUND

Field

[0002] The present application relates to wireless communication devices, and more particularly, to systems and methods for implementing low power modes for femto cells.

Background

[0003] Wireless communication systems are widely deployed to provide various types of communication (e.g., voice, data, multimedia services, etc.) to multiple users. As the demand for high-rate and multimedia data services rapidly grows, there lies a challenge to implement efficient and robust communication systems with enhanced performance.

[0004] In recent years, users have started to replace fixed line communications with mobile communications and have increasingly demanded great voice quality, reliable service, and low prices. In addition to mobile phone networks currently in place, a new class of small base stations has emerged, which may be installed in residential or business locations to provide indoor wireless coverage to mobile units using existing broadband internet connections. Such personal miniature base stations are generally known as an access point (AP) base station, also referred to as Home Node B (HNB) unit, femto cell, femto base station (fBS), base station, or base station transceiver system (BTS). Typically, such miniature base stations are connected to the internet and the mobile operator's network via a digital subscriber line (DSL) router or cable modem.

[0005] AP base stations or femto cells allow for cellular access where base station support is weak or unavailable (e.g., indoors, remote locations, and the like). AP base stations may be described as small base stations that connect to wireless service providers via a broadband backhaul link, such as DSL, cable internet access, T1/T3,

etc., and offer typical base station functionality, such as base transceiver station (BTS) technology, radio network controller, and gateway support node services. This allows an access terminal (AT), also referred to as a cellular/mobile device or handset, or user equipment (UE), to connect to the AP base stations and utilize the wireless service. It is noted that ATs can include, for example, cellular phones, smart phones, laptops, handheld communication devices, handheld computing devices, satellite radios, navigational devices, personal digital assistants (PDAs), and/or any other suitable device for communicating over a wireless communication system.

[0006] There will sometimes be extended periods of time when (a) there are no ATs within the coverage area(s) associated with a given AP base station, and/or (b) each of the ATs is in an idle state. In such circumstances, if the given AP base station transmits at a high power, the given AP base station will be wasting electric power, and may be causing unnecessary interference to users being served by neighboring AP base stations and/or macro base stations. Accordingly, it would be desirable to provide a technique for AP base stations to selectively reduce transmit power, while at the same time transmitting those signals necessary for ATs to detect the presence of the AP base stations and receive pages in their assigned wake-up cycles.

SUMMARY

[0007] The following presents a simplified summary of one or more embodiments in order to provide a basic understanding of such embodiments. This summary is not an extensive overview of all contemplated embodiments, and is intended to neither identify key or critical elements of all embodiments nor delineate the scope of any or all embodiments. Its sole purpose is to present some concepts of one or more embodiments in a simplified form as a prelude to the more detailed description that is presented later.

[0008] In accordance with one or more embodiments and corresponding disclosure thereof, various aspects are described in connection with methods for deployment of a low power mode in an access point (AP) base station. In one embodiment, the method may involve determining whether any access terminals (ATs) are present within at least one defined coverage area. The method may involve, in response to no ATs being within the at least one coverage area, entering the low power mode. The method may also involve, when in the low power mode, varying a transmission power at which the AP base station transmits at least one common channel (e.g., at least one of a synchronization channel, a pilot signal, and a broadcast channel) as a function of time.

[0009] In related aspects, the step of determining may comprise determining whether at least one AT is present within a femto coverage area of the AP base station. The step of varying may comprise varying the transmission power of at least one of a synchronization channel, a pilot signal, and a broadcast channel.

[0010] In further related aspects, the step of determining may comprise receiving mobility data regarding at least one AT as determined by a macro network. In the alternative, or in addition, the step of determining may comprise receiving information regarding whether at least one AT is present within a macro coverage area of a macro base station of a macro network. In the alternative, or in addition, the step of determining may comprise aggregating information regarding at least one AT from a plurality of macro base stations of a macro network.

[0011] In yet further related aspects, the step of receiving the information may comprise receiving a wake-up signal transmitted from the macro network. The method may involve receiving the wake-up signal based at least in part on identification of at least one of a serving cell and a neighboring cell reported by the at least one AT. The method may also involve receiving the wake-up signal based at least in part on mobility data regarding the at least one AT as determined by the macro network. The method may further involve ceasing to operate in the low power mode in response to receiving the wake-up signal, and/or modifying (e.g. increasing) the transmission power in response to receiving the wake-up signal.

[0012] In still further related aspects, the method may involve: in response to at least one AT being within the at least one coverage area, determining whether each of the at least one AT is an idle state; and in response to each of the at least one AT being in the idle state, entering a second low power mode. The method may involve, in response to a given one of the at least one AT being in an awake state, operating in a normal mode.

[0013] In another embodiment, the method may involve determining whether each of at least one AT in at least one defined coverage area is in an idle state. The method may involve, in response to each of the at least one AT being in the idle state, entering the low power mode. The method may also involve varying a transmission power at which the AP base station transmits at least one common channel as a function of time. The method may further involve, in response to a given one of the at least one AT being in an awake state, operating in a normal mode.

[0014] In accordance with one or more embodiments and corresponding disclosure thereof, various aspects are described in connection with devices and apparatuses

configured for deployment of a low power mode. In one example, the device may include a backhaul interface for a communication backhaul in operative communication with a macro network. The device may include a transceiver module for communicating with at least one of (a) at least one AT, (b) the macro network via the backhaul, and (c) at least one base station (e.g., at least one of a macro base station and a neighboring AP base station) in operative communication with the macro network. The device may also include at least one processor operatively coupled with the backhaul interface and the transceiver module. The device may further include a memory module operatively coupled with the at least one processor and comprising executable code for the at least one processor.

[0015] In one embodiment, the at least one processor may: (a) determine whether any ATs are present within at least one defined coverage area; (b) in response to no ATs being within the at least one coverage area, place the device in a low power mode; and (c) when the device is in the low power mode, instruct the transceiver module to vary a transmission power at which the transceiver module transmits at least one common channel (e.g., at least one of a synchronization channel, a pilot signal, and a broadcast channel) as a function of time.

[0016] In related aspects, the at least one coverage area comprises a femto coverage area of an AP base station. In the alternative, or in addition, the at least one coverage area may comprise a macro coverage area of a macro base station of the macro network. The at least one processor may determine whether any ATs are present within the at least one coverage by receiving mobility data regarding the at least one AT as determined by a macro network. The at least one processor may determine whether any ATs are present within the at least one coverage area by aggregating information regarding the at least one AT from a plurality of macro base stations of a macro network.

[0017] In further related aspects, the transceiver module may receive a wake-up signal transmitted from the macro network. The wake-up signal may be based at least in part on identification of at least one of a serving cell and a neighboring cell reported by the at least one AT. The wake-up signal may be based at least in part on mobility data regarding the at least one AT as determined by the macro network. The device may cease to operate in the low power mode in response to receiving the wake-up signal. The at least one processor may instruct the transceiver module to modify (e.g., increase) the transmission power in response to receiving the wake-up signal.

[0018] In yet further related aspects, the at least one processor may: in response to the at least one AT being within the at least one coverage area, determine whether each of the at least one AT is an idle state; and, in response to each of the at least one AT being in the idle state, place the device in a second low power mode. The at least one processor may place the device in a normal mode, in response to a given one of the at least one AT being in an awake state.

[0019] In another embodiment, the at least one processor may: (a) determine whether each of at least one AT in at least one defined coverage area is an idle state; (b) in response to each of the at least one AT being in the idle state, place the device in a low power mode; and (c) when the device is in the low power mode, instruct the transceiver module to vary a transmission power at which the transceiver module transmits at least one common channel as a function of time. The at least one processor may, in response to a given one of the at least one AT being in an awake state, place the device in a normal mode.

[0020] To the accomplishment of the foregoing and related ends, the one or more embodiments comprise the features hereinafter fully described and particularly pointed out in the claims. The following description and the annexed drawings set forth in detail certain illustrative aspects of the one or more embodiments. These aspects are indicative, however, of but a few of the various ways in which the principles of various embodiments may be employed and the described embodiments are intended to include all such aspects and their equivalents.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] FIG. 1 illustrates an exemplary wireless communication system.

[0022] FIG. 2 is an illustration of a wireless communication system in accordance with one or more aspects set forth herein.

[0023] FIG. 3 illustrates an exemplary environment within which an AP base station may be implemented.

[0024] FIG. 4 provides a block diagram of an exemplary AP base station.

[0025] FIG. 5 is a general component block diagram illustrating a system that deploys a low power mode in an AP base station.

[0026] FIG. 6 is a flow chart illustrating a generalized method that facilitates deployment of a low power mode in an AP base station.

[0027] FIG. 7 is a flow chart illustrating aspects of a generalized method for facilitating deployment of a low power mode in an AP base station.

[0028] FIG. 8A shows one embodiment for a method for facilitating deployment of a low power mode in an AP base station.

[0029] FIGS. 8B-C show sample aspects of the method shown in FIG. 8A.

[0030] FIG. 9A shows another embodiment for a method for facilitating deployment of a low power mode in an AP base station.

[0031] FIGS. 9B shows sample aspects of the method shown in FIG. 9A.

[0032] FIG. 10A illustrates one embodiment of an apparatus configured for deployment of a low power mode.

[0033] FIGS. 10B-C illustrate sample aspects of the apparatus shown in FIG. 10A.

[0034] FIG. 11 illustrates another embodiment of an apparatus configured for deployment of a low power mode.

DETAILED DESCRIPTION

[0035] Various embodiments are now described with reference to the drawings, wherein like reference numerals are used to refer to like elements throughout. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of one or more embodiments. It may be evident, however, that such embodiment(s) can be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form in order to facilitate describing one or more embodiments.

[0036] Access point (AP) base stations can be deployed to individual consumers and placed in homes, apartment buildings, office buildings, and the like. An AP base station can communicate wirelessly with an AT in range of the AP base station utilizing a licensed cellular transmission band. Further, AP base stations may be connected to a core cellular network by way of an Internet Protocol (IP) connection, such as a Digital Subscriber Line (DSL, e.g., including Asymmetric DSL (ADSL), High data rate DSL (HDSL), Very high speed DSL (VDSL), etc.), a TV cable carrying IP traffic, a Broadband over Power Line (BPL) connection, or like connection. The connection between the IP line and the cellular network can be a direct connection, or by way of the internet. An AP base station, therefore, can provide cellular support to an AT or cellular handset and route cellular traffic (e.g., voice, data, video, audio, internet, etc.) to a macro cellular network through the IP connection. This mechanism can save consumers

air time costs and reduce a network provider's cellular network traffic load. Also, cellular coverage inside a home, office building, apartment, etc. can be greatly improved via implementation of AP base stations. It is noted that the AP base station can communicate with the core cellular network by way of a non-IP connection that implements Asynchronous Transfer Mode (ATM) or the like.

[0037] Although an AP base station is capable of forming a cellular link (e.g., a wireless link utilizing one or more licensed radio network frequencies) with multiple ATs, a consumer typically desires only his or her own traffic to be carried by a private IP connection connected to the AP base station. For instance, consumers may wish to preserve IP bandwidth for their own use, rather than for the use of other AT users. As a result, in certain deployments, an AP base station may be associated with a single AT or group of ATs, and traffic related to such AT(s) is routed over the consumer's IP connection, whereas traffic related to other ATs may have a lower priority or be blocked. Consequently, although the AP base station can communicate with multiple ATs regardless of subscriber, the AP base station is typically programmed to ignore devices that are not associated with a particular consumer, service plan, or the like.

[0038] FIG. 1 illustrates an exemplary wireless communication system 100 configured to support a number of users, in which various disclosed embodiments and aspects may be implemented. As shown in FIG. 1, by way of example, system 100 provides communication for multiple cells 102, such as, for example, macro cells 102a-102g, with each cell being serviced by a corresponding macro base station 104 (such as base stations 104a-104g). Each cell may be further divided into one or more sectors. Various access terminals (ATs) 106, including ATs 106a-106k, also known interchangeably as user equipment (UE), are dispersed throughout the system. Each AT 106 may communicate with one or more base stations 104 on a forward link (FL) and/or a reverse link (RL) at a given moment, depending upon whether the AT is active and whether it is in soft handoff, for example. Wireless communication system 100 may provide service over a large geographic region, for example, macro cells 102a-102g may cover a few blocks in a neighborhood.

[0039] Referring now to FIG. 2, a wireless communication system 200 is illustrated in accordance with various embodiments presented herein. System 200 comprises a macro base station 202 that can include multiple antenna groups. For example, one antenna group can include antennas 204 and 206, another group can comprise antennas 208 and 210, and an additional group can include antennas 212 and 214. Two antennas are

illustrated for each antenna group; however, more or fewer antennas can be utilized for each group. Base station 202 can additionally include a transmitter chain and a receiver chain, each of which can in turn comprise a plurality of components associated with signal transmission and reception (e.g., processors, modulators, multiplexers, demodulators, demultiplexers, antennas, etc.), as will be appreciated by one skilled in the art. Base station 202 can communicate with one or more ATs, such as, for example, AT 216 and AT 222.

[0040] As depicted in FIG. 2, AT 216 is in communication with antennas 212 and 214, where antennas 212 and 214 transmit information to AT 216 over a forward link 218 and receive information from AT 216 over a reverse link 220. Moreover, AT 222 is in communication with antennas 204 and 206, where antennas 204 and 206 transmit information to AT 222 over a forward link 224 and receive information from AT 222 over a reverse link 226. In a Frequency Division Duplex (FDD) system, forward link 218 can utilize a different frequency band than that used by reverse link 220, and forward link 224 can employ a different frequency band than that employed by reverse link 226, for example. Further, in a Time Division Duplex (TDD) system, forward link 218 and reverse link 220 can utilize a common frequency band and forward link 224 and reverse link 226 can utilize a common frequency band.

[0041] Each group of antennas and/or the area in which they are designated to communicate can be referred to as a sector of macro base station 202. For example, antenna groups can be designed to communicate to ATs in a sector of the areas covered by base station 202. In communication over forward links 218 and 224, the transmitting antennas of base station 202 can utilize beamforming to improve the signal-to-noise ratio of forward links 218 and 224 for ATs 216 and 222. Also, while base station 202 utilizes beamforming to transmit to ATs 216 and 222 scattered randomly through an associated coverage, ATs in neighboring cells can be subject to less interference as compared to a base station transmitting through a single antenna to all its ATs. Moreover, ATs 216 and 222 can communicate directly with one another using a peer-to-peer or ad hoc technology in one example.

[0042] Similar functionality of macro base station 202 can be implemented in AP base stations 228 and 230, which can be deployed in smaller scale locations, such as a residence or office building for example. As mentioned previously, AP base stations are also referred to as femto cells or Home Node B (HNB) units, and can have a broadband backhaul link to a wireless service provider, such as over DSL, cable, T1/T3, etc., and

can provide wireless communication service to one or more ATs. As shown, AP base station 228 can communicate with one or more AT(s) 232 over a forward link 234 and receive communication from the AT(s) 232 over a reverse link 236 similarly to the base station 202.

[0043] According to an example, AP base station 230 can be deployed to provide wireless service access. Upon being deployed, AP base station 230 can optionally self-configure to avoid interference with surrounding femto cells (e.g., AP base station 228) and macro cells (e.g., base station 202 or a sector/cell thereof). In this regard, AP base station 230 can receive signals from the base station 202 and disparate AP base station 228 much like ATs 216, 222, and 232. The signals can be overhead system messages that can be utilized by the AP base station 230 to determine configuration parameters utilized by the disparate AP base station 228 and/or base station 202.

[0044] The configuration parameters can be determined by AP base station 230 for similar environment configuration. In addition, the parameters can be determined and utilized to ensure AP base station 230 selects different parameters to mitigate interference. These parameters can include, for example, a channel identifier (e.g., a Code Division Multiple Access (CDMA) channel ID), a pseudo-noise (PN) offset, and/or the like, for AP base station 228, macro base station 202, and/or substantially any other surrounding transmitters. AP base station 230 can accordingly self-configure its channel identifier, PN offset, etc. so as not to interfere with the surrounding femto cells and macro cells. Additionally, AP base station 230 can utilize this information to build a neighbor list of surrounding femto cells and macro cells to facilitate hard and soft handoffs for devices communicating with AP base station 230. It is noted that AP base station 230 may be adapted to receive radio frequency (RF) signals, for example, from AP base station 228 and/or base station 202 to determine timing, location, and/or the like.

[0045] In accordance with one or more aspects of the embodiments described herein, FIG. 3 illustrates an exemplary system 300 within which an AP base station 315 may be implemented. System 300 may include an AT 305a in operative communication with a macro base station 310 operatively coupled to a macro network 330, which comprises or is otherwise operatively coupled to a macro network core. System 300 may also include an AT 305b in operative communication with AP base station 315, operatively coupled to a communication backhaul 325, which is in turn operatively coupled to the network core of macro network 330.

[0046] In operation, mobile device 305a may send and receive data from macro base station 310 via a communication link 307, which may use various communication standards such as CDMAone, CDMA2000, Wideband CDMA (W-CDMA, also known as Universal Mobile Telecommunications System (UMTS)), Ultra Mobile Broadband (UMB), Long Term Evolution (LTE), LTE-Advanced (LTE-A), Worldwide Interoperability for Microwave Access (WiMAx), etc. Base station 310 may be in communication with macro network 330 via link 308. It is noted that system 300 may be configured to operate on 3rd Generation Partnership Project (3GPP) (Rel99, Rel5, Rel6, Rel7) technology, as well as 3GPP2 (1xRTT, 1xEV-DO Rel0, RevA, RevB) technology, and other known and related technologies.

[0047] Macro network 330 may include a network controller at its network core. Depending on the types of the communication network deployed, the network controller may be a Radio Network Controller (RNC), a modified RNC, an Unlicensed Mobile Access (UMA) network controller, or a Session Initiation Protocol (SIP) gateway, or the like. In the illustrated example, macro base station 310 is in operative communication with RNC 332 of macro network 330. In the embodiment of FIG. 3, macro network 330 includes a Base Station Controller (BSC) or RNC 332. BSC/RNC 332 may be in operative communication with a Message Switching Center (MSC) 334 or similar service delivery node responsible for handling voice calls, Short Message Service (SMS), as well as other services (e.g., conference calls, FAX and circuit switched data). MSC 334 may set up and release the end-to-end connections, handle mobility and hand-over requirements during the call, take care of charging and real time pre-paid account monitoring, etc.

[0048] MSC 334 may include or be coupled to a Visitor Location Register (VLR) 336 or similar temporary database of network subscribers who have entered or roamed into a particular area. VLR 336 may be in operative communication with a registry (not shown), which may generally comprise a database that contains details of mobile phone subscribers authorized to use the operator's network. MSC 334 may be in operative communication with a Public Switched Telephone Network (PSTN) 340, Public Line Mobile Network (PLMN), or other similar network. In this way, macro network 330 can deliver voice and data services to end users that are connected to one of those networks. System 300 may be scaled to include additional MSCs and registries (not shown) in operative communication with MSC 334 to increase capacity.

[0049] In related aspects, mobile device 305b may communicate with macro network 330 via macro base station 310 and/or AP base station 315 configured to use backhaul service 325 to transfer voice and/or non-voice data there between. Backhaul service 325 may include the internet, a DSL service, a cable internet service, a Local Area Network (LAN), a Wide Area Network (WAN), a Plain Old Telephone System (POTS), or any other suitable broadband network or the like. Mobile 305b may communicate with base station 315 via communication link 309, and may incorporate one or more features of AP base stations described above with reference to FIG. 2. It is noted that base station 315 includes as one of its features the ability to provide a femto cell through which a given AT may communicate with the network core of the macro network 330.

[0050] AP base station 315 may be configured to transfer data over backhaul network 325 via communication link 311 (wired or wireless). Depending on the type of system being deployed, communication link 311 may use Voice over IP (VoIP), UMA signaling, SIP signaling, or other suitable communication network protocol, such as, for example, Iub over IP. Iub is a standard transport protocol that may be designed to encapsulate voice and/or non-voice data and to signal as an IP that is tunneled over network 325.

[0051] Macro network 330 may process data received from network 325 with a suitable network controller, analogous to the manner in which macro network 330 handles data from macro base station 310. The type of network controller used by macro network 330 depends at least in part on the architecture or types of components of AP base station 315. For example, there are various femto cell architectures such as, for example, IP Radio Access Network (RAN) and SIP/IMS. Within the IP RAN architecture there may be provided various femto cell solutions, such as, for example, modified RNCs, concentrators, etc. implementing various hardware architectures in the network core and/or in the AP base station.

[0052] It is also noted that system 300 may comprise WAN macro cells and femto cells deployed within the same general geographical area that reuse the same carrier as the WAN system. In one approach, the WAN system may use a legacy technology, while the femto cell system may use a new technology, such as, for example, an evolved version of the legacy technology that supports AP base station operation efficiently.

[0053] In accordance with one or more embodiments and corresponding disclosure thereof, various aspects are described in connection with an AP base station configured to utilize selectively operate in operate in one or more low power modes. With

reference to FIG. 4, there is provided an exemplary system 400 comprising an AP base station 402 that may include a receiver component/module 410 adapted to receive signal(s) from AT(s) 404 or from other AP base stations (not depicted) through a plurality of receive antennas 406. AP base station 402 may also include a transmitter component/module 426 adapted to transmit to the AT(s) 404 (or other AP base stations) through one or more transmit antennas 408. Receiver component 410 may receive information from receive antennas 406 and may further comprise a signal recipient (not shown) that receives uplink data transmitted by AT(s) 404. It should be appreciated that receiver component 410 and transmission component 426 may be configured to communicate with ATs or other AP base stations via wireless local area network (WLAN), BPL, Ethernet, UMTS-TDD, or WLAN over UMTS-TDD (e.g., to implement WLAN over a cellular frequency to communicatively couple AP base stations). It is noted a transceiver module (not depicted) may be used in lieu of, or in conjunction with, receiver component 410 and transmission component 426.

[0054] Receiver component 410 may be operatively associated with a demodulator 412 adapted to demodulate received information. Demodulated symbols may be analyzed by a processor 422 to generate additional signals (e.g., in the form of transmission and/or routing instructions) modulated by modulator 424 and transmitted by transmitter component 426. Further, processor 422 may be coupled to a memory 420. Memory 420 may store information pertinent to effectuating wired and/or wireless communication, application modules for routing information between neighboring AP base stations, macro base stations, and/or ATs, and/or any other suitable information related to performing the various actions and functions set forth herein.

[0055] Processor 422 may route at least a portion of traffic associated with a communication link between AP base station 402 and AT 404 to a neighboring AP base station (not depicted) for transfer to a cellular network (e.g., by way of a direct connection to the cellular network, or by way of the Internet). Furthermore, processor 422 may be adapted to direct traffic affiliated with AP base station 402 (e.g., generated by a predetermined AT or group of ATs, for instance) directly to the cellular network by way of an IP upload link 430 (e.g., DSL connection, such as ADSL, VDSL, HDSL, or cable IP connection, or BPL connection). In addition, data may be received from the cellular network via an IP download link 428 (e.g., DSL, cable, BPL) and directed to an AT 404 affiliated with the AP base station 402. It is noted that AP base station 402 may comprise one or more processors 422.

[0056] Receiver component 410 and transmitter component 426 may receive and transmit, respectively, various information to/from a cellular network (e.g., via IP upload 430 and/or IP download 428) or to/from other AP base stations by way of an IP router 427 that communicates over unlicensed frequencies or wired connections (e.g., WLAN router, LAN router, or the like). It is noted that the receiver and transmitter components/modules 410, 426 may be part of or replaced with a transceiver module (not depicted) in other embodiments. The depicted receiver 410 and transmitter 426, or alternatively a transceiver, may be adapted to support communication links with a plurality of APs.

[0057] AP base station 402 may include a positioning receiver (not depicted) for acquiring signals from a first data source, such as, a plurality of satellites of a Global Positioning Satellite (GPS) system or other Satellite Positioning System (SPS) (e.g., the Global Navigation Satellite System (GLONASS/GNSS), the proposed European Galileo System, etc.). AP base station 402 may include a transceiver module (not depicted) for communicating with at least one of (a) an AT, (b) the macro network via the backhaul, and (c) a macro base station and/or neighboring AP base station in operative communication with the macro network.

[0058] In related aspects, memory 420 may contain application modules or applications that generate or comprise code/instructions for processor 422 to: (a) determine whether any ATs are present within at least one defined coverage area; (b) in response to no ATs being within the at least one coverage area, place AP base station 402 in a first low power mode; (c) in response to at least one AT being within the at least one coverage area, determine whether each of the at least one AT is an idle state; (d) in response to each of the at least one AT being in the idle state, place AP base station 402 in a second low power mode; and (e) when AP base station is in the first/second low power mode, instruct transmitter component 426 or a transceiver module to vary a transmission power at which at least one common channel is transmitted as a function of time. It is noted that processor 422 may, in response to a given one of the at least one AT being in an awake state, place the AP base station 402 in a normal mode.

[0059] In further related aspects, processor 422 may determine whether the at least one AT is present within the at least one coverage area by determining whether the at least one AT is present within a femto coverage area of an AP base station. Transmitter component 426 may vary the transmission power of at least one of a synchronization channel, a pilot/reference signal, and a broadcast channel.

[0060] In yet further related aspects, processor 422 may determine whether the at least one AT is present within the at least one coverage area by receiving information regarding whether the at least one AT is present within a macro coverage area of a macro base station of the macro network. Receiver component 410 or a transceiver module may receive a wake-up signal transmitted from the macro network. The wake-up signal may be based at least in part on identification of at least one of a serving cell and a neighboring cell reported by the at least one AT. In the alternative, or in addition, the wake-up signal may be based at least in part on mobility data regarding the at least one AT as determined by the macro network.

[0061] In still further related aspects, AP base station 402 may cease to operate in the low power mode in response to receiving the wake-up signal. Processor 422 may instruct transmitter component 426 to modify the transmission power in response to receiving the wake-up signal, such as, for example, by increasing the transmission power.

[0062] FIG. 5 provides a general component block diagram illustrating a system to enable lower power modes in AP base stations. As shown in FIG. 5, a system 500 may include an AP base station 502 having a presence component 504 and a power control component 506.

[0063] In one embodiment, presence component 504 may determine the presence of at least one AT associated (e.g. registered) with AP base station 502. Additionally, presence component 504 may determine the state of the associated AT(s). For instance, the presence component 504 can determine if the synchronized ATS are awake or idle.

[0064] Presence component 504 may communicate information regarding the presence and the state of the associated ATs (e.g. presence data) to power control component 506. The power control component 506 may control the power level at which AP base station 502 transmits a plurality of signals based at least in part on the presence data. For instance, when no ATs are registered with AP base station 502, or all registered ATs are idle, power control component 506 may direct AP base station 502 to transmit in a low power mode. In low power mode, AP base station 502 may vary (e.g., as a function of time) the power level at which it transmits one or more common channels.

[0065] Power control component 506 may ensure that the power level is maintained at a nominal level with adequate frequency to allow new ATs to detect the AP base station 502, and/or ensure alignment between the awake periods of associated ATs and periods when the transmission power of AP base station 502 is at the nominal level. The

common channels may be channels that AP base station 502 is required to transmit in order to allow ATs to detect and/or connect to AP base station 502. The common channels may include but are not limited to synchronization channels, pilot or reference signals, and broadcast channels.

[0066] It is noted that, in another embodiment, presence component 504 may be configured to detect or determine the presence of any ATs within a femto coverage area of AP base station 502, regardless of whether the ATs are associated with the AP base station 502.

[0067] Additionally or alternatively, a macro network 508 may communicate with AP base station 502 to send wake-up signals to AP base station cell 502 based on identification of a serving cell and/or identification of neighbor cells reported by ATs, associated or otherwise, to macro network 508. Furthermore, macro network 508 may also send to AP base station 502 data or estimates regarding a given AT's mobility. In turn, AP base station 502 may modify or eliminate usage of low power modes based on the mobility data or estimates thereof.

[0068] In view of the exemplary systems described above, an exemplary method that may be implemented in accordance with the disclosed subject matter will be better appreciated with reference to the flow charts of FIGS. 6 and 7. While for purposes of simplicity of explanation, the methods are shown and described as a series of blocks, it is to be understood and appreciated that the claimed subject matter is not limited by the order of the blocks, as some blocks may occur in different orders and/or concurrently with other blocks from what is depicted and described herein. Moreover, the illustrated blocks do not represent all possible steps, and not all illustrated blocks may be required to implement the methods described below.

[0069] FIG. 6 illustrates a method 600 that facilitates implementing a low power mode in an AP base station. At step 602, the AP base station is operating normally or in a non-low power mode. At step 604, the AP base station determines the presence of one or more ATs (e.g., ATs associated with the AP base station). At step 606, if there is at least one AT present, then the AP base station determines the wake state/status (e.g. awake or idle) of the ATs. At step 608, if all ATs are idle (YES at step 606), or there are no ATs (NO at step 604), then the AP base station enters a low power mode. At step 610, in low power mode, the AP base station may vary the power level at which it transmits common channels (e.g., synchronization, pilot or reference signals, broadcast channels, etc.) as a function of time. The AP base station may ensure the power level is

maintained at a nominal level often enough to allow any new ATs to detect its presence, and/or connect to the AP base station. The AP base station preferably adjusts or modifies the transmission power and/or the transmission timing of a transmitter component (or a transceiver module) to correlate or match (a) the awake periods of the ATs and (b) the periods of nominal power transmission. The nominal power level can be predetermined or varied/adjusted (e.g., determined in real time) by the AP base station.

[0070] FIG. 7 illustrates aspects of a method 700 that facilitates implementing a low power mode in an AP base station. At step 702, one or more ATs report serving cell and/or neighbor cell identifications to the macro network. At step 704, the macro network may transmit a wake-up signal or the like to the AP base station (typically an AP base station associated with the ATs) based at least in part on the ATs reports. Additionally or alternatively, the macro network may estimate the mobility of the ATs, and transmit wake-up signals to the AP base station based at least in part on the mobility estimates. At step 706, the AP base station may receive the wake-up signals from the macro network, and may modify or eliminate its usage of low power modes based at least in part on the received wake-up signals.

[0071] In accordance with one or more aspects of the embodiments described herein, FIG. 8A illustrates an exemplary method 800 for facilitating deployment of a low power mode in an AP base station that may involve steps 810-874 described below. At step 810, method 800 may involve determining whether any access terminals (ATs) are present within at least one defined coverage area. In response to no ATs being within the at least one coverage area, the low power mode may be entered (step 820). Method 800 may involve, when in the low power mode, varying a transmission power at which the AP base station transmits at least one common channel as a function of time (step 830).

[0072] With reference to FIG. 8B, step 810 may involve determining whether at least one AT is present within a femto coverage area of the AP base station (step 840). Step 830 may involve varying the transmission power of at least one of a synchronization channel, a pilot signal, and a broadcast channel (step 842). In another approach, step 810 may involve receiving mobility data regarding at least one AT as determined by a macro network (step 850).

[0073] In related aspects, step 810 may involve receiving information regarding whether at least one AT is present within a macro coverage area of a macro base station

of a macro network (step 860). At step 862, method 800 may involve receiving a wake-up signal transmitted from the macro network. Step 862 may involve receiving the wake-up signal based at least in part on identification of at least one of a serving cell and a neighboring cell reported by the at least one AT (step 864). In the alternative, or in addition, step 862 may involve receiving the wake-up signal based at least in part on mobility data regarding the at least one AT as determined by the macro network (step 866).

[0074] With reference to FIG. 8C, at step 870, method 800 may further involve ceasing to operate in the low power mode in response to receiving the wake-up signal. In response to receiving the wake-up signal, the transmission power may be modified (step 872). Step 882 may involve increasing the transmission power (step 874).

[0075] In further related aspects, method 800 may further involve, in response to at least one AT being within the at least one coverage area, determining whether each of the at least one AT is an idle state (step 880). Method 800 may involve, in response to each of the at least one AT being in the idle state, entering a second low power mode (step 882). At step 884, in response to a given one of the at least one AT being in an awake state, the method 800 may involve operating in a normal mode. In yet further related aspects, step 810 may involve aggregating information regarding at least one AT from a plurality of macro base stations of a macro network (sub-step 890).

[0076] In accordance with one or more aspects of the embodiments described herein, FIG. 9A illustrates another embodiment of a method for facilitating deployment of a low power mode in an AP base station. With reference to FIG. 9A, there is provided an exemplary method 900 for facilitating deployment of a low power mode in an AP base station that may involve steps 910-950 described below. At step 910, method 900 may involve determining whether each of at least one access terminal (AT) in at least one defined coverage area is in an idle state. In response to each of the at least one AT being in the idle state, the low power mode may be entered (step 920). When in the low power mode, method 900 may involve varying a transmission power at which the AP base station transmits at least one common channel as a function of time (step 930).

[0077] With reference to FIG. 9B, method 900 may further involve, in response to a given one of the at least one AT being in an awake state, operating in a normal mode (step 940). Step 930 may involve varying the transmission power of at least one of a synchronization channel, a pilot signal, and a broadcast channel (step 950).

[0078] In accordance with one or more aspects of the embodiments described herein, FIG. 10A illustrates an exemplary device/apparatus 1000 that may be configured as either an AP base station, or as a processor or similar device for use within an AP base station.

[0079] As illustrated, apparatus 1000 may include a means 1020 for determining whether any ATs are present within at least one defined coverage area. Apparatus 1000 may include a means 1030 for entering a low power mode in response to no ATs being within the at least one coverage area. Apparatus 1000 may also include a means 1040 for varying a transmission power at which the apparatus transmits at least one common channel as a function of time when in the low power mode. The at least one common channel may comprise at least one of a synchronization channel, a pilot signal, and a broadcast channel.

[0080] In one embodiment, the at least one coverage area may comprise a femto coverage area of an AP base station. In another embodiment, the at least one coverage area may comprise a macro coverage area of a macro base station of the macro network. With reference to FIG. 10B, apparatus 1000 may comprise a means 1050 for receiving a wake-up signal transmitted from the macro network. Apparatus 1000 may comprise a means 1052 for receiving a wake-up signal based at least in part on identification of at least one of a serving cell and a neighboring cell reported by the at least one AT. Apparatus 1000 may comprise a means 1054 for receiving a wake-up signal based at least in part on mobility data regarding the at least one AT as determined by the macro network.

[0081] In related aspects, apparatus 1000 may comprise a means 1060 for ceasing to operate in the low power mode in response to receiving the wake-up signal. Apparatus 1000 may comprise a means 1062 for modifying (e.g., increasing) the transmission power in response to receiving the wake-up signal.

[0082] With reference to FIG. 10C, apparatus 1000 may comprise: a means 1070 for, in response to the at least one AT being within the at least one coverage area, determining whether each of the at least one AT is an idle state; and a means 1072 for, in response to each of the at least one AT being in the idle state, placing apparatus 1000 in a second low power mode. Apparatus 1000 may comprise a means 1074 for, in response to a given one of the at least one AT being in an awake state, placing apparatus 1000 in a normal mode.

[0083] In related aspects, apparatus 1000 may comprise a means 1080 for receiving mobility data regarding the at least one AT as determined by a macro network. Apparatus 1000 may comprise a means 1090 for aggregating information regarding the at least one AT from a plurality of macro base stations of a macro network.

[0084] It is noted that apparatus 1000 may optionally include a processor module 1008 having at least one processor, in the case of apparatus 1000 configured as an AP base station, rather than as a processor. Processor 1008, in such case, may be in operative communication with means 1020-1090, and components thereof, via a bus 1002 or similar communication coupling. Processor 1008 may effect initiation and scheduling of the processes or functions performed by means 1020-1090, and components thereof.

[0085] In related aspects, apparatus 1000 may include a backhaul interface 1004 for the backhaul in operative communication with a macro network. Apparatus 1000 may include a transceiver module 1006 for communicating with at least one of (a) an AT, (b) the macro network via the backhaul, and (c) a base station (e.g., macro base station or neighboring AP base station) in operative communication with the macro network. A stand alone receiver and/or stand alone transmitter may be used in lieu of or in conjunction with transceiver 1006.

[0086] In further related aspects, apparatus 1000 may optionally include a means for storing information, such as, for example, a memory device/module 1010. Computer readable medium or memory device/module 1010 may be operatively coupled to the other components of apparatus 1000 via bus 1002 or the like. The computer readable medium or memory device 1010 may be adapted to store computer readable instructions and data for effecting the processes and behavior of means 1020-1090, and components thereof, or processor 1008 (in the case of apparatus 1000 configured as an AP base station) or the methods disclosed herein.

[0087] In yet further related aspects, the memory module 1010 may optionally include executable code for the processor module 1008 to: (a) determine whether any ATs are present within at least one defined coverage area; (b) in response to no ATs being within the at least one coverage area, place apparatus 1000 in a low power mode; and (c) when apparatus 1000 is in the low power mode, instruct the transceiver module 1006 to vary a transmission power at which the transceiver module transmits at least one common channel as a function of time. One or more of steps (a)-(c) may be performed by processor module 1008 in lieu of or in conjunction with the means 1020-1090 described above.

[0088] In accordance with one or more aspects of the embodiments described herein, FIG. 11 illustrates another embodiment of a device/apparatus for facilitating deployment of a low power mode by an AP base station. With reference to FIG. 11A, apparatus 1100 that may be configured as either an AP base station, or as a processor or similar device for use within an AP base station.

[0089] As illustrated, apparatus 1100 may include a means 1120 for determining whether each of at least one AT in at least one defined coverage area is an idle state. Apparatus 1100 may include a means 1130 for placing apparatus 1100 in a low power mode, in response to each of the at least one AT being in the idle state. Apparatus 1100 may also include a means 1140 for varying a transmission power at which the transceiver module transmits at least one common channel as a function of time. Apparatus 1100 may further include a means 1150 for placing apparatus 1100 in a normal mode in response to a given one of the at least one AT being in an awake state. It is noted that the at least one common channel may comprise at least one of a synchronization channel, a pilot signal, and a broadcast channel.

[0090] It is noted that apparatus 1100 may optionally include a processor module 1108 having at least one processor, in the case of apparatus 1100 configured as an AP base station, rather than as a processor. Processor 1108, in such case, may be in operative communication with means 1120-1150, and components thereof, via a bus 1102 or similar communication coupling. Processor 1108 may effect initiation and scheduling of the processes or functions performed by means 1120-1150, and components thereof.

[0091] In related aspects, apparatus 1100 may include a backhaul interface 1104 for the backhaul in operative communication with a macro network. Apparatus 1100 may include a transceiver module 1106 for communicating with at least one of (a) an AT, (b) the macro network via the backhaul, and (c) a base station (e.g., macro base station or neighboring AP base station) in operative communication with the macro network. A stand alone receiver and/or stand alone transmitter may be used in lieu of or in conjunction with transceiver 1106.

[0092] In further related aspects, apparatus 1100 may optionally include a means for storing information, such as, for example, a memory device/module 1110. Computer readable medium or memory device/module 1110 may be operatively coupled to the other components of apparatus 1100 via bus 1102 or the like. The computer readable medium or memory device 1110 may be adapted to store computer readable instructions and data for effecting the processes and behavior of means 1120-1150, and components

thereof, or processor 1108 (in the case of apparatus 1100 configured as an AP base station) or the methods disclosed herein.

[0093] In yet further related aspects, the memory module 1110 may optionally include executable code for the processor module 1108 to: (a) determine whether each of at least one AT in at least one defined coverage area is an idle state; (b) in response to each of the at least one AT being in the idle state, place apparatus 1100 in a low power mode; and (c) when apparatus 1100 is in the low power mode, instruct the transceiver module 1106 to vary a transmission power at which the transceiver module transmits at least one common channel as a function of time. One or more of steps (a)-(c) may be performed by processor module 1108 in lieu of or in conjunction with the means 1120-1150 described above.

[0094] While this application describes particular examples of the present invention, those of ordinary skill can devise variations of the present invention without departing from the inventive concept. For example, the teachings herein refer to circuit-switched network elements but are equally applicable to packet-switched domain network elements. It is noted that the word "exemplary" is used herein to mean "serving as an example, instance, or illustration." Any embodiment described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments.

[0095] It will be appreciated that, in accordance with one or more aspects described herein, inferences can be made regarding determining communication parameters for a plurality of surrounding femto cells and/or macro cells as described. As used herein, the term to "infer," or "inference," refers generally to the process of reasoning about or inferring states of the system, environment, and/or user from a set of observations as captured via events and/or data. Inference can be employed to identify a specific context or action, or can generate a probability distribution over states, for example. The inference can be probabilistic–that is, the computation of a probability distribution over states of interest based on a consideration of data and events. Inference can also refer to techniques employed for composing higher-level events from a set of events and/or data. Such inference results in the construction of new events or actions from a set of observed events and/or stored event data, whether or not the events are correlated in close temporal proximity, and whether the events and data come from one or several event and data sources.

[0096] Terms and phrases used in this document, and variations thereof, unless otherwise expressly stated, should be construed as open ended as opposed to limiting.

As examples of the foregoing: the term "including" should be read as meaning "including, without limitation" or the like; the term "example" is used to provide exemplary instances of the item in discussion, not an exhaustive or limiting list thereof; the terms "a" or "an" should be read as meaning "at least one," "one or more" or the like; and adjectives such as "conventional," "traditional," "normal," "standard," "known" and terms of similar meaning should not be construed as limiting the item described to a given time period or to an item available as of a given time, but instead should be read to encompass conventional, traditional, normal, or standard technologies that may be available or known now or at any time in the future. Likewise, where this document refers to technologies that would be apparent or known to one of ordinary skill in the art, such technologies encompass those apparent or known to the skilled artisan now or at any time in the future.

[0097] A group of items linked with the conjunction "and" should not be read as requiring that each and every one of those items be present in the grouping, but rather should be read as "and/or" unless expressly stated otherwise. Similarly, a group of items linked with the conjunction "or" should not be read as requiring mutual exclusivity among that group, but rather should also be read as "and/or" unless expressly stated otherwise. Furthermore, although items, elements or components of the invention may be described or claimed in the singular, the plural is contemplated to be within the scope thereof unless limitation to the singular is explicitly stated.

[0098] The presence of broadening words and phrases such as "one or more," "at least," "but not limited to" or other like phrases in some instances shall not be read to mean that the narrower case is intended or required in instances where such broadening phrases may be absent.

[0099] Additionally, the various embodiments set forth herein are described in terms of exemplary block diagrams, flow charts and other illustrations. As will become apparent to one of ordinary skill in the art after reading this document, the illustrated embodiments and their various alternatives can be implemented without confinement to the illustrated examples. For example, block diagrams and their accompanying description should not be construed as mandating a particular architecture or configuration.

[00100] As used in this application, the terms "component," "module," "system," and the like are intended to refer to a computer-related entity, either hardware, firmware, a combination of hardware and software, software, or software in execution. For

example, a component can be, but is not limited to being, a process running on a processor, a processor, an object, an executable, a thread of execution, a program, and/or a computer. By way of illustration, both an application running on a computing device and the computing device can be a component. One or more components can reside within a process and/or thread of execution and a component can be localized on one computer and/or distributed between two or more computers. In addition, these components can execute from various computer readable media having various data structures stored thereon. The components can communicate by way of local and/or remote processes such as in accordance with a signal having one or more data packets (e.g., data from one component interacting with another component in a local system, distributed system, and/or across a network such as the internet with other systems by way of the signal).

[00101] It is understood that the specific order or hierarchy of steps in the processes disclosed herein in an example of exemplary approaches. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the processes may be rearranged while remaining within the scope of the present disclosure. The accompanying method claims present elements of the various steps in sample order, and are not meant to be limited to the specific order or hierarchy presented.

[00102] Those skilled in the art will understand that information and signals may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[00103] Those skilled in the art will further appreciate that the various illustrative logical blocks, modules, circuits, methods and algorithms described in connection with the examples disclosed herein may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, methods and algorithms have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for

each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present invention.

[00104] Furthermore, various embodiments are described herein in connection with a mobile device. A mobile device can also be called a system, subscriber unit, subscriber station, mobile station, mobile, remote station, remote terminal, Access Terminal (AT), user terminal, terminal, wireless communication device, user agent, user device, or User Equipment (UE). A mobile device can be a cellular telephone, a cordless telephone, a Session Initiation Protocol (SIP) phone, a Wireless Local Loop (WLL) station, a Personal Digital Assistant (PDA), a handheld device having wireless connection capability, computing device, or other processing device connected to a wireless modem. Moreover, various embodiments are described herein in connection with a base station. A base station can be utilized for communicating with mobile device(s) and can also be referred to as an access point, Node B, evolved Node B (eNode B or eNB), base transceiver station (BTS) or some other terminology.

[00105] Moreover, various aspects or features described herein can be implemented as a method, apparatus, or article of manufacture using standard programming and/or engineering techniques. The term "article of manufacture" as used herein is intended to encompass a computer program accessible from any computer-readable device, carrier, or media. For example, computer-readable media can include but are not limited to magnetic storage devices (e.g., hard disk, floppy disk, magnetic strips, etc.), optical disks (e.g., compact disk (CD), digital versatile disk (DVD), etc.), smart cards, and flash memory devices (e.g., Erasable Programmable Read Only Memory (EPROM), card, stick, key drive, etc.). Additionally, various storage media described herein can represent one or more devices and/or other machine-readable media for storing information. The term "machine-readable medium" can include, without being limited to, wireless channels and various other media capable of storing, containing, and/or carrying instruction(s) and/or data.

[00106] The techniques described herein may be used for various wireless communication systems such as Code Division Multiple Access (CDMA), Multiple-Carrier CDMA (MC-CDMA), Wideband CDMA (W-CDMA), High-Speed Packet Access (HSPA, HSPA+), Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), Orthogonal Frequency Division Multiple Access (OFDMA), Single Carrier Frequency Domain Multiplexing (SC-FDMA) and other multiple access systems/techniques. The terms "system" and "network" may be used interchangeably.

A CDMA system may implement a radio technology such as Universal Terrestrial Radio Access (UTRA), CDMA2000, etc. UTRA may include W-CDMA and/or other variants of CDMA. CDMA2000 covers IS-2000, IS-95 and IS-856 standards. A TDMA system may implement a radio technology such as Global System for Mobile Communications (GSM). An OFDMA system may implement a radio technology such as Evolved UTRA (E-UTRA), Ultra Mobile Broadband (UMB), IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, Flash-OFDM, etc. UTRA and E-UTRA are part of Universal Mobile Telecommunication System (UMTS). 3GPP Long Term Evolution (LTE) is an upcoming release of UMTS that uses E-UTRA, which employs OFDMA on the downlink and SC-FDMA on the uplink. UTRA, E-UTRA, UMTS, LTE and GSM are described in documents from an organization named "3rd Generation Partnership Project" (3GPP). CDMA2000 and UMB are described in documents from an organization named "3rd Generation Partnership Project 2" (3GPP2). It is further noted that the wireless communication system described herein may implement one or more standards, such as, for example, IS-95, CDMA2000, IS-856, W-CDMA, TD-SCDMA, etc.

[00107] The various illustrative logical blocks, modules, and circuits described in connection with the examples disclosed herein may be implemented or performed with a general purpose processor, a Digital Signal Processor (DSP), an Application Specific Integrated Circuit (ASIC), a Field Programmable Gate Array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[00108] The methods or algorithms described in connection with the examples disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module may reside in Random Access Memory (RAM), flash memory, Read-Only Memory (ROM), EPROM, Electrically Erasable Programmable Read-Only Memory (EEPROM), registers, hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the

art. A storage medium may be coupled to the processor such that the processor can read information from, and write information to, the storage medium. In the alternative, the storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC.

[00109] In one or more exemplary embodiments, the functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Computer-readable media includes both computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A storage media may be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a computer. Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk and blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above should also be included within the scope of computer-readable media.

[00110] The previous description of the disclosed examples is provided to enable any person skilled in the art to make or use the present invention. Various modifications to these examples will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other examples without departing from the spirit or scope of the invention. Thus, the present invention is not intended to be limited to the examples shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

CLAIMS

WHAT IS CLAIMED IS:

1. A method for facilitating deployment of a low power mode in an access point (AP) base station, comprising:

determining whether any access terminals (ATs) are present within at least one defined coverage area;

in response to no ATs being within the at least one coverage area, entering the low power mode; and

when in the low power mode, varying a transmission power at which the AP base station transmits at least one common channel as a function of time.

2. The method of Claim 1, wherein determining whether any ATs are present within the at least one coverage area comprises determining whether at least one AT is present within a femto coverage area of the AP base station.

3. The method of Claim 1, wherein varying the transmission power comprises varying the transmission power of at least one of a synchronization channel, a pilot signal, and a broadcast channel.

4. The method of Claim 1, wherein determining whether any ATs are present within the at least one coverage area comprises receiving mobility data regarding at least one AT as determined by a macro network.

5. The method of Claim 1, wherein determining whether any ATs are present within the at least one coverage area comprises receiving information regarding whether at least one AT is present within a macro coverage area of a macro base station of a macro network.

6. The method of Claim 1, wherein determining whether any ATs are present within the at least one coverage area comprises receiving a wake-up signal transmitted from a macro network.

7. The method of Claim 6, further comprising receiving the wake-up signal based at least in part on identification of at least one of a serving cell and a neighboring cell reported by the at least one AT.

8. The method of Claim 6, further comprising receiving the wake-up signal based at least in part on mobility data regarding the at least one AT as determined by the macro network.

9. The method of Claim 6, further comprising ceasing to operate in the low power mode in response to receiving the wake-up signal.

10. The method of Claim 6, further comprising modifying the transmission power in response to receiving the wake-up signal.

11. The method of Claim 10, wherein modifying comprises increasing the transmission power.

12. The method of Claim 1, further comprising:

in response to at least one AT being within the at least one coverage area, determining whether each of the at least one AT is an idle state; and

in response to each of the at least one AT being in the idle state, entering a second low power mode.

13. The method of Claim 12, further comprising, in response to a given one of the at least one AT being in an awake state, operating in a normal mode.

14. The method of Claim 1, wherein determining whether any ATs are present within the at least one coverage area comprises aggregating information regarding at least one AT from a plurality of macro base stations of a macro network.

15. A method for facilitating deployment of a low power mode in an access point (AP) base station, comprising:

determining whether each of at least one access terminal (AT) in at least one defined coverage area is in an idle state;

in response to each of the at least one AT being in the idle state, entering the low power mode; and

when in the low power mode, varying a transmission power at which the AP base station transmits at least one common channel as a function of time.

16. The method of Claim 15, further comprising, in response to a given one of the at least one AT being in an awake state, operating in a normal mode.

17. The method of Claim 15, wherein varying the transmission power comprises varying the transmission power of at least one of a synchronization channel, a pilot signal, and a broadcast channel.

18. A wireless communication device, comprising:

a backhaul interface for a communication backhaul in operative communication with a macro network;

a transceiver module for communicating with at least one of (a) at least one access terminal (AT), (b) the macro network via the backhaul, and (c) at least one base station in operative communication with the macro network;

at least one processor operatively coupled with the backhaul interface and the transceiver module; and

a memory module operatively coupled with the at least one processor and comprising executable code for the at least one processor to:

determine whether any ATs are present within at least one defined coverage area;

in response to no ATs being within the at least one coverage area, place the device in a low power mode; and

when the device is in the low power mode, instruct the transceiver module to vary a transmission power at which the transceiver module transmits at least one common channel as a function of time.

19. The device of Claim 18, wherein the at least one coverage area comprises a femto coverage area of an AP base station.

20. The device of Claim 18, wherein the at least one common channel comprises at least one of a synchronization channel, a pilot signal, and a broadcast channel.

21. The device of Claim 18, wherein the at least one processor determines whether any ATs are present within the at least one coverage area by receiving mobility data regarding the at least one AT as determined by the macro network.

22. The device of Claim 18, wherein the at least one coverage area comprises a macro coverage area of a macro base station of the macro network.

23. The device of Claim 22, wherein the transceiver module receives a wake-up signal transmitted from the macro network.

24. The device of Claim 23, wherein the wake-up signal is based at least in part on identification of at least one of a serving cell and a neighboring cell reported by the at least one AT.

25. The device of Claim 23, wherein the wake-up signal is based at least in part on mobility data regarding the at least one AT as determined by the macro network.

26. The device of Claim 23, wherein the device ceases to operate in the low power mode in response to receiving the wake-up signal.

27. The device of Claim 23, wherein the at least one processor instructs the transceiver module to modify the transmission power in response to receiving the wake-up signal.

28. The device of Claim 27, wherein the transceiver module increases the transmission power.

29. The device of Claim 18, wherein the at least one base station comprises at least one of a macro base station and a neighboring AP base station.

30. The device of Claim 18, wherein the at least one processor:

in response to the at least one AT being within the at least one coverage area, determines whether each of the at least one AT is an idle state; and

in response to each of the at least one AT being in the idle state, places the device in a second low power mode.

31. The device of Claim 30, wherein the at least one processor, in response to a given one of the at least one AT being in an awake state, places the device in a normal mode.

32. The device of Claim 18, wherein the at least one processor determines whether any ATs are present within the at least one coverage area by aggregating information regarding the at least one AT from a plurality of macro base stations of the macro network.

33. A wireless communication device, comprising:

a backhaul interface for a communication backhaul in operative communication with a macro network;

a transceiver module for communicating with at least one of (a) at least one access terminal (AT), (b) the macro network via the backhaul, and (c) at least one base station in operative communication with the macro network;

at least one processor operatively coupled with the backhaul interface and the transceiver module; and

a memory module operatively coupled with the at least one processor and comprising executable code for the at least one processor to:

determine whether each of at least one AT in at least one defined coverage area is an idle state;

in response to each of the at least one AT being in the idle state, place the device in a low power mode; and

when the device is in the low power mode, instruct the transceiver module to vary a transmission power at which the transceiver module transmits at least one common channel as a function of time.

34. The device of Claim 33, wherein the at least one processor, in response to a given one of the at least one AT being in an awake state, places the device in a normal mode.

35. The device of Claim 33, wherein the at least one common channel comprises at least one of a synchronization channel, a pilot signal, and a broadcast channel.

36. A wireless communications apparatus, comprising:

means for determining whether any access terminals (ATs) are present within at least one defined coverage area;

means for entering a low power mode in response to no ATs being within the at least one coverage area; and

means for varying a transmission power at which the apparatus transmits at least one common channel as a function of time when in the low power mode.

37. The apparatus of Claim 36, wherein the at least one coverage area comprises a femto coverage area of an AP base station.

38. The apparatus of Claim 36, wherein the at least one common channel comprises of at least one of a synchronization channel, a pilot signal, and a broadcast channel.

39. A wireless communications apparatus, comprising:

means for determining whether each of at least one access terminal (AT) in at least one defined coverage area is in an idle state;

means for entering a low power mode in response to each of the at least one AT being in the idle state; and

means for varying a transmission power at which the AP base station transmits at least one common channel as a function of time when in the low power mode.

40. The apparatus of Claim 39, wherein the at least one common channel comprises of at least one of a synchronization channel, a pilot signal, and a broadcast channel.

41. A computer program product, comprising:

a computer-readable medium comprising:

code for causing a computer to determine whether any access terminals (ATs) are present within at least one defined coverage area;

code for causing a computer to, in response to no ATs being within the at least one coverage area, place an access point (AP) base station in a low power mode; and

code for causing a computer to, when the AP base station is in the low power mode, vary a transmission power at which at least one common channel is transmitted as a function of time.

42. The computer program product of Claim 41, wherein the at least one coverage area comprises a femto coverage area of an AP base station.

43. The computer program product of Claim 41, wherein the at least one common channel comprises of at least one of a synchronization channel, a pilot signal, and a broadcast channel.

44. A computer program product, comprising:

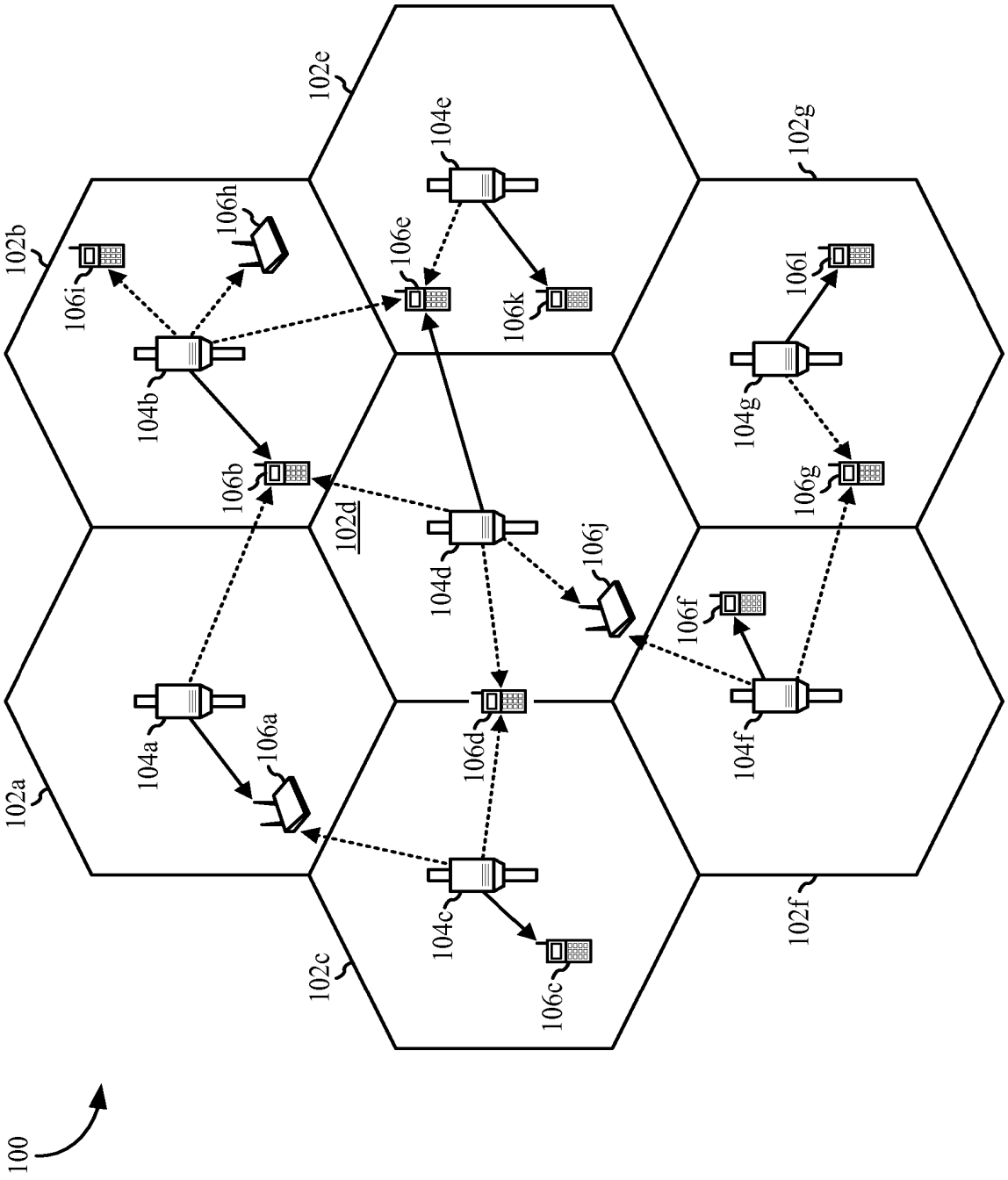
a computer-readable medium comprising:

code for causing a computer to determine whether each of at least one access terminal (AT) in at least one defined coverage area is in an idle state;

code for causing a computer to place an access point (AP) base station in a low power mode in response to each of the at least one AT being in the idle state; and

code for causing a computer to, when the AP base station is in the low power mode, vary a transmission power at which at least one common channel is transmitted as a function of time.

45. The computer program product of Claim 44, wherein the at least one common channel comprises of at least one of a synchronization channel, a pilot signal, and a broadcast channel.


100
102a
102b
102c
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102e
102f
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104a
104b
104c
104d
104e
104f
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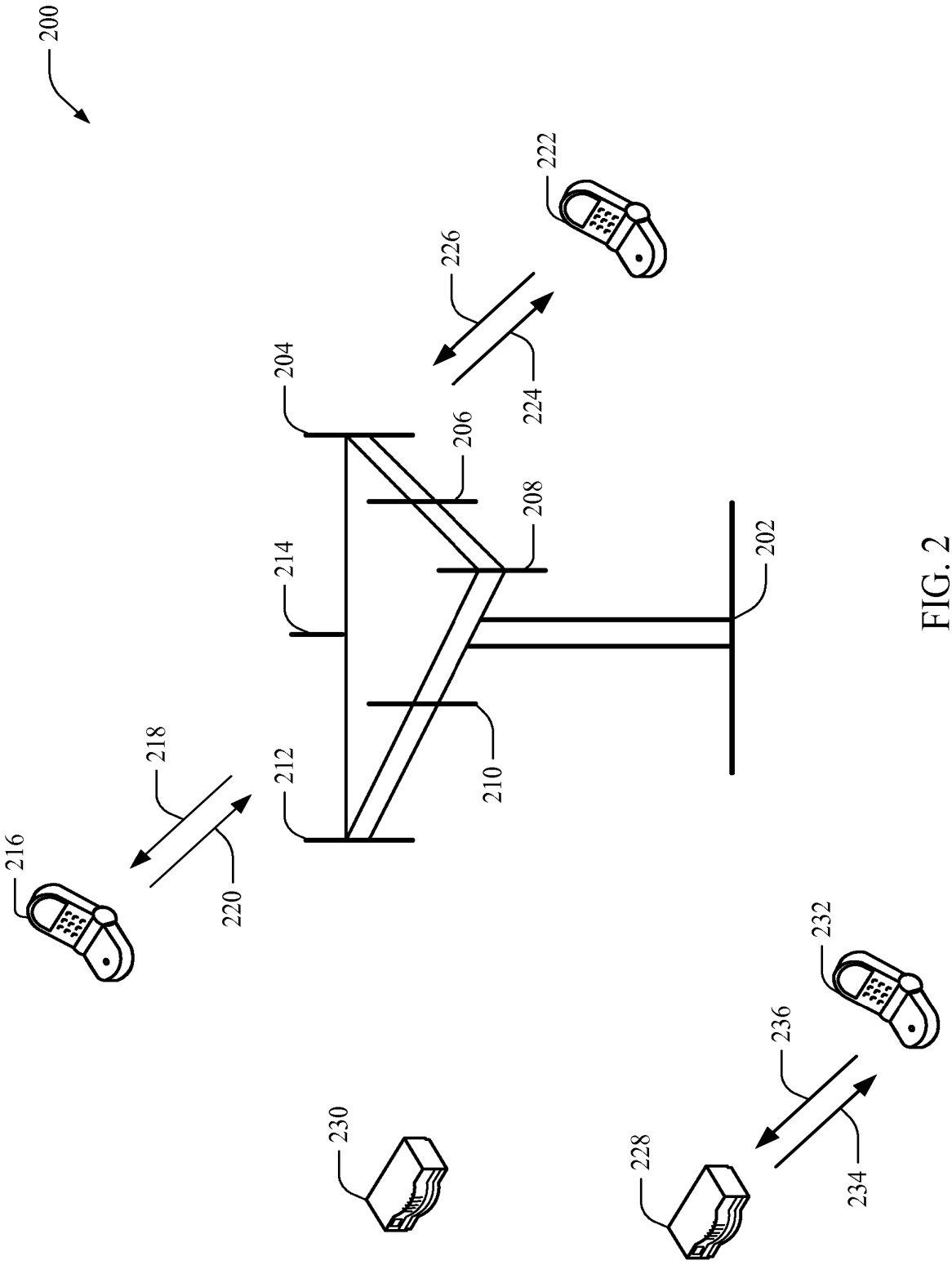
106j
106k
106l

FIG. 1


200
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226
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204
206
208
214
202
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212
218
216
220
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232
236
228
234

FIG. 2

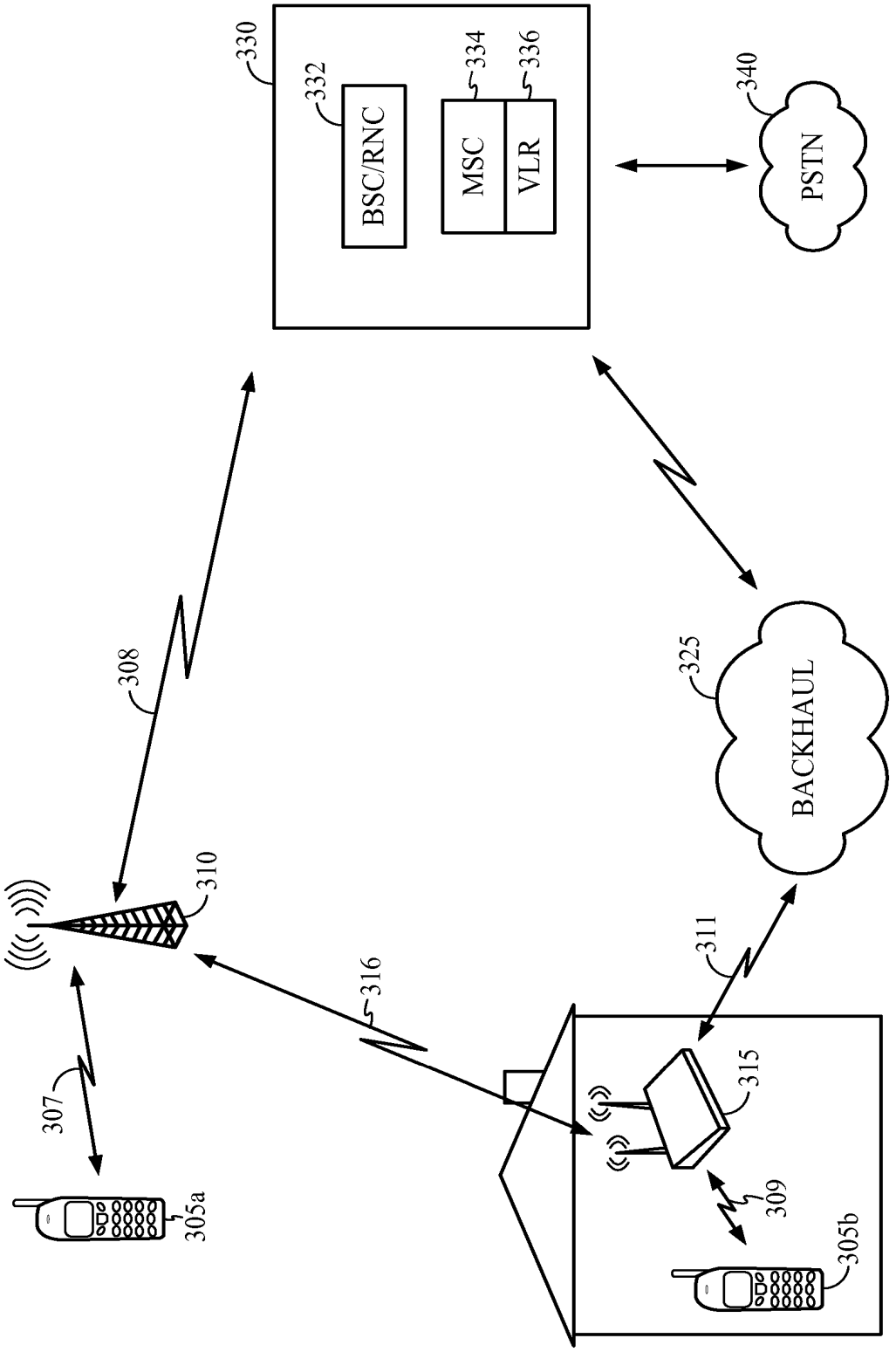
330
332
BSC/RNC
334
MSC
336
VLR
340
PSTN
308
325
BACKHAUL
310
311
316
307
315
309
305a
305b

FIG. 3

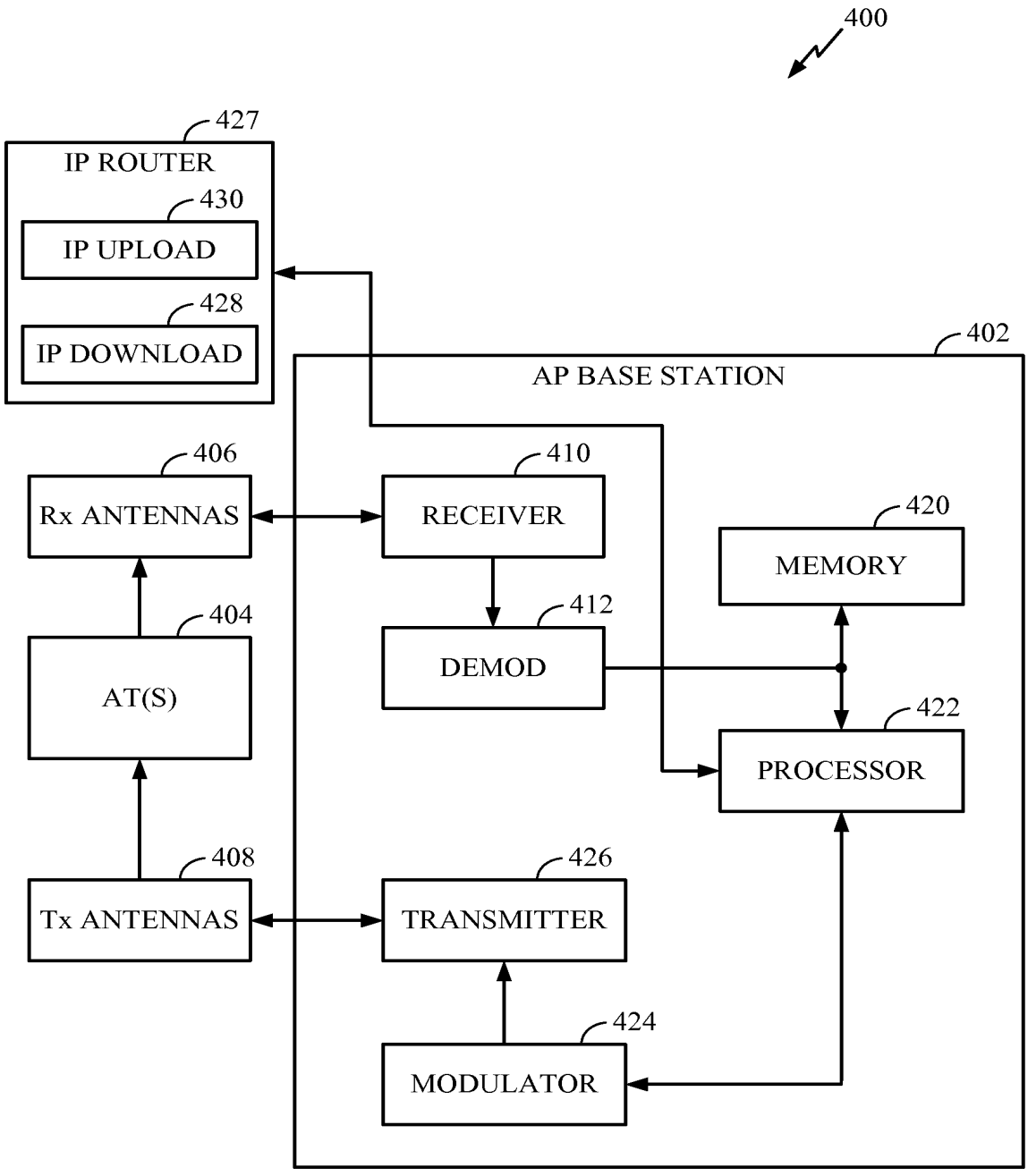
400
427
IP ROUTER
430
IP UPLOAD
428
IP DOWNLOAD
402
AP BASE STATION
406
Rx ANTENNAS
410
RECEIVER
420
MEMORY
404
AT(S)
412
DEMOD
422
PROCESSOR
408
Tx ANTENNAS
426
TRANSMITTER
424
MODULATOR

FIG. 4

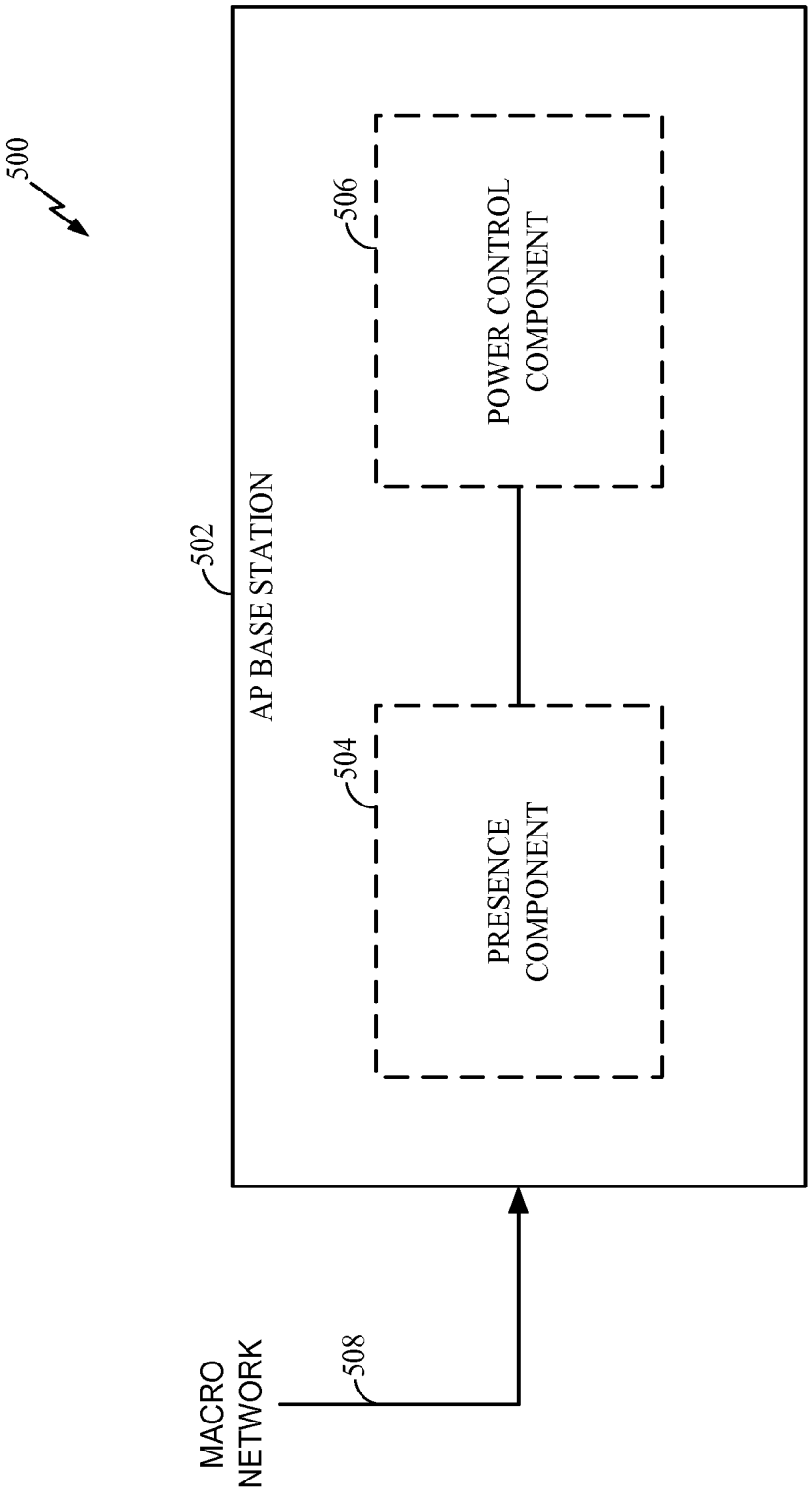
500
502
AP BASE STATION
504
PRESENCE COMPONENT
506
POWER CONTROL COMPONENT
508
MACRO NETWORK

FIG. 5

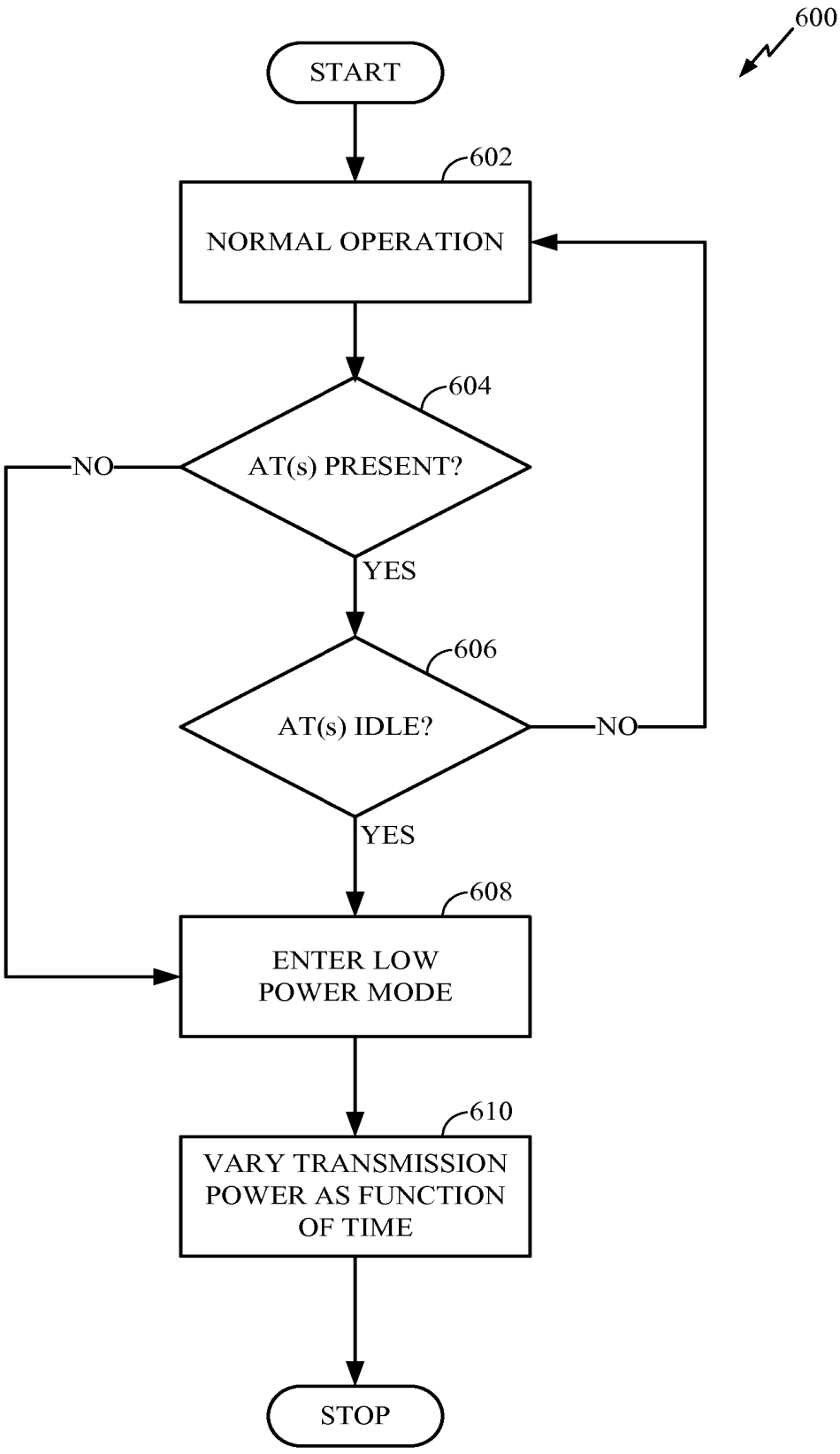
600
START
602
NORMAL OPERATION
604
AT(s) PRESENT?
NO
YES
606
AT(s) IDLE?
NO
YES
608
ENTER LOW POWER MODE
610
VARY TRANSMISSION POWER AS FUNCTION OF TIME
STOP

FIG. 6

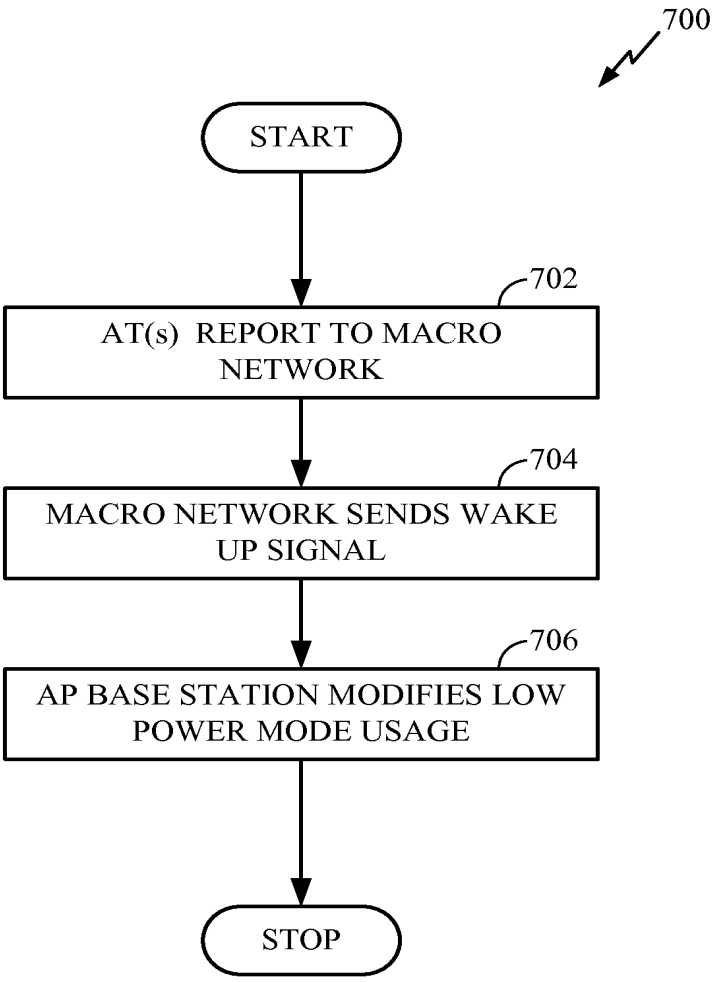
700
START
702
AT(s) REPORT TO MACRO NETWORK
704
MACRO NETWORK SENDS WAKE UP SIGNAL
706
AP BASE STATION MODIFIES LOW POWER MODE USAGE
STOP

FIG. 7

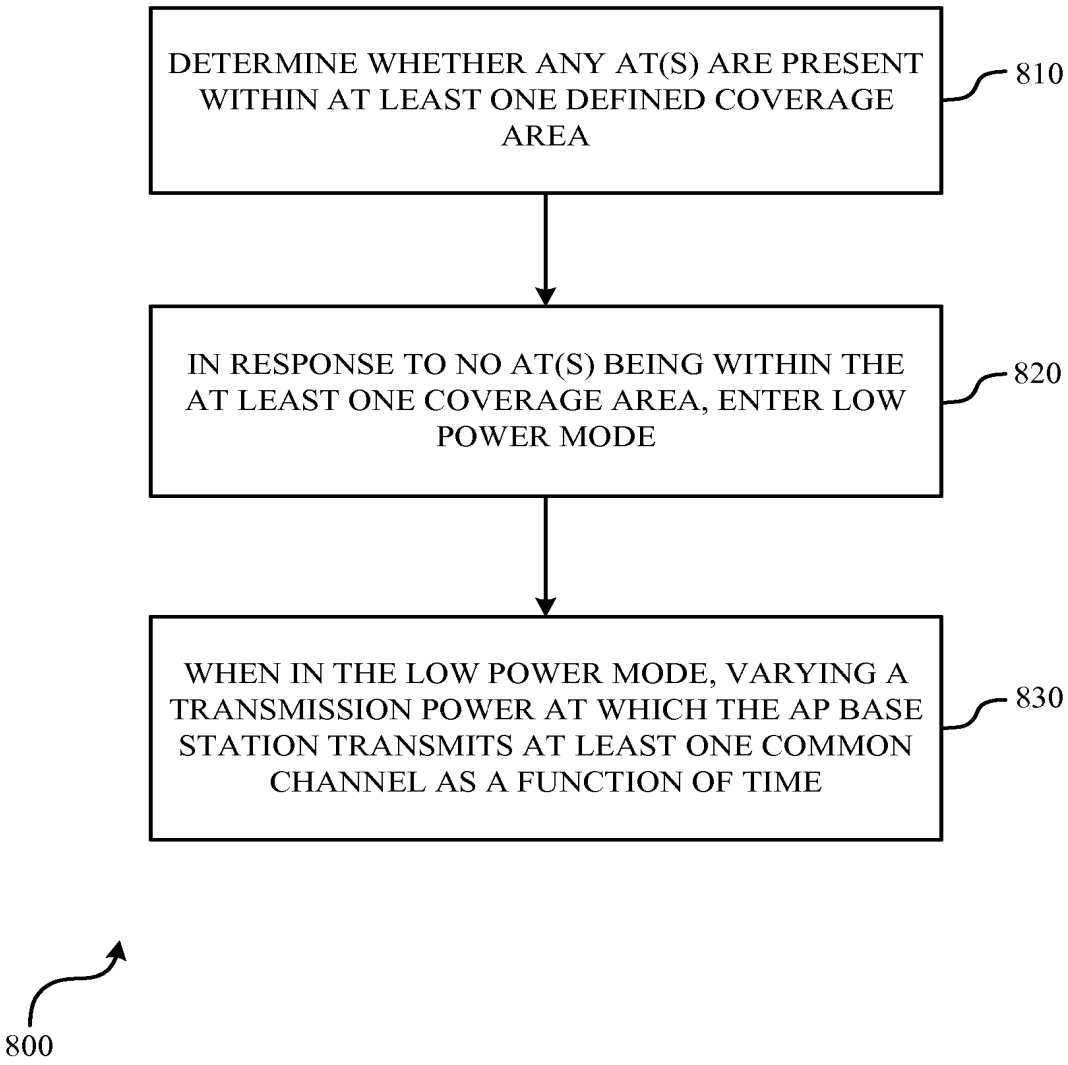
DETERMINE WHETHER ANY AT(S) ARE PRESENT WITHIN AT LEAST ONE DEFINED COVERAGE AREA
810
IN RESPONSE TO NO AT(S) BEING WITHIN THE AT LEAST ONE COVERAGE AREA, ENTER LOW POWER MODE
820
WHEN IN THE LOW POWER MODE, VARYING A TRANSMISSION POWER AT WHICH THE AP BASE STATION TRANSMITS AT LEAST ONE COMMON CHANNEL AS A FUNCTION OF TIME
830
800

FIG. 8A

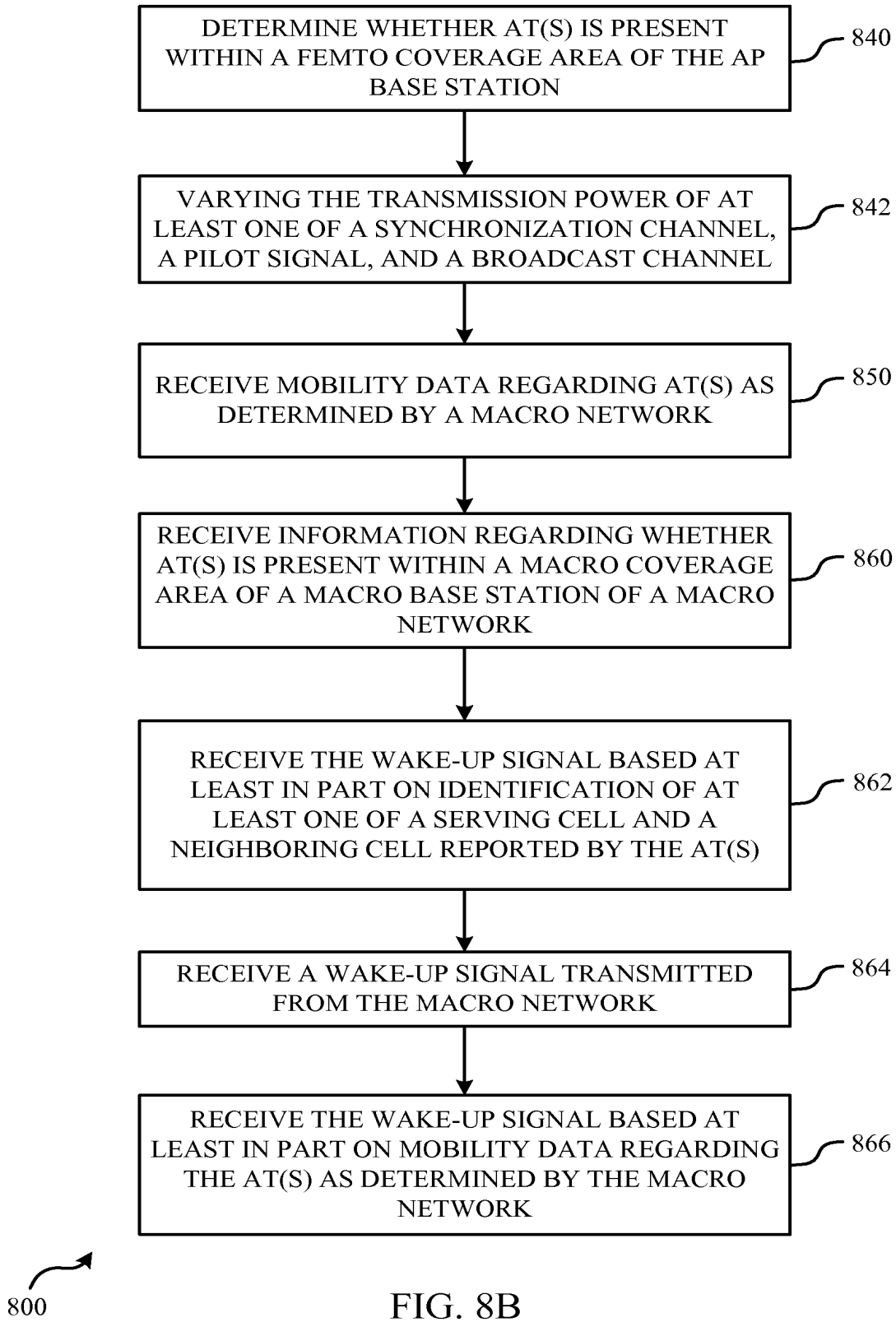
DETERMINE WHETHER AT(S) IS PRESENT WITHIN A FEMTO COVERAGE AREA OF THE AP BASE STATION
840
VARYING THE TRANSMISSION POWER OF AT LEAST ONE OF A SYNCHRONIZATION CHANNEL, A PILOT SIGNAL, AND A BROADCAST CHANNEL
842
RECEIVE MOBILITY DATA REGARDING AT(S) AS DETERMINED BY A MACRO NETWORK
850
RECEIVE INFORMATION REGARDING WHETHER AT(S) IS PRESENT WITHIN A MACRO COVERAGE AREA OF A MACRO BASE STATION OF A MACRO NETWORK
860
RECEIVE THE WAKE-UP SIGNAL BASED AT LEAST IN PART ON IDENTIFICATION OF AT LEAST ONE OF A SERVING CELL AND A NEIGHBORING CELL REPORTED BY THE AT(S)
862
RECEIVE A WAKE-UP SIGNAL TRANSMITTED FROM THE MACRO NETWORK
864
RECEIVE THE WAKE-UP SIGNAL BASED AT LEAST IN PART ON MOBILITY DATA REGARDING THE AT(S) AS DETERMINED BY THE MACRO NETWORK
866
800

FIG. 8B

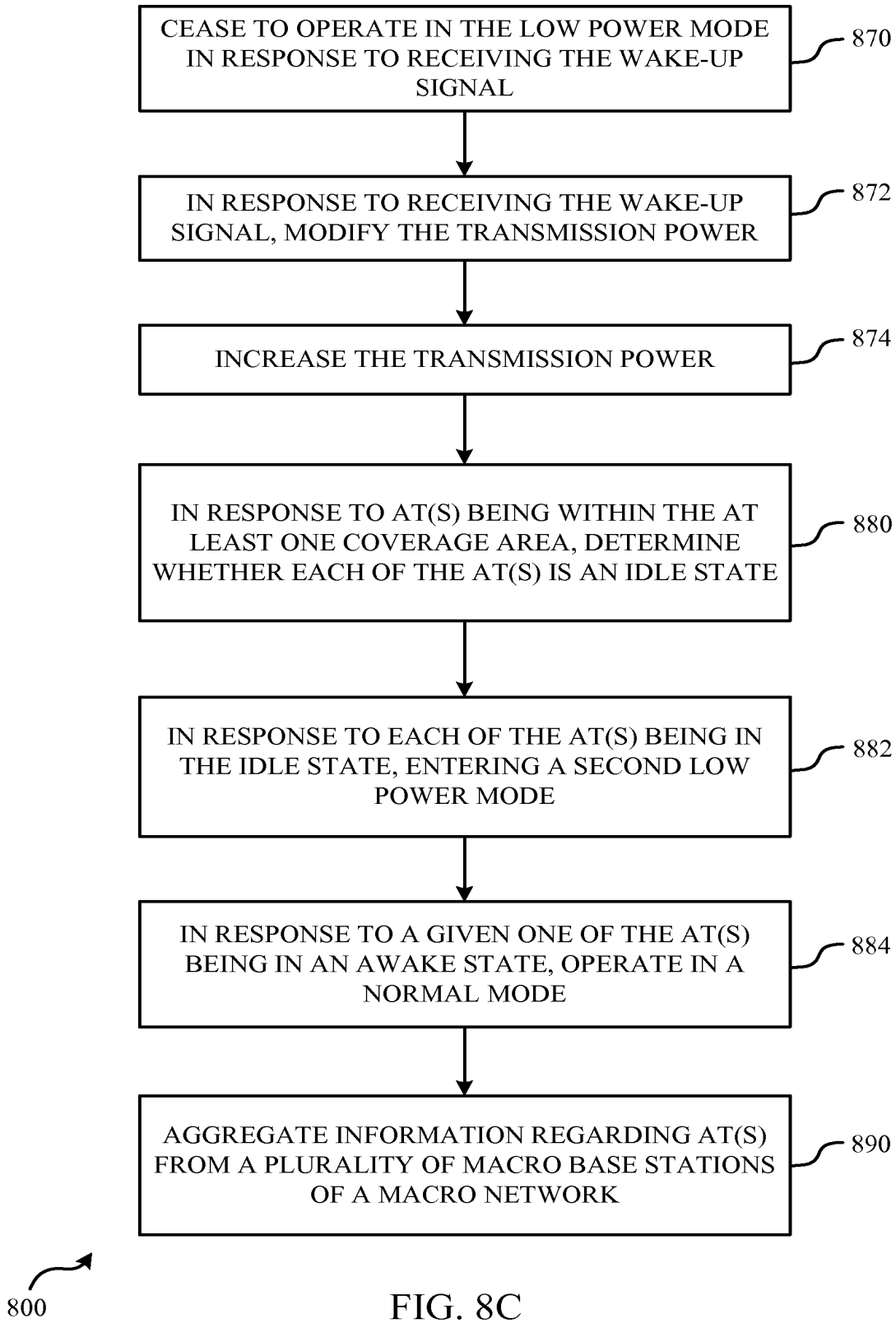
CEASE TO OPERATE IN THE LOW POWER MODE IN RESPONSE TO RECEIVING THE WAKE-UP SIGNAL
870
IN RESPONSE TO RECEIVING THE WAKE-UP SIGNAL, MODIFY THE TRANSMISSION POWER
872
INCREASE THE TRANSMISSION POWER
874
IN RESPONSE TO AT(S) BEING WITHIN THE AT LEAST ONE COVERAGE AREA, DETERMINE WHETHER EACH OF THE AT(S) IS AN IDLE STATE
880
IN RESPONSE TO EACH OF THE AT(S) BEING IN THE IDLE STATE, ENTERING A SECOND LOW POWER MODE
882
IN RESPONSE TO A GIVEN ONE OF THE AT(S) BEING IN AN AWAKE STATE, OPERATE IN A NORMAL MODE
884
AGGREGATE INFORMATION REGARDING AT(S) FROM A PLURALITY OF MACRO BASE STATIONS OF A MACRO NETWORK
890
800

FIG. 8C

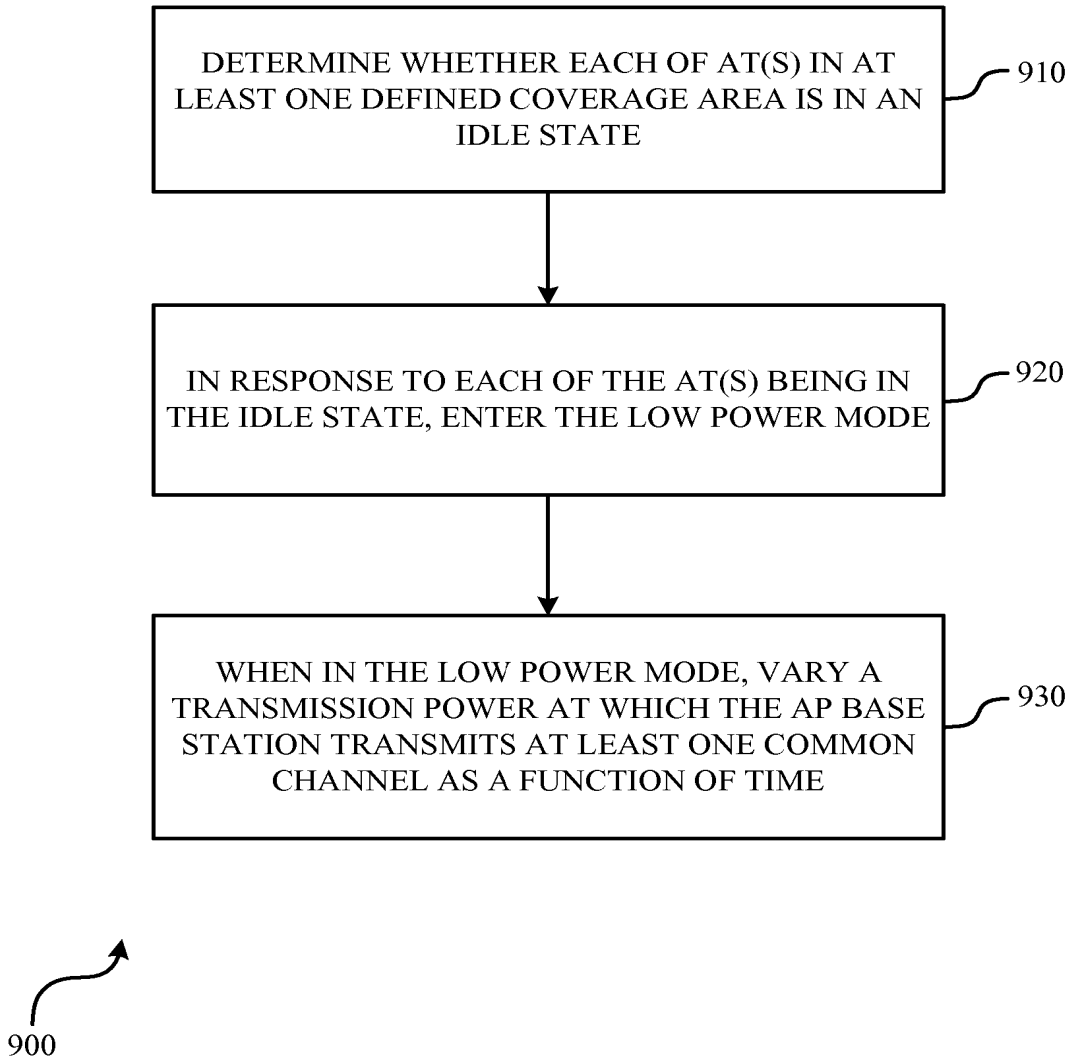
DETERMINE WHETHER EACH OF AT(S) IN AT LEAST ONE DEFINED COVERAGE AREA IS IN AN IDLE STATE
910
IN RESPONSE TO EACH OF THE AT(S) BEING IN THE IDLE STATE, ENTER THE LOW POWER MODE
920
WHEN IN THE LOW POWER MODE, VARY A TRANSMISSION POWER AT WHICH THE AP BASE STATION TRANSMITS AT LEAST ONE COMMON CHANNEL AS A FUNCTION OF TIME
930
900

FIG. 9A

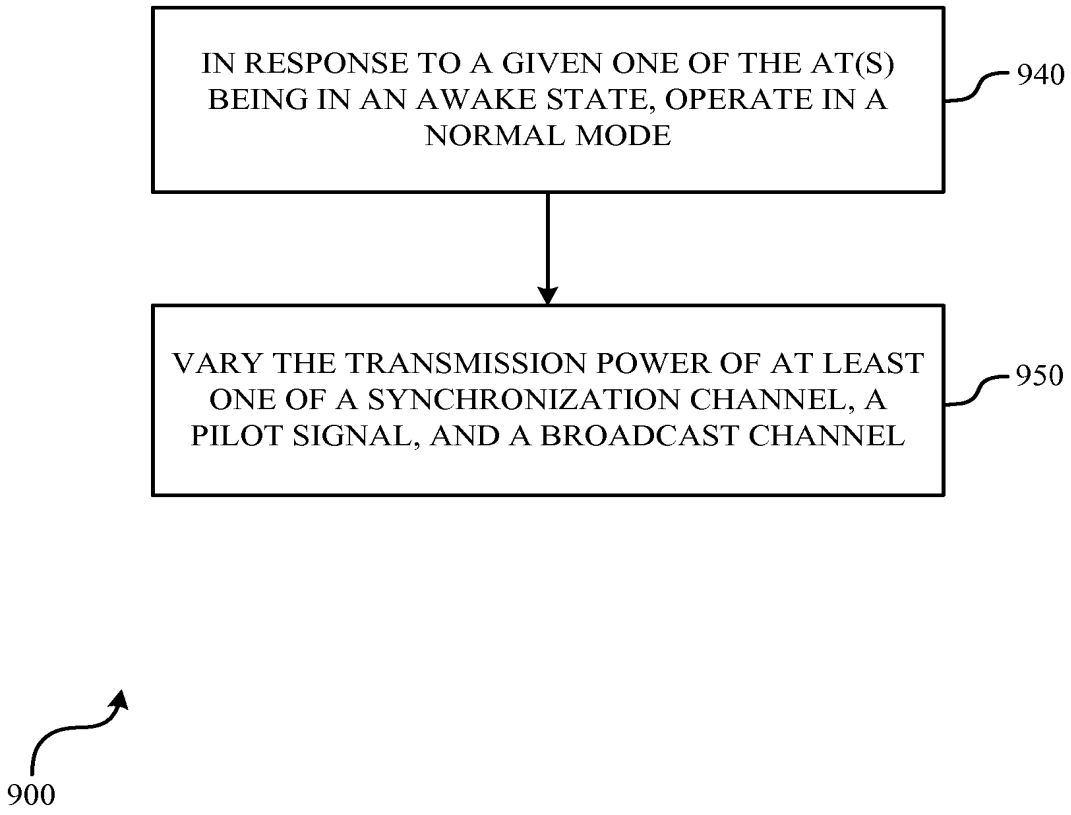
IN RESPONSE TO A GIVEN ONE OF THE AT(S) BEING IN AN AWAKE STATE, OPERATE IN A NORMAL MODE
940
VARY THE TRANSMISSION POWER OF AT LEAST ONE OF A SYNCHRONIZATION CHANNEL, A PILOT SIGNAL, AND A BROADCAST CHANNEL
950
900

FIG. 9B

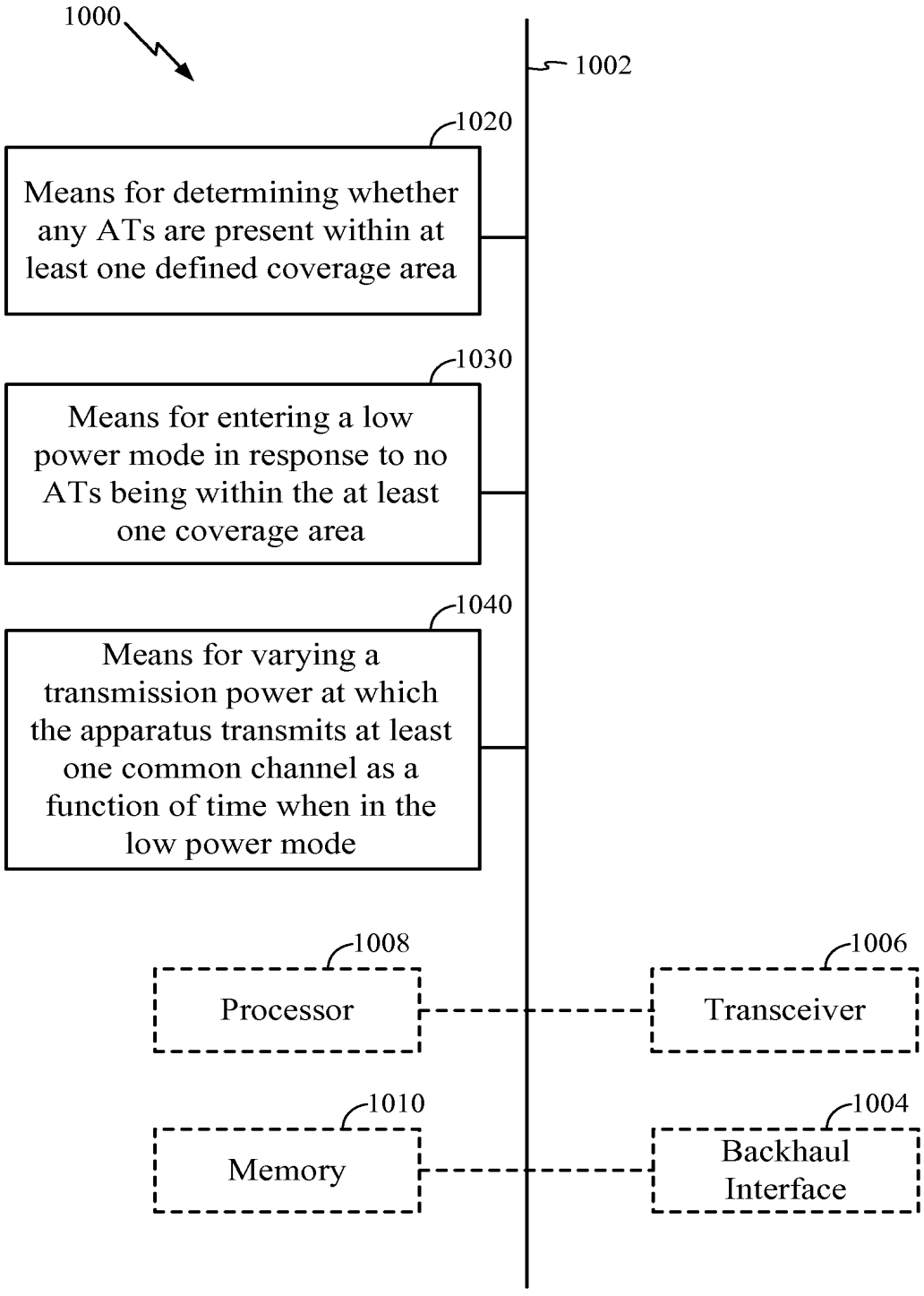
1000
1002
1020
Means for determining whether any ATs are present within at least one defined coverage area
1030
Means for entering a low power mode in response to no ATs being within the at least one coverage area
1040
Means for varying a transmission power at which the apparatus transmits at least one common channel as a function of time when in the low power mode
1008
Processor
1006
Transceiver
1010
Memory
1004
Backhaul Interface

FIG. 10A

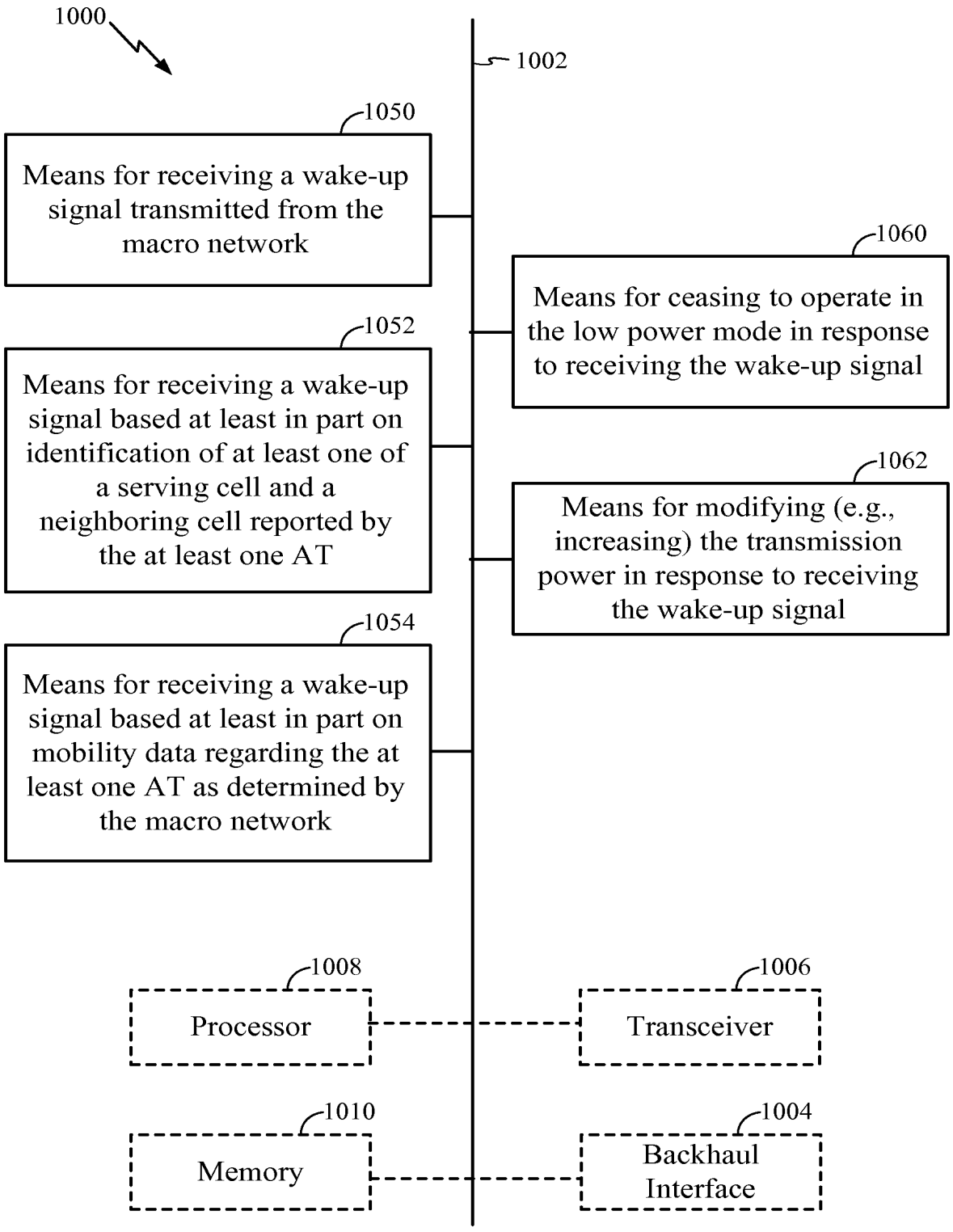
1000
1002
1050
Means for receiving a wake-up signal transmitted from the macro network
1060
Means for ceasing to operate in the low power mode in response to receiving the wake-up signal
1052
Means for receiving a wake-up signal based at least in part on identification of at least one of a serving cell and a neighboring cell reported by the at least one AT
1062
Means for modifying (e.g., increasing) the transmission power in response to receiving the wake-up signal
1054
Means for receiving a wake-up signal based at least in part on mobility data regarding the at least one AT as determined by the macro network
1008
Processor
1006
Transceiver
1010
Memory
1004
Backhaul Interface

FIG. 10B

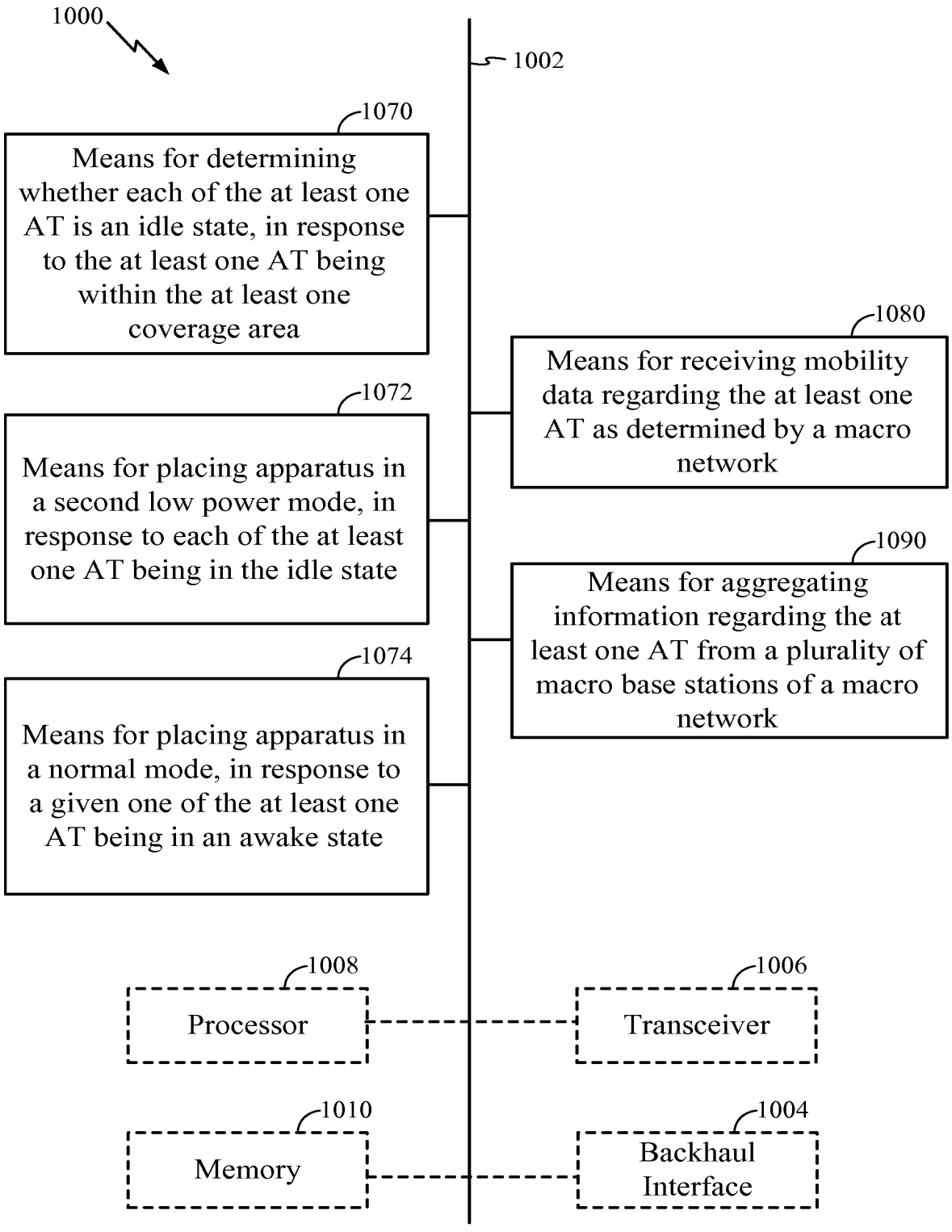
1000
1002
1070
Means for determining whether each of the at least one AT is an idle state, in response to the at least one AT being within the at least one coverage area
1080
Means for receiving mobility data regarding the at least one AT as determined by a macro network
1072
Means for placing apparatus in a second low power mode, in response to each of the at least one AT being in the idle state
1090
Means for aggregating information regarding the at least one AT from a plurality of macro base stations of a macro network
1074
Means for placing apparatus in a normal mode, in response to a given one of the at least one AT being in an awake state
1008
Processor
1006
Transceiver
1010
Memory
1004
Backhaul Interface

FIG. 10C

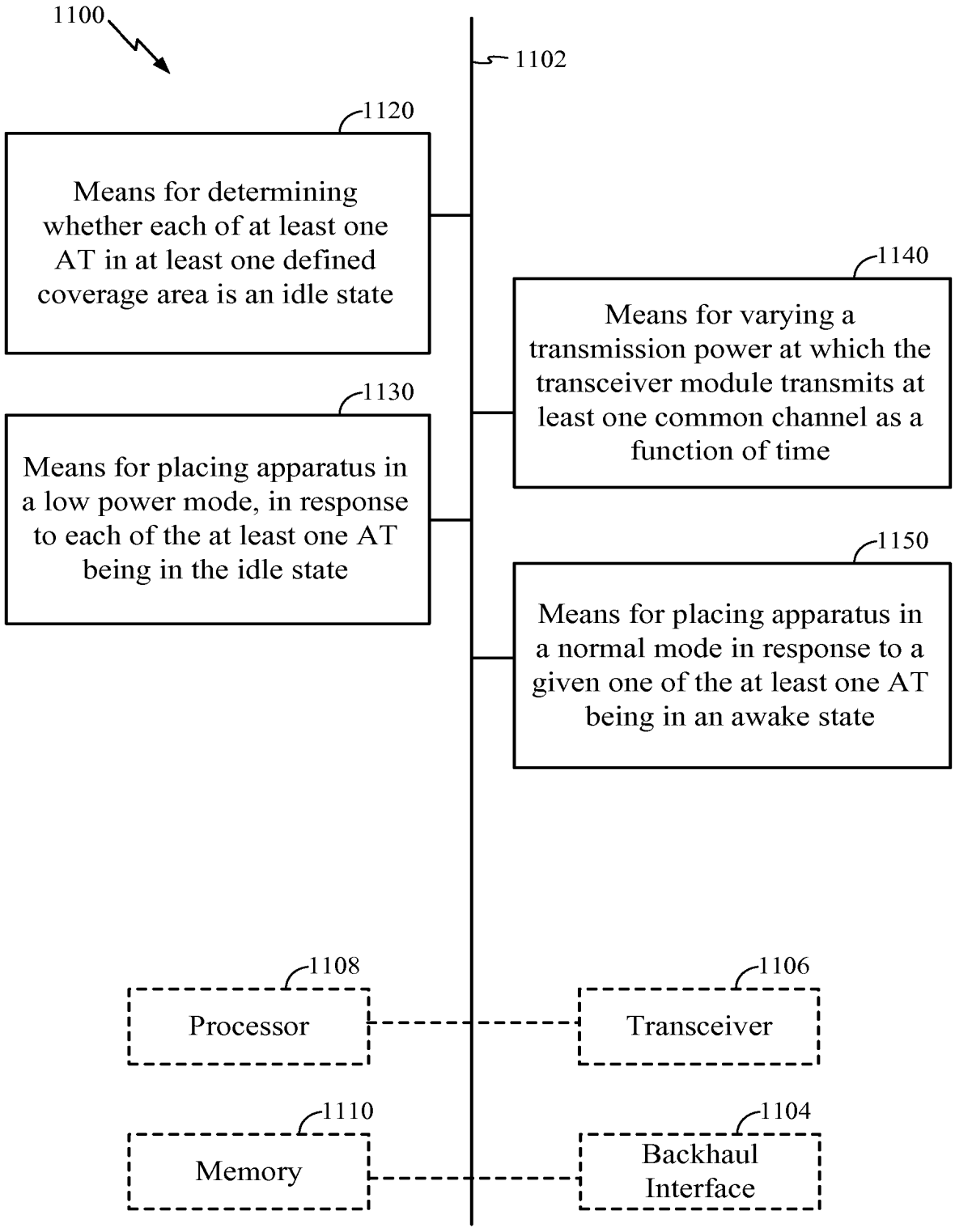
1100
1102
1120
Means for determining whether each of at least one AT in at least one defined coverage area is an idle state
1140
Means for varying a transmission power at which the transceiver module transmits at least one common channel as a function of time
1130
Means for placing apparatus in a low power mode, in response to each of the at least one AT being in the idle state
1150
Means for placing apparatus in a normal mode in response to a given one of the at least one AT being in an awake state
1108
Processor
1106
Transceiver
1110
Memory
1104
Backhaul Interface

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/049404

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W52/02

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 practical, 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.
A	"A method for interference control and power saving for home access point" IP.COM JOURNAL, IP.COM INC., WEST HENRIETTA, NY, US, 13 December 2007 (2007-12-13), XP013122942 ISSN: 1533-0001 Pg 1; option A.1 - A.3; Pg 2; option D.1 -D.3; Pg 1-2; options B and C; page 1	1-45
A	JP 2008 109423 A (FUJITSU LTD) 8 May 2008 (2008-05-08) abstract	1-45
A	JP 07 170566 A (NIPPON ELECTRIC CO) 4 July 1995 (1995-07-04) abstract	1-45

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 October 2009	29/10/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Losada Corderí, Iker

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/049404

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	WO 2008/136416 A (NTT DOCOMO INC [JP]; MORI SHINICHI [JP]; ISHII AKIRA [JP]; IWAMURA MIK) 13 November 2008 (2008-11-13) the whole document	1-45
P,A	EP 2 056 628 A (NOKIA SIEMENS NETWORKS OY [FI]) 6 May 2009 (2009-05-06) the whole document	1-45

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2009/049404

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2008109423 A	08-05-2008	NONE	
JP 7170566 A	04-07-1995	JP 2606570 B2	07-05-1997
WO 2008136416 A	13-11-2008	NONE	
EP 2056628 A	06-05-2009	NONE	

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

(54) **Title**: RE-ACTIVATION OF A BASE STATION IN STANDBY MODE

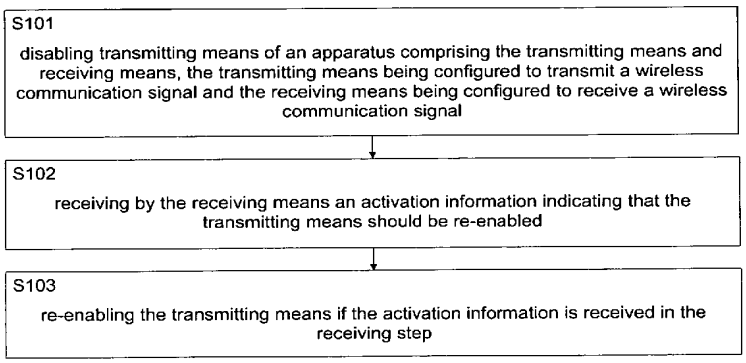

Fig. 3

(57) **Abstract**: The present invention relates to methods, apparatuses, a system and a computer program product for reducing a power consumption in low load scenarios. An apparatus (20) can comprise transmitting means (21), receiving means (22) and determining means (23) for determining whether a signal quality of a broadcast channel of a wireless network cell is insufficient, wherein the transmitting means (21) may transmit on a wireless access channel an activation information to a further apparatus (30, 40) if the determination is affirmative. The activation information can indicate that disabled transmitting means (31) of the further apparatus (30, 40) should be re-enabled. The further apparatus (30, 40) may comprise transmitting means (31), receiving means (32), disabling means (33) for disabling the transmitting means (31) and enabling means (34) for re-enabling the transmitting means (31), wherein the receiving means (32) can be configured to receive the activation in-formation, and wherein the enabling means (34) may be configured to re-enable the transmitting means (31) if the activation information is received.

WO 2009/140988 A1

RE-ACTIVATION OF A BASE STATION IN STANDBY MODE

FIELD OF THE INVENTION

The present invention relates to methods, apparatuses, a computer program product and a system for reducing a power consumption of a wireless device in low load scenarios.

BACKGROUND OF THE INVENTION

Advanced technologies for mobile wireless communications are being developed in order to cope with increasing demands regarding improved efficiency, lower costs, improved services, usage of new spectrum opportunities, better integration with other open standards and so on. For example, 3rd generation partnership project (3GPP) long-term evolution (LTE) and LTE advanced (LTE-A) are approaches to providing next generation mobile wireless broadband technology. For future and present wireless networks, automated configuration and optimization such as e.g. energy optimization is of concern to reduce a total cost of ownership for operators of the networks.

A base station of a current wireless communication system such as e.g. a global system for mobile communications (GSM) base transceiver station (BTS) or a universal mobile telecommunications system (UMTS) node B has a remarkable power consumption, and generates a significant operating or operational expenditure (OPEX) by its power consumption. Besides of the cost aspect for the operator, the electromagnetic radiation and possible adverse health effect as well as the ecological impact should be considered. This also applies to e.g. an enhanced node B (eNB) or home enhanced node B (H(e)NB) according to 3GPP LTE or LTE-A. For example, the power consumption of a H(e)NB can cause significant costs if there is no efficient standby mode solution applied in case of service inactivity.

Previously proposed base stations are not or little adaptive to their traffic needs. Further, the base stations even totally unloaded consume a lot of primary energy. This is mainly due to the power amplifier with its linear requirements, caused by the applied transmission technology. It requires a minimum current driven through the amplifier transistors in order to set the operational point in such a way that the

required linear behavior can be achieved. Even in case of an unloaded operating state the power consumption remains high.

Current implementations of base stations have about a factor of two between power consumptions for a fully loaded wireless network cell and an unloaded wireless network cell. A significant part of the load-independent power consumption socket is contributed by the power amplifier. Further, the permanent operation of controller and baseband processing cards contributes to the power consumption. The transmitter part, in particular the high power amplifier, is a top contributor to power consumption. However, digital and analogue transmitter signal predistortion also consumes power.

In offload or low load operational periods, e.g. during night time, the power consumption remains while probably only few users are served. In an extreme case, there is no active user at all, but the power consumption is still quite high. This keeps the OPEX high, and the eco-balance bad. In capacity-driven systems, the base station density is high. Therefore, in principle some of the base stations may be entirely turned or switched off, assuming that the other base stations can partly take over a coverage. In this case, a problem with the uplink (UL) can arise. The output power of a mobile terminal device is limited, and the battery capacity prevents a simple solution like the increase of the mobile terminal device's transmit power. Thus, the uplink might be difficult if one or more base stations close to the mobile terminal device are switched off.

Hence, at present base stations in a wireless network such as e.g. node Bs, eNBs and H(e)NBs are continuously operated. If a base station should be switched off, manual procedures and re-configurations or operation & maintenance (O&M) configurations are needed. The mobile terminal device's uplink limitation in transmit power may cause an imbalance between UL and downlink (DL).

Further, a re-activation of a switched off base station would require a special formed UL signal. This enhances range capabilities of the mobile terminal device, and requires a specific receiver in active base stations to detect this special formed signal.

In addition to automated configuration and optimization, a network behavior in emergency situations is of concern for future and present wireless networks. For example, in case of an emergency call it should be possible to re-activate an eNB

or H(e)NB that is in a standby mode, even if a mobile terminal device initiating the emergency call is not in a home zone of the eNB or H(e)NB and member of its closed subscriber group.

SUMMARY OF SOME EXAMPLES OF THE INVENTION

It is an object of the present invention to provide a mechanism for reducing a power consumption without requiring a special formed UL signal or specific receiver.

This object can be achieved at a first transmission end by a method comprising:

disabling transmitting means of an apparatus comprising the transmitting means and receiving means, the transmitting means being configured to transmit a wireless communication signal and the receiving means being configured to receive a wireless communication signal;

receiving by the receiving means an activation information indicating that the transmitting means should be re-enabled; and

re-enabling the transmitting means if the activation information is received in the receiving step.

Furthermore, at a second transmission end the above object may be achieved by a method comprising:

determining whether a signal quality of a broadcast channel of a wireless network cell is insufficient; and

transmitting on a wireless access channel an activation information to an apparatus, if the determination in the determining step is affirmative, the activation information indicating that disabled transmitting means of the apparatus should be re-enabled.

Moreover, at the first transmission end the above object can be achieved by an apparatus comprising:

transmitting means for transmitting a wireless communication signal;

receiving means for receiving a wireless communication signal;

disabling means for disabling the transmitting means; and

enabling means for re-enabling the transmitting means,

wherein the receiving means is configured to receive an activation information indicating that the transmitting means should be re-enabled, and

wherein the enabling means is configured to re-enable the transmitting means if the activation information is received by the receiving means.

In addition, at the second transmission end the above object can be achieved by an apparatus comprising:

transmitting means for transmitting a wireless communication signal;

receiving means for receiving a wireless communication signal; and

determining means for determining whether a signal quality of a broadcast channel of a wireless network cell is insufficient,

wherein the transmitting means is configured to transmit on a wireless access channel an activation information to a further apparatus, if the determination of the determining means is affirmative, the activation information indicating that disabled transmitting means of the further apparatus should be re-enabled.

The above methods may be implemented as a computer program product comprising code means for performing the respective above steps when run on a computer device.

The above apparatuses may be implemented as network elements or nodes, access devices such as e.g. base stations, fixed or mobile terminal devices, or as modules, chips, chip sets or chip devices provided in these elements, nodes or devices.

Accordingly, a mechanism can be provided that enables to disable or to switch off entire transmitter chains of sectors and/or entire access devices such as e.g. base stations, whereas receiver chains are kept activated. An activation information may be received by a receiver remaining active. The activation information can be transmitted in a usual transmission form. Thus, there is no need for a signal of a special form and/or a specific receiver in a base station. As a result, a power consumption of an access device such as e.g. a base station or a home base station and the overall power consumption in a network can be reduced without the above-mentioned specific measures. Further, there is no need for an extended range of a device at the other transmission end such as e.g. a mobile terminal device trying to access a base station. As a result, the OPEX and the eco-balance may be improved, without disadvantages as caused by previously proposed solutions.

In addition, in case of an emergency call it is possible to re-activate an access device such as e.g. an eNB or H(e)NB that is in a standby mode, even if a mobile terminal device initiating the emergency call is not in a home zone of the eNB or H(e)NB and member of its closed subscriber group. The procedure can be enhanced in a manner such that in case of emergency a re-activation signal contains an element that identifies the re-activation signal as caused by an emergency call. If this signal is system specific, not network and operator specific, the signal may re-activate any sleeping eNB or H(e)NB, independent of the service provision relationship the user has with the operator who owns the network element.

Further advantageous modifications are defined in the dependent claims.

The above examples are intended to be merely exemplary and should not be construed as limiting in any way.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described based on embodiments with reference to the accompanying drawings, in which:

Fig. 1 shows a schematic diagram of a general network architecture in which the embodiments can be implemented;

Fig. 2 shows schematic block diagrams of apparatuses such as e.g. a terminal device and base stations according to the embodiments;

Fig. 3 shows a flow diagram of a basic processing at an apparatus such as e.g. a base station according to the embodiments;

Fig. 4 shows a flow diagram of a basic processing at an apparatus such as e.g. a terminal device according to the embodiments;

Fig. 5 shows a schematic diagram illustrating cells of a wireless network in a normal or high load scenario;

Fig. 6 shows a schematic diagram illustrating the cells of the wireless network in a low load scenario;

Fig. 7 shows a schematic diagram illustrating a synchronization of a terminal device located in a cell with a disabled transmitting unit;

Fig. 8 shows a schematic diagram illustrating a transmission of an activation information from the terminal device to the cell with the disabled transmitting unit;

Fig. 9 shows a schematic diagram illustrating a situation where a receive only cell informs an operation & maintenance center; and

Fig. 10 shows a schematic block diagram of a software-based implementation of the embodiments.

DESCRIPTION OF EMBODIMENTS

Fig. 1 shows a schematic diagram of a general network architecture in which the embodiments can be implemented. A wireless network 10 such as e.g. a GSM network or a cellular UMTS terrestrial radio access network (UTRAN) according to 3GPP LTE or LTE-A can provide access to an apparatus such as e.g. a user equipment (UE), a mobile station (MS), or a fixed or mobile terminal device 20. Access may be obtained via apparatuses like a first access device or network device 30 such as e.g. a GSM, UMTS or LTE base station device and a second access device or network device 40 such as e.g. a GSM, UMTS or LTE base station device. For example, each of the network devices 30 and 40 can be a base station device such as e.g. an eNB or H(e)NB according to LTE or LTE-A. It is noted that other apparatuses may be provided, which are not shown in Fig. 1.

Fig. 2 shows schematic block diagrams of apparatuses such as e.g. a terminal device 20 and base stations 30, 40 according to the embodiments. In Fig. 2, a mobile terminal device 20 and a base station 30, 40 are depicted as examples of the apparatuses. However, the apparatuses may not only be implemented in this form but also e.g. as network elements or nodes, access devices, fixed terminal devices etc., or as modules, chips, chip sets or chip devices provided in such elements, nodes or devices.

The terminal device 20 may comprise a transmitting unit or means 21, a receiving unit or means 22, a determining unit or means 23, and a detecting unit or means 24. The transmitting unit 21 can transmit a wireless communication signal via an antenna, the receiving unit 22 may receive a wireless communication signal via

the antenna, the determining unit 23 can determine whether a signal quality of a broadcast channel (BCH) of a wireless network cell is insufficient, and the detecting unit 24 may detect whether a suitable wireless network such as e.g. the wireless network 10 is available. The functionality of these components is described in further detail below. All or part of the components can be integrated in a single component, even if they are represented by separate blocks in Fig. 2. For example, the transmitting unit 21 and the receiving unit 22 can be integrated in a transceiver, the determining unit 23 and the detecting unit 24 may be integrated in a processor or controller, and all of the components can be integrated in a single module or chip. Further, the terminal device 20 may comprise additional components not depicted in Fig. 2. For example, it can include a storing unit such as e.g. a memory for storing received information such as e.g. the system information described below.

The base station 30, 40 may comprise a transmitting unit or means 31, a receiving unit or means 32, a disabling unit or means 33, and an enabling unit or means 34. The transmitting unit 31 can transmit a wireless communication signal via an antenna, the receiving unit 32 may receive a wireless communication signal via the antenna, the disabling unit 33 can disable the transmitting unit 31, and the enabling unit 34 may re-enable the transmitting unit 31. The functionality of these components is described in further detail below. All or part of the components can be integrated in a single component, even if they are represented by separate blocks in Fig. 2. For example, the transmitting unit 31 and the receiving unit 32 can be integrated in a transceiver, the disabling unit 33 and the enabling unit 34 may be integrated in a processor or controller, and all of the components can be integrated in a single module or chip. Further, the base station 30, 40 can comprise additional components not depicted in Fig. 2. For example, it may include a storing unit such as e.g. a memory for storing received information such as e.g. the activation information described below.

According to the embodiments, a concept is introduced, where the wireless network 10 network can disable, turn off or switch off entire transmitter chains of sectors and/or entire base stations, whereas receiver chains remain activated. A capability message, capability signal or capability information indicating the capability to disable transmitter parts can be broadcasted by network devices such as e.g. the base stations 30, 40. For example, a capability information indicating that the transmitting unit 31 is capable of being disabled may be broadcasted by means of the transmitting unit 31. In other words, cell disable capability information can be

broadcasted on the BCH of a cell associated with the transmitting unit 31. In this way, terminal devices such as e.g. the terminal device 20 can be informed on the possibility that there may be network devices with disabled transmitter parts.

A lifetime message, lifetime signal or lifetime information may be broadcasted by the base stations 30, 40, i.e. the transmitting unit 31. The lifetime information can define a validity of the capability information, i.e. how long the capability information is valid, and may be broadcasted together with the capability information. That is, a signaling information (and probably also a lifetime information about message validity) can be added beforehand to broadcast information of all cells of a region, which indicates for a service area that cells can be disabled in that region.

Further, a wake up information or activation information to be transmitted to the base stations 30, 40 in order to effect re-enabling of a disabled transmitting unit thereof may be broadcasted. There are multiple options for the activation information, i.e. related system information. In general, random access channel (RACH) messages or RACH bursts with specific assigned preamble sequences can be used to transmit activation information for waking up or re-enabling a base station downlink transmitter or transmitting unit. According to a first option, a specific assigned preamble sequence or preamble sequence set that is exclusively used for wake up RACH messages may be applied. That is, each base station can have its own unique activation information. According to a second option, a same RACH preamble sequence set may be used for wake up in the whole wireless network 10, and then no further signaling can be needed on that. That is, a common activation information of a plurality of base stations may be applied.

An additional information such as e.g. an attempt information may contain an information for the terminal device 20 how long and intense the terminal device 20 shall try to synchronize and send activation information. This limitation can help in preventing that the terminal device 20 drains out its battery by infinitely sending activation information and doing excessive cell search activities when being constantly out of coverage.

The above-described system information, i.e. capability information, lifetime information and attempt information, as well as related system information such as e.g. the activation information may be broadcasted e.g. on a broadcast control channel (BCCH). However, system information may or may not contain information about an existence of sleeping base stations in the service area.

According to a first embodiment, the system information does not contain capability information. Thus, the terminal device 20 does not have knowledge of base stations that might be disabled. In this case, the terminal device 20 can presume that there might be base stations in the neighborhood, which can be waked up, activated or enabled. Hence, it may perform a different idle mode procedure as described below, if a signal quality of a broadcast channel of a wireless network cell is insufficient, i.e. the terminal device 20 can not receive a DL broadcast channel of available cells with a sufficient signal to interference and noise ratio (SINR). In this case, it may transmit activation information e.g. to all neighboring base stations.

According to a second embodiment, system information including at least the capability information may be broadcasted beforehand, i.e. when the transmitting unit 31 is active. The terminal device 20 can receive this information by means of its receiving unit 22. Thus, it may have a priori knowledge of transmitting units that might be disabled. As a result, it can transmit activation information to those base stations comprising the potentially disabled transmitting units, if a signal quality of the broadcast channel of the wireless network cell is insufficient, i.e. the terminal device 20 may not receive the DL broadcast channel of available cells with a sufficient signal to interference and noise ratio (SINR). That is, the terminal device 20 that has read the capability information at an earlier stage can enter a different idle mode behavior if no suitable cell may be found, i.e. perform the different idle mode procedure as described below. In this case, it can transmit activation information to base stations comprising potentially disabled transmitting units.

According to a third embodiment, the terminal device 20 may try to read the system information if a signal quality of the broadcast channel of the wireless network cell is insufficient, i.e. it can not receive the DL broadcast channel of available cells with a sufficient SINR. In this way, it may get information on possible sleeping or disabled base stations, i.e. transmitting units, in the service area. Then, the terminal device 20 can possibly apply the different idle mode procedure as described in the following.

If the terminal device 20 has read the cell disable capability information, it may store it for a given time, e.g. in a memory of the terminal device 20. The lifetime information can also be stored. As long as the capability information has a valid lifetime, which is indicated by the lifetime information, the idle mode behavior in

case that no suitable cells are detected may be modified. That is, the lifetime information indicates how long the capability information is valid, and if it is valid, the terminal device 20 can try to re-activate a sleeping or disabled base station in case that it can not receive the DL broadcast channel of available cells with a sufficient SINR.

As described in further detail below, the terminal device 20 can send an activation information for waking up or re-enabling a disabled (sleeping) base station, i.e. a transmitting unit thereof, if a signal quality of a broadcast channel of a wireless network cell is insufficient. The activation information may be contained e.g. in a RACH message, a RACH burst or a sequence of RACH bursts using specific assigned preamble sequences, i.e. at least one RACH message or burst. It can be at least one specific preamble sequence or preamble sequence set. For example, it may be a specific preamble sequence associated with a specific cell, or a plurality of preamble sequences associated with respective cells.

It should be noted that the RACH preamble format can be predetermined or standardized for cell waking up RACH messages or bursts, e.g. a preamble format 1 or 3 in case of LTE. That is, the at least one specific preamble sequence may conform to a predetermined preamble format of a 3rd generation partnership project long-term evolution standard or another present or future communication standard.

Further, the system information can also comprise information about the transmission power and power ramp up for the waking up or re-activating preambles, i.e. power information. These parameters may be other than for normal RACH messages or bursts, since they will impact a probability that an activation information sent within one disabled cell will be detected also in other disabled cells. That is, a different transmission power and/or power ramp up can be used when transmitting activation information.

After transmitting the activation information, the terminal device 20 may return into a cell reselection stage and search for the waking up cell or base station. The activation information can be received by the still active receiving unit of the sleeping or disabled base station and cause a re-activation of the base station. Then, e.g. a DL signal from the waked up base station may be detected.

In order to prevent that the terminal device 20 transmits an activation information where it is not allowed to do, e.g. the terminal device 20 transmits a LTE RACH

message or burst in a country where LTE is not yet deployed, the described procedure can be allowed only if a weak signal of the mobile communication system used by the terminal device 20 can be identified by the terminal device 20. In other words, the detecting unit 24 of the terminal device 20 may be used to detect whether a wireless network supporting to disable the transmitting unit 31 of the base station 30, 40 is available. The activation information can be transmitted only if a suitable wireless network such as e.g. the wireless network 10 has been detected. The detection may be performed e.g. by trying to synchronize to a strongest received cell of the wireless network 10.

In general, a terminal device can permanently monitor a serving cell of a wireless network and neighboring cells. If the serving cell disappears, the terminal device may try to select a next best suitable base station. However, if all next best suitable base stations are considered to be insufficient from a reception quality point of view, a terminal device as previously proposed usually continues to search until it finds a suitable cell.

According to the embodiments, an idle mode behavior of a terminal device such as e.g. the terminal device 20 can be modified. If the terminal device 20 does not find a suitable cell of the wireless network 10, it can send an activation message, activation signal or activation information to a sleeping or disabled cell in order to trigger a re-activation of the same. That is, in a state of no suitable cell being detected and disabled cells existing, the activation information allowing to re-activate or re-enable a disabled cell may be transmitted to such disabled cell.

The prerequisite that cells of a region are synchronized can reduce a computation complexity for a detection of an activation signal. A frame synchronization may provide the terminal device 20 with an a priori knowledge of a frame timing of all cells in the region, derived from a synchronization on any single cell. The terminal device 20 can read a signaling or synchronization channel (SCH). In the specific case where at least some of the base station transmitting units are switched off, the terminal device 20 may measure longer, to derive the slot and frame synchronization with any cell of the region. The frame timing does not have to be perfect, because the RACH messages or bursts can have an extended cyclic prefix in order to cope with different transmission delay times due to an unknown position of the terminal device 20. Further, since the cell is in sleeping mode or disabled mode, there is in principle no other user that can be disturbed.

If a cell search of the terminal device 20 has been unsuccessful for a specific time, the terminal device 20 may perform a different idle mode procedure such as e.g. a wake up RACH procedure. This can be done if a cell disabled cell indicator such as e.g. the capability information was received and the information has a valid lifetime. However, as described above with reference to the first embodiment, the terminal device 20 may also perform a different idle mode procedure without having received such information. Then, the terminal device 20 can enter a mode for reading an available weak SCH, if needed with an extended correlation time frame.

After achieving synchronization, i.e. reading the SCH of a cell, the terminal device 20 may try to read the BCH of this cell. If it determines that the BCH can not be detected, the terminal device 20 may now send an activation information. For example, a wake up RACH message utilizing an assigned group of preamble sequences for sleeping or disabled base stations such as e.g. node Bs can be transmitted.

The receiver or receiving unit in a transmit (TX) disabled base station such as e.g. the receiving unit 32 of the base station 30, 40 may still be active for the UL. This means for the terminal device 20 that in practice no modification to a normal TX operation is needed. The base station 30, 40 in receive (RX) only mode can receive the activation information such as a RACH message or burst that has been sent in the usual transmission form of the wireless network 10. As described above, only the used preamble indicates the wake up RACH message nature.

Thus, no signal of a special form and no specific receiver device in the base station 30, 40 are needed. The usual RACH format may be used. This is due to the fact that there is no need for an extended range, because the receiver of the disabled cell, i.e. the receiving unit 32 of the disabled base station 30, 40, is still active and can detect the wake up RACH message.

Fig. 3 shows a flow diagram of a basic processing at an apparatus 30, 40 such as e.g. a base station according to the embodiments. In a step S101, the transmitting means 31 of the apparatus 30, 40 comprising the transmitting means 31 and the receiving means 32 can be disabled, wherein the transmitting means 31 may be configured to transmit a wireless communication signal and the receiving means 32 can be configured to receive a wireless communication signal. In a step S102, an activation information indicating that the transmitting means 31 should be re-

enabled may be received by the receiving means 32. In a step S103, the transmitting means 31 can be re-enabled if the activation information is received in the receiving step S102.

Fig. 4 shows a flow diagram of a basic processing at an apparatus 20 such as e.g. a terminal device according to the embodiments. In a step S201, it may be determined whether a signal quality of a broadcast channel of a wireless network cell is insufficient. In a step S202, an activation information can be transmitted on a wireless access channel to an apparatus 30, 40, if the determination in the determining step S201 is affirmative, the activation information indicating that disabled transmitting means 31 of the apparatus 30, 40 should be re-enabled.

As described above, a terminal such as e.g. the apparatus 20 may be informed by means of system information communicated on e.g. the BCCH about the existence of sleeping or disabled base stations such as e.g. the apparatuses 30, 40 and the activation information to be used by the terminal or apparatus 20. For example, specific assigned RACH preamble sequences that are exclusively used by terminals can be communicated. In case of using a RACH burst as an example of the activation information and a user equipment (UE) as an example of the apparatus 20, the re-activation or wake up procedure for the UE that does not get connected to an active base station can be described as follows:

- UE detects that a "correct mobile communication system" is available
- UE does synchronization to a strongest received cell
- UE notices that a BCH of this strongest cell can not be decoded or is not received with sufficient signal quality
- UE transmits a RACH burst from a sleeping base station set (possibly with limited power ramp up)
- UE waits for a DL signal from a waked up base station to appear (if not, it repeats the transmission of the sleeping RACH burst a predefined number of times), synchronizes to an appearing cell, and reads normal mode RACH parameters
- UE transmits a normal mode RACH message, entering a normal RACH procedure

The above procedure is illustrated in Fig. 5 to Fig. 8. Fig. 5 shows a schematic diagram illustrating cells 50 to 56 of the wireless network 10 in a normal or high load scenario. Transmitting and receiving units of all the cells 50 to 56 are active,

i.e. all the cells 50 and 56 are active for both UL and DL. This corresponds to an original cell layout.

Fig. 6 shows a schematic diagram illustrating the cells 50 to 56 of the wireless network 10 in a low load scenario. A transmitting unit of the cell 50 has been disabled. That is, the cell 50 is only active for UL while all the other cells 51 to 56 are active for both UL and DL. This is illustrated by a hatching of the cell 50. Thus, an asymmetric uplink/downlink operation in a low load scenario is possible.

Fig. 7 shows a schematic diagram illustrating a synchronization of the terminal device 20 located in the cell 50 with the disabled transmitting unit. As depicted by an arrow from the terminal device 20 to the cell 56, the terminal device 20 can synchronize to a surrounding cell active for DL, i.e. synchronize with a DL SCH.

Fig. 8 shows a schematic diagram illustrating a transmission of an activation information from the terminal device 20 to the cell 50 with the disabled transmitting unit. As depicted by an arrow from the terminal device 20 to the cell 50, the terminal device 20 may transmit an activation information such as e.g. a RACH burst via the UL to the cell 50 in RX only mode.

Fig. 9 shows a schematic diagram illustrating a situation where a RX only cell informs an O&M center 60. The base station 30, 40 in RX only mode can have an O&M logical relationship with a software (SW) agent for monitoring a reception of activation information such as wake up RACH signals. The agent may have a threshold that can be configured between e.g. 1 and n. If the number of activation information transmissions received is above the threshold, the agent can activate procedures in the O&M center 60, which in turn can re-activate the disabled base station 30, 40. That is, in this case the disabled base station 30, 40 may not be re-enabled by the activation information transmitted by the terminal device 20, but by actions taken by the O&M center 60. For example, a predetermined message can be used for the procedure between the O&M center 60 and the base station 30, 40.

The embodiments described above enable a standby or idle mode of the base station 30, 40. In this standby mode the base station 30, 40 may disable or turn off its entire transmitter chain in case there is no service requested for a longer time period or it is manually/remotely switched off. The receiver chain of the base station 30, 40 remains activated, and then the base station 30, 40 can be re-activated or

waked up by using a cell unique activation information such as e.g. a RACH burst having a specific cell unique RACH preamble sequence.

If the base station 30, 40 is a home enhanced base station such as e.g. a H(e)NB, the terminal device 20 can be registered for the base station 30, 40. A home zone may be defined as a roughly circular region around a location of the base station 30, 40. If the terminal device 20 is located in the home zone, it can use an alternative access technology instead of a wide area (WA) access technology utilized outside of the home zone. For example, wireless local area network (WLAN) access technology may be used in case the terminal device 20 is located in the home zone.

The terminal device 20 can enter a different idle mode behavior (re-activation procedure) if WA fingerprint or global positioning system (GPS) data indicate that its current location is in its home zone but no broadcast signal from the base station 30, 40 can be found. In case of a H(e)NB as an example of the base station 30, 40 and a RACH burst or sequence of RACH bursts as an example of the activation information, the re-activation procedure may be described as follows:

- The terminal device 20 detects with WA fingerprint or GPS data that its current location is in its home zone.
- The terminal device 20 sends a H(e)NB cell unique RACH burst or a sequence of RACH bursts using specific assigned preamble sequences for re-activation or wake up.
- After that the terminal device 20 returns into the cell reselection stage and searches for the waking up cell.

In the above procedure, the RACH burst can be received by the still active receiver of the disabled (sleeping) H(e)NB in the cell of the home zone and may cause a re-activation of the H(e)NB. A H(e)NB cell unique preamble sequence can be planned similar to a downlink scrambling code or even be derived from a physical cell identification. The main reason for using the H(e)NB cell unique preamble sequence is to avoid that sending a RACH message or burst including this preamble sequence results in also re-activating H(e)NBs in neighboring cells (where the terminal device 20 is not member of a subscriber group) at the same time.

With the above procedure, in case of emergency calls a H(e)NB in the standby mode would only wake up if the terminal device 20 is in the home zone and member of the H(e)NB closed subscriber group. Thus, a modification as described in

the following may be used so as to enable waking up of a H(e)NB or other base station in an emergency situation.

According to a fourth embodiment, any terminal device can re-activate or wake up base stations such as e.g. H(e)NBs and eNBs in case of an emergency call. This may be achieved by reserving at least one unique activation information in the whole wireless network 10, i.e. at least one network unique activation information, for emergency calls. For example, in case of a LTE or LTE-A network one specific RACH preamble can be reserved in the whole network for emergency calls. In case of a system comprising multiple networks, at least one unique activation information in the whole system, i.e. at least one system unique activation information, may be reserved for emergency calls. For example, a unique emergency activation information could be reserved for a system comprising networks in a certain region such as e.g. Europe or even for a worldwide system including all available networks. The fourth embodiment may be combined with any one of the first to third embodiments.

In the following, the fourth embodiment is described with reference to an eNB and/or H(e)NB as an example of the base station 30, 40. However, this description is merely exemplary. The discussed mechanism may also be applied to base stations other than eNBs and H(e)NBs. For example, it can be used for base stations and sectors that can be switched of by a self-organizing network (SON) procedure, for the sake of energy efficiency.

If in case of an emergency call no WA or H(e)NB network is available, the terminal device 20 may transmit the network or system unique activation information to re-activate or wake up disabled eNBs and H(e)NBs. For example, a network or system specific RACH burst with a specific RACH preamble unique in a whole LTE or LTE-A network can be transmitted. Alternatively, a network or system unique sequence of RACH bursts using specific assigned preamble sequences for emergency wake up may be transmitted.

The different idle mode procedure for re-activating or waking up a H(e)NB or eNB, i.e. its downlink transmitter, if in an emergency case no WA network is seen can be described as follows:

- The terminal device 20 sends the network or system unique activation information for emergency re-activation or wake up.

- After that the terminal device 20 returns into the cell reselection stage and searches for the waking up cells.

In the above procedure, the activation information may be received by the still active receiver of the disabled (sleeping) H(e)NB or eNB and can cause a re-activation of the H(e)NB or eNB.

The network or system unique activation information may be transmitted with a more aggressive transmission power ramping or a maximum allowed transmission power. That is, the transmission power ramping procedure can be different from that of other transmissions, e.g. have a more aggressive power ramping. For example, a RACH power ramping procedure may be different e.g. with a more aggressive ramping, or a maximum allowed RACH preamble emergency power can always be utilized.

In case of using a LTE or LTE-A system specific RACH burst as an example of the network or system unique activation information and a UE as an example of the terminal device 20, the emergency re-activation or wake up procedure for the UE can be described as follows:

- UE detects no WA network and no H(e)NB with sufficient signal strength for service available
- UE transmits a system specific RACH burst (possible with maximum allowed RACH preamble power for emergency calls and no power ramping procedure)
- UE waits for a DL signal from a waked up H(e)NB and/or eNB to appear

Either:

- UE synchronizes to an appearing cell and reads normal mode RACH parameters
- UE transmits a normal mode RACH message (entering a normal RACH procedure)

Or:

- UE synchronizes to an appearing cell
- UE transmits a system specific RACH burst (possible with maximum allowed RACH preamble power for emergency calls and no power ramping procedure)
- NB transmits an acknowledgement indicator
- UE sends RACH message part

Thus, other than with the "normal" re-activation or wake up procedure described in connection with the first to third embodiments, the terminal device 20 can transmit an activation information even without previously detecting that a "correct mobile communication system" is available. That is, in the normal re-activation or wake up procedure the activation information may be only transmitted if a weak signal of the mobile communication system used by the terminal device 20 can be identified by the terminal device 20. For example, the terminal device 20 may try to detect at least a weak LTE or LTE-A signal from the environment. If there is no weak LTE or LTE-A signal detected, the terminal device 20 can not be allowed to transmit an activation information such as e.g. a wake up RACH message. In this way, it may be prevented that the terminal device 20 transmits the activation information where it is not allowed to do, e.g. in a country where LTE is not yet deployed.

On the other hand, in an emergency case the terminal device 20 can be allowed to transmit an emergency activation information such as an emergency RACH message if only a weak signal such as e.g. a LTE or LTE-A signal or even no signal at all from the environment can be found. Thus, in the emergency case the terminal device 20 may transmit e.g. a LTE signal even in an environment where it is not clear if this is allowed. For example, in the emergency case the terminal device 20 can transmit an emergency wake up RACH message even in a country where LTE is not yet deployed. Hence, the normal re-activation or wake up procedure and the emergency re-activation or wake up procedure performed in the terminal device 20 may differ from each other.

According to a first option of the fourth embodiment, a single network or system unique emergency activation information can be defined for emergency calls. In case that the terminal device 20 transmits such activation information, multiple base stations may wake up. This can lead to lots of changes regarding handover borders etc.

Thus, according to a second option of the fourth embodiment, more than one unique emergency activation information may be reserved for emergency calls, and neighboring sleeping nodes can react on different emergency activation information. For example, multiple RACH sequences may be reserved, and neighboring sleeping nodes can react on different sequences. Wake up RACH sequences may be planned e.g. like downlink scrambling codes in node B downlink transmissions, which wake up RACH sequences are applicable for a specific area. This can avoid that all sleeping neighboring nodes would wake up.

If the terminal device 20 is registered at a home base station, home node B or any other type of home access device (in the following referred to as "HNB"), it can know for the conventional RACH which is the HNB wake up sequence. This home RACH wake up sequence may be calculated from a physical cell identification of the HNB to ensure that RACH wake up sequences of neighboring HNBs are different from each other. This can utilize the fact that downlink scrambling codes of neighboring cells and, therefore, physical cell identifications are different from each other.

According to a fifth embodiment based on the fourth embodiment, the terminal device 20 can first search through all access technologies that it is capable of. For example, the terminal device 20 may search through different radio access technologies (RATs) that it is capable of. In case of e.g. a terminal device 20 capable of UMTS communications and WLAN communications, the terminal device 20 can first try to receive a signal with any of these technologies.

If the terminal device 20 can not find a good candidate or even can find no signal at all with any one of the access technologies that it is capable of, it may transmit an emergency activation information. For example, if no good candidate is found or no signal is found on all RATs the terminal device 20 is capable of, the terminal device 20 can transmit an emergency RACH message.

According to the fourth and fifth embodiments, an apparatus such as e.g. the terminal device 20 may be capable of sending an eNB and/or H(e)NB wake up system specific RACH signal in an emergency case and where the apparatus can not connect to another available active WA base station. Thus, in case of an emergency call it may be possible to re-activate an eNB or H(e)NB that is in a standby mode, even if the terminal device 20 initiating the emergency call is not in a home zone of the eNB or H(e)NB and member of its closed subscriber group. Hence, eNBs and/or H(e)NBs can be re-activated or waked up in an emergency situation, while electromagnetic radiation from such base stations and power consumption may be reduced during service inactivity by means of an efficient standby mode.

Fig. 10 shows a schematic block diagram of a software-based implementation of the embodiments. The required functionalities can be implemented in a processing unit 70, which may be any processor or computer device with a control unit 71 that performs control based on software routines of a control program stored in a

memory 72. The control program may also be stored separately on a computer-readable medium. Program code instructions can be fetched from the memory 72 and loaded into the control unit 71 of the processing unit 70 in order to perform the processing steps of the above functionalities of the embodiments, which may be implemented as the above-mentioned software routines. The processing steps can be performed on the basis of input data DI and may generate output data DO. At the network side the input data DI may correspond e.g. to an activation information indicating that a disabled transmitting unit of a base station such as e.g. the transmitting unit 31 of the base station 30, 40 should be re-enabled. The output data DO can correspond e.g. to a DL signal from the re-enabled transmitting unit 31. At the terminal device side the input data DI may correspond e.g. to a capability information indicating that disabled base stations may be available. The output data DO can correspond to the activation information.

Thus, the above embodiments may be implemented as a computer program product comprising code means for performing each individual processing step when run on a computer device or data processor of the apparatus 10 or the apparatuses 30, 40.

By the above-described principle e.g. an improvement of a node B power consumption in a UMTS system may be achieved by switching off the transceiver chains. This is possible due to a modified initial random access procedure. A whole transmission of a base station can be shut down in this way, resulting in a reduced power consumption and, therefore, a reduced OPEX and an improved eco-balance.

The above embodiments are at least partially described with reference to 3GPP LTE and LTE-A, and they may be advantageous for future wireless networks, where automated configuration and optimization are of concern to reduce a total cost of ownership for operators of the networks and the network behavior in emergency situations is also of concern. However, the use of the described principle in existing technologies is not precluded, but can be possible based on parameters and procedures of the existing technology, interfaces and architecture. With both of present and future technologies operational costs may be saved in times and areas with low load, by re-configuring base station sites in order to minimize energy consumptions while still providing a sufficient coverage and service.

The present invention is applicable to frequency division duplex (FDD) and time division duplex (TDD) technologies. It may be applied in connection with research body activities like the system of cellular radio for traffic efficiency and safety (SOCRATES), or operator initiatives like next generation mobile networks (NGMN).

It is apparent that the present invention can easily be extended to any communication system with varying load. Specifically, the present invention is not intended to be restricted to the described communication technologies. The embodiments may thus vary within the scope of the attached claims. Furthermore, while the embodiments have been described mainly for the case of a terminal device 20 and base stations 30, 40, other devices can take the respective role as well.

In summary, the present invention relates to methods, apparatuses, a system and a computer program product for reducing a power consumption in low load scenarios. An apparatus 20 can comprise transmitting means 21, receiving means 22 and determining means 23 for determining whether a signal quality of a broadcast channel of a wireless network cell is insufficient, wherein the transmitting means 21 may transmit on a wireless access channel an activation information to a further apparatus 30, 40 if the determination is affirmative. The activation information can indicate that disabled transmitting means 31 of the further apparatus 30, 40 should be re-enabled. The further apparatus 30, 40 may comprise transmitting means 31, receiving means 32, disabling means 33 for disabling the transmitting means 31 and enabling means 34 for re-enabling the transmitting means 31, wherein the receiving means 32 can be configured to receive the activation information, and wherein the enabling means 34 may be configured to re-enable the transmitting means 31 if the activation information is received.

The invention can also be implemented in accordance with the following aspects.

According to a first aspect, a method may comprise: disabling a transmitting unit of an apparatus comprising the transmitting unit and a receiving unit, the transmitting unit being configured to transmit a wireless communication signal and the receiving unit being configured to receive a wireless communication signal; receiving by the receiving unit an activation information indicating that the transmitting unit should be re-enabled; and re-enabling the transmitting unit if the activation information is received in the receiving step.

According to a second aspect, the method according to the first aspect can comprise: broadcasting a capability information indicating that the transmitting unit is capable of being disabled.

According to a third aspect, the method according to the second aspect may comprise: broadcasting a lifetime information defining how long the capability information is valid.

According to a fourth aspect, the method according to any one of the preceding aspects can comprise: broadcasting the activation information, the activation information being a unique activation information of the apparatus or a common activation information of a plurality of apparatuses.

According to a fifth aspect, the method according to any one of the preceding aspects may comprise: broadcasting an attempt information indicating how long and intense a further apparatus should try to transmit the activation information to the apparatus.

According to a sixth aspect, the method according to any one of the preceding aspects can comprise: broadcasting a power information indicating at least one of a transmission power and power ramp up for transmitting the activation information.

According to a seventh aspect, a method may comprise: determining whether a signal quality of a broadcast channel of a wireless network cell is insufficient; and transmitting on a wireless access channel an activation information to an apparatus, if the determination in the determining step is affirmative, the activation information indicating that a disabled transmitting unit of the apparatus should be re-enabled.

According to an eighth aspect, the method according to the seventh aspect can comprise: receiving a capability information indicating that the transmitting unit of the apparatus is capable of being disabled, wherein the activation information is transmitted in the transmitting step if the capability information is received in the receiving step.

According to a ninth aspect, the method according to the eighth aspect may comprise: receiving a lifetime information defining how long the capability information

is valid, wherein the activation information can be transmitted if the capability information is valid.

According to a tenth aspect, in the method according to the eighth or ninth aspect the capability information can be received if the determination in the determining step is affirmative.

According to an eleventh aspect, the method according to any one of the seventh to tenth aspects may comprise: receiving an attempt information indicating how long and intense it should be tried to transmit the activation information to the apparatus.

According to a twelfth aspect, the method according to any one of the seventh to eleventh aspects can comprise: trying to receive a signal from the apparatus; and repeating the transmission of the activation information for a certain number of times if no signal from the apparatus has been received after a certain period of time.

According to a thirteenth aspect, the method according to any one of the seventh to twelfth aspects may comprise: receiving a power information indicating at least one of a transmission power and power ramp up for transmitting the activation information, wherein the activation information may be transmitted by using the power information.

According to a fourteenth aspect, the method according to any one of the seventh to thirteenth aspects can comprise: detecting whether a wireless network supporting to disable the transmitting unit of the apparatus is available; and synchronizing to a strongest received cell of the wireless network if the detection in the detecting step is affirmative, wherein it may be determined in the determining step whether a signal quality of a broadcast channel of the strongest received wireless network cell is insufficient.

According to a fifteenth aspect, in the method according to any one of the seventh to fourteenth aspects, the activation information can be transmitted with a more aggressive transmission power ramping or a maximum allowed transmission power.

According to a sixteenth aspect, in the method according to any one of the preceding aspects, the activation information can be contained in at least one random access channel message or burst.

According to a seventeenth aspect, in the method according to any one of the preceding aspects, the activation information may be at least one specific preamble sequence of an access channel message or burst.

According to an eighteenth aspect, in the method according to any one of the preceding aspects, the activation information can conform to a predetermined format of a 3rd generation partnership project long-term evolution standard.

According to a nineteenth aspect, in the method according to any one of the preceding aspects, the activation information can be a unique activation information reserved in a whole network for emergency calls.

According to a twentieth aspect, an apparatus may comprise: a transmitting unit configured to transmit a wireless communication signal; a receiving unit configured to receive a wireless communication signal; a disabling unit configured to disable the transmitting unit; and an enabling unit configured to re-enable the transmitting unit, wherein the receiving unit can be configured to receive an activation information indicating that the transmitting unit should be re-enabled, and wherein the enabling unit may be configured to re-enable the transmitting unit if the activation information is received by the receiving unit.

According to a twenty-first aspect, in the apparatus according to the twentieth aspect, the transmitting unit can be configured to broadcast a capability information indicating that the transmitting unit is capable of being disabled.

According to a twenty-second aspect, in the apparatus according to the twenty-first aspect, the transmitting unit may be configured to broadcast a lifetime information defining how long the capability information is valid.

According to a twenty-third aspect, in the apparatus according to any one of the twentieth to twenty-second aspects, the transmitting unit can be configured to broadcast the activation information, the activation information being a unique activation information of the apparatus or a common activation information of a plurality of apparatuses.

According to a twenty-fourth aspect, in the apparatus according to any one of the twentieth to twenty-third aspects, the transmitting unit may be configured to broadcast an attempt information indicating how long and intense a further apparatus should try to transmit the activation information to the apparatus.

According to a twenty-fifth aspect, in the apparatus according to any one of the twentieth to twenty-fourth aspects, the transmitting unit can be configured to broadcast a power information indicating at least one of a transmission power and power ramp up for transmitting the activation information.

According to a twenty-sixth aspect, an apparatus may comprise: a transmitting unit configured to transmit a wireless communication signal; a receiving unit configured to receive a wireless communication signal; and a determining unit configured to determine whether a signal quality of a broadcast channel of a wireless network cell is insufficient, wherein the transmitting unit can be configured to transmit on a wireless access channel an activation information to a further apparatus, if the determination of the determining unit is affirmative, the activation information indicating that a disabled transmitting unit of the further apparatus should be re-enabled.

According to a twenty-seventh aspect, in the apparatus according to the twenty-sixth aspect, the receiving unit may be configured to receive a capability information indicating that the transmitting unit of the further apparatus is capable of being disabled, and the transmitting unit can be configured to transmit the activation information if the capability information has been received by the receiving unit.

According to a twenty-eighth aspect, in the apparatus according to the twenty-seventh aspect, the receiving unit may be configured to receive a lifetime information defining how long the capability information is valid, and the transmitting unit can be configured to transmit the activation information if the capability information is valid.

According to a twenty-ninth aspect, in the apparatus according to the twenty-seventh or twenty-eighth aspect, the receiving unit may be configured to receive the capability information if the determination of the determining unit is affirmative.

According to a thirtieth aspect, in the apparatus according to any one of the twenty-sixth to twenty-ninth aspects, the receiving unit can be configured to re-

ceive an attempt information indicating how long and intense the apparatus should try to transmit the activation information to the further apparatus.

According to a thirty-first aspect, in the apparatus according to any one of the twenty-sixth to thirtieth aspects, the receiving unit may be configured to try to receive a signal from the further apparatus, and the transmitting unit can be configured to repeat the transmission of the activation information for a certain number of times if no signal from the further apparatus has been received by the receiving unit after a certain period of time.

According to a thirty-second aspect, in the apparatus according to any one of the twenty-sixth to thirty-first aspects, the receiving unit may be configured to receive a power information indicating at least one of a transmission power and power ramp up for transmitting the activation information, and the transmitting unit can be configured to transmit the activation information by using the power information.

According to a thirty-third aspect, the apparatus according to any one of the twenty-sixth to thirty-second aspects may comprise: a detecting unit configured to detect whether a wireless network supporting to disable the transmitting unit of the further apparatus is available, wherein the receiving unit can be configured to synchronize to a strongest received cell of the wireless network if the detection of the detecting unit is affirmative, and wherein the determining unit may be configured to determine whether a signal quality of a broadcast channel of the strongest received wireless network cell is insufficient.

According to a thirty-fourth aspect, in the apparatus according to any one of the twenty-sixth to thirty-third aspects, the transmitting means can be configured to transmit the activation information with a more aggressive transmission power ramping or a maximum allowed transmission power.

According to a thirty-fifth aspect, in the apparatus according to any one of the twentieth to thirty-fourth aspects, the activation information can be contained in at least one random access channel message or burst.

According to a thirty-sixth aspect, in the apparatus according to any one of the twentieth to thirty-fifth aspects, the activation information may be at least one specific preamble sequence of an access channel message or burst.

According to a thirty-seventh aspect, in the apparatus according to any one of the twentieth to thirty-sixth aspects, the at least one specific preamble sequence can conform to a predetermined preamble format of a 3rd generation partnership project long-term evolution standard.

According to a thirty-eighth aspect, in the apparatus according to any one of the twentieth to thirty-seventh aspects, the activation information can be a unique activation information reserved in a whole network for emergency calls.

According to a thirty-ninth aspect, a computer-readable storage medium may be encoded with instructions that, when executed by a computer, perform: disabling a transmitting unit of an apparatus comprising the transmitting unit and a receiving unit, the transmitting unit being configured to transmit a wireless communication signal and the receiving unit being configured to receive a wireless communication signal; receiving by the receiving unit an activation information indicating that the transmitting unit should be re-enabled; and re-enabling the transmitting unit if the activation information is received in the receiving step.

According to a fortieth aspect, a computer-readable storage medium can be encoded with instructions that, when executed by a computer, perform: determining whether a signal quality of a broadcast channel of a wireless network cell is insufficient; and transmitting on a wireless access channel an activation information to an apparatus, if the determination in the determining step is affirmative, the activation information indicating that a disabled transmitting unit of the apparatus should be re-enabled.

According to a forty-first aspect, a system may comprise: at least one apparatus according to any one of the twentieth to twenty-fifth aspects or any one of the thirty-fifth to thirty-eighth aspects if dependent on any one of the twentieth to twenty-fifth aspects; and an operation and maintenance center comprising an agent for monitoring a reception of the activation information, wherein the agent is configured to count a number of receptions of the activation information, and to activate procedures in the operation and maintenance center for re-enabling the transmitting unit of the at least one apparatus if the counted number is above a certain threshold.

According to a forty-second aspect, a base station device can comprise an apparatus according to any one of the twentieth to twenty-fifth aspects or any one of the

thirty-fifth to thirty-eighth aspects if dependent on any one of the twentieth to twenty-fifth aspects.

According to a forty-third aspect, a mobile terminal device may comprise an apparatus according to any one of the twenty-sixth to thirty-fourth aspects or any one of the thirty-fifth to thirty-eighth aspects if dependent on any one of the twenty-sixth to thirty-fourth aspects.

According to a forty-fourth aspect, a chip device can comprise an apparatus according to any one of the twentieth to thirty-eighth aspects.

Claims

1. A method comprising:

disabling transmitting means (31) of an apparatus (30, 40) comprising said transmitting means (31) and receiving means (32), said transmitting means (31) being configured to transmit a wireless communication signal and said receiving means (32) being configured to receive a wireless communication signal (S101);

receiving by said receiving means (32) an activation information indicating that said transmitting means (31) should be re-enabled (S102); and

re-enabling said transmitting means (31) if said activation information is received in said receiving step (S103).

2. The method according to claim 1, comprising:

broadcasting a capability information indicating that said transmitting means (31) is capable of being disabled.

3. The method according to claim 2, comprising:

broadcasting a lifetime information defining how long said capability information is valid.

4. The method according to any one of the preceding claims, comprising:

broadcasting said activation information, said activation information being a unique activation information of said apparatus (30, 40) or a common activation information of a plurality of apparatuses.

5. The method according to any one of the preceding claims, comprising:

broadcasting an attempt information indicating how long and intense a further apparatus (20) should try to transmit said activation information to said apparatus (30, 40).

6. The method according to any one of the preceding claims, comprising:

broadcasting a power information indicating at least one of a transmission power and power ramp up for transmitting said activation information.

7. A method comprising:

determining whether a signal quality of a broadcast channel of a wireless network cell (50, 51, 52, 53, 54, 55, 56) is insufficient (S201); and

transmitting on a wireless access channel an activation information to an apparatus (30, 40), if said determination in said determining step (S201) is affirmative, said activation information indicating that disabled transmitting means (31) of said apparatus (30, 40) should be re-enabled (S202).

8. The method according to claim 7, comprising:

receiving a capability information indicating that said transmitting means (31) of said apparatus (30, 40) is capable of being disabled,

wherein said activation information is transmitted in said transmitting step if said capability information is received in said receiving step.

9. The method according to claim 8, comprising:

receiving a lifetime information defining how long said capability information is valid,

wherein said activation information is transmitted if said capability information is valid.

10. The method according to claim 8 or 9,

wherein said capability information is received if said determination in said determining step (S201) is affirmative.

11. The method according to any one of claims 7 to 10, comprising:

receiving an attempt information indicating how long and intense it should be tried to transmit said activation information to said apparatus (30, 40).

12. The method according to any one of claims 7 to 11, comprising:

trying to receive a signal from said apparatus (30, 40); and

repeating said transmission of said activation information for a certain number of times if no signal from said apparatus (30, 40) has been received after a certain period of time.

13. The method according to any one of claims 7 to 12, comprising:

receiving a power information indicating at least one of a transmission power and power ramp up for transmitting said activation information,

wherein said activation information is transmitted by using said power information.

14. The method according to any one of claims 7 to 13, comprising:

detecting whether a wireless network (10) supporting to disable said transmitting means (31) of said apparatus (30, 40) is available; and

synchronizing to a strongest received cell (50, 51, 52, 53, 54, 55, 56) of said wireless network (10) if said detection in said detecting step is affirmative,

wherein it is determined in said determining step (S201) whether a signal quality of a broadcast channel of said strongest received wireless network cell (50, 51, 52, 53, 54, 55, 56) is insufficient.

15. The method according to any one of claims 7 to 14,

wherein said activation information is transmitted with a more aggressive transmission power ramping or a maximum allowed transmission power.

16. The method according to any one of the preceding claims,

wherein said activation information is contained in at least one random access channel message or burst.

17. The method according to any one of the preceding claims,

wherein said activation information is at least one specific preamble sequence of an access channel message or burst.

18. The method according to any one of the preceding claims,

wherein said activation information conforms to a predetermined format of a 3rd generation partnership project long-term evolution standard.

19. The method according to any one of the preceding claims,

wherein said activation information is a unique activation information reserved in a whole network for emergency calls.

20. An apparatus comprising:

transmitting means (31) for transmitting a wireless communication signal;

receiving means (32) for receiving a wireless communication signal;

disabling means (33) for disabling said transmitting means (31); and

enabling means (34) for re-enabling said transmitting means (31),

wherein said receiving means (32) is configured to receive an activation information indicating that said transmitting means (31) should be re-enabled, and

wherein said enabling means (34) is configured to re-enable said transmitting means (31) if said activation information is received by said receiving means (32).

21. The apparatus according to claim 20,

wherein said transmitting means (31) is configured to broadcast a capability information indicating that said transmitting means (31) is capable of being disabled.

22. The apparatus according to claim 21,

wherein said transmitting means (31) is configured to broadcast a lifetime information defining how long said capability information is valid.

23. The apparatus according to any one of claims 20 to 22,

wherein said transmitting means (31) is configured to broadcast said activation information, said activation information being a unique activation information of said apparatus (30, 40) or a common activation information of a plurality of apparatuses.

24. The apparatus according to any one of claims 20 to 23,

wherein said transmitting means (31) is configured to broadcast an attempt information indicating how long and intense a further apparatus (20) should try to transmit said activation information to said apparatus (30, 40).

25. The apparatus according to any one of claims 20 to 24,

wherein said transmitting means (31) is configured to broadcast a power information indicating at least one of a transmission power and power ramp up for transmitting said activation information.

26. An apparatus comprising:

transmitting means (21) for transmitting a wireless communication signal;

receiving means (22) for receiving a wireless communication signal; and

determining means (23) for determining whether a signal quality of a broadcast channel of a wireless network cell (50, 51, 52, 53, 54, 55, 56) is insufficient,

wherein said transmitting means (21) is configured to transmit on a wireless access channel an activation information to a further apparatus (30, 40), if said determination of said determining means (23) is affirmative, said activation information indicating that disabled transmitting means (31) of said further apparatus (30, 40) should be re-enabled.

27. The apparatus according to claim 26,

wherein said receiving means (22) is configured to receive a capability information indicating that said transmitting means (31) of said further apparatus (30, 40) is capable of being disabled, and

wherein said transmitting means (21) is configured to transmit said activation information if said capability information has been received by said receiving means (22).

28. The apparatus according to claim 27,

wherein said receiving means (22) is configured to receive a lifetime information defining how long said capability information is valid, and

wherein said transmitting means (21) is configured to transmit said activation information if said capability information is valid.

29. The apparatus according to claim 27 or 28,

wherein said receiving means (22) is configured to receive said capability information if said determination of said determining means (23) is affirmative.

30. The apparatus according to any one of claims 26 to 29,

wherein said receiving means (22) is configured to receive an attempt information indicating how long and intense said apparatus (20) should try to transmit said activation information to said further apparatus (30, 40).

31. The apparatus according to any one of claims 26 to 30,

wherein said receiving means (22) is configured to try to receive a signal from said further apparatus (30, 40), and

wherein said transmitting means (21) is configured to repeat said transmission of said activation information for a certain number of times if no signal from said further apparatus (30, 40) has been received by said receiving means (22) after a certain period of time.

32. The apparatus according to any one of claims 26 to 31,

wherein said receiving means (22) is configured to receive a power information indicating at least one of a transmission power and power ramp up for transmitting said activation information, and

wherein said transmitting means (21) is configured to transmit said activation information by using said power information.

33. The apparatus according to any one of claims 26 to 32, comprising:

detecting means (24) for detecting whether a wireless network (10) supporting to disable said transmitting means (31) of said further apparatus (30, 40) is available,

wherein said receiving means (22) is configured to synchronize to a strongest received cell (50, 51, 52, 53, 54, 55, 56) of said wireless network (10) if said detection of said detecting means (24) is affirmative, and

wherein said determining means (23) is configured to determine whether a signal quality of a broadcast channel of said strongest received wireless network cell (50, 51, 52, 53, 54, 55, 56) is insufficient.

34. The apparatus according to any one of claims 26 to 33,

wherein said transmitting means (21) is configured to transmit said activation information with a more aggressive transmission power ramping or a maximum allowed transmission power.

35. The apparatus according to any one of claims 20 to 34,

wherein said activation information is contained in at least one random access channel message or burst.

36. The apparatus according to any one of claims 20 to 35,

wherein said activation information is at least one specific preamble sequence of an access channel message or burst.

37. The apparatus according to any one of claims 20 to 36,

wherein said at least one specific preamble sequence conforms to a predetermined preamble format of a 3rd generation partnership project long-term evolution standard.

38. The apparatus according to any one of claims 20 to 37,

wherein said activation information is a unique activation information reserved in a whole network for emergency calls.

39. A computer program product comprising code means for performing the steps of the method according to any one of claims 1 to 19 when run on a computer device.

40. A system comprising:

at least one apparatus (30, 40) according to any one of claims 20 to 25 or any one of claims 35 to 38 if dependent on any one of claims 20 to 25; and

an operation and maintenance center (60) comprising an agent for monitoring a reception of said activation information,

wherein said agent is configured to count a number of receptions of said activation information, and to activate procedures in said operation and maintenance center (60) for re-enabling said transmitting means (31) of said at least one apparatus (30, 40) if said counted number is above a certain threshold.

41. A base station device comprising an apparatus (30, 40) according to any one of claims 20 to 25 or any one of claims 35 to 38 if dependent on any one of claims 20 to 25.

42. A mobile terminal device comprising an apparatus (20) according to any one of claims 26 to 34 or any one of claims 35 to 38 if dependent on any one of claims 26 to 34.

43. A chip device comprising an apparatus according to any one of claims 20 to 38.

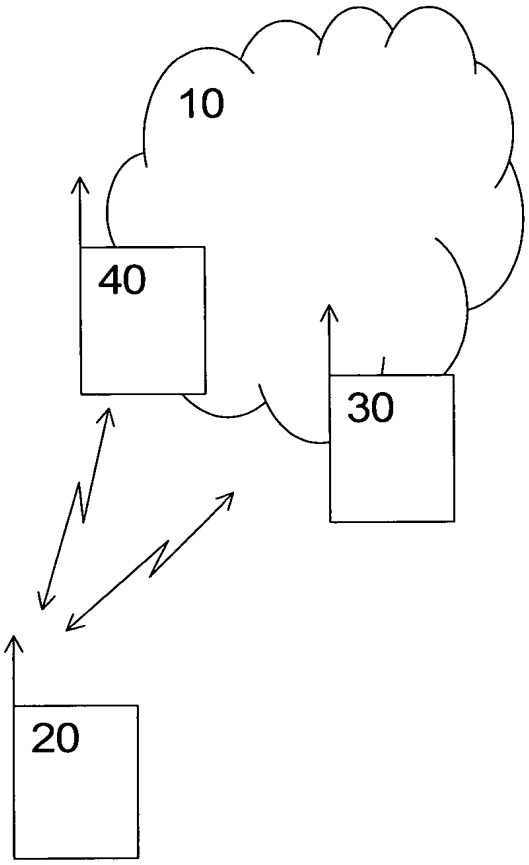

Fig. 1

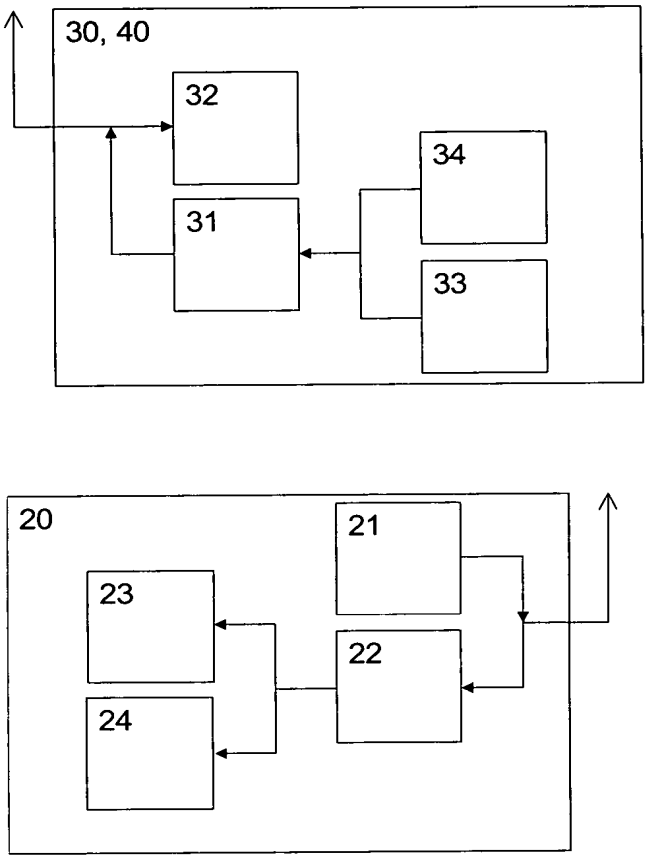

Fig. 2

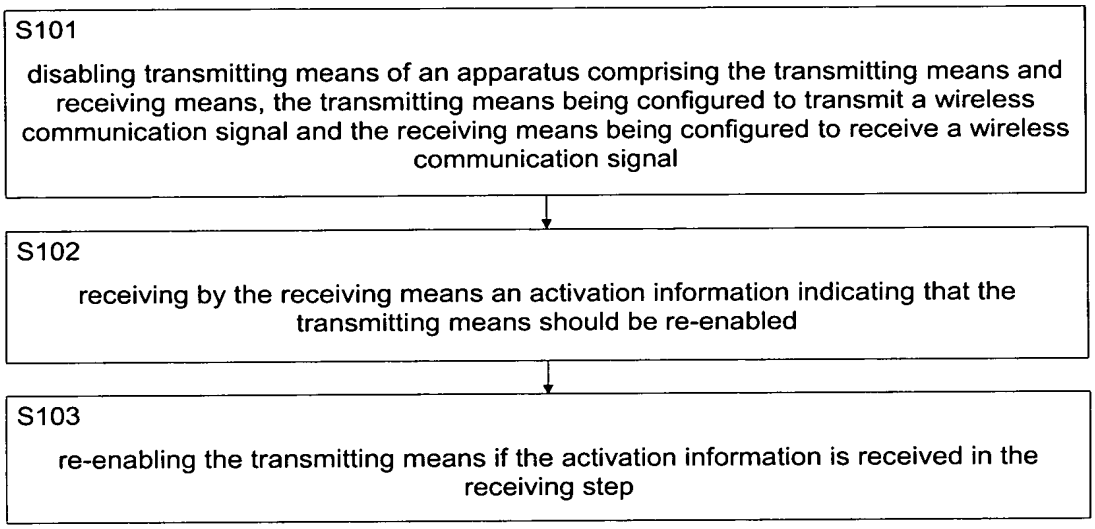
S101
disabling transmitting means of an apparatus comprising the transmitting means and receiving means, the transmitting means being configured to transmit a wireless communication signal and the receiving means being configured to receive a wireless communication signal
S102
receiving by the receiving means an activation information indicating that the transmitting means should be re-enabled
S103
re-enabling the transmitting means if the activation information is received in the receiving step

Fig. 3

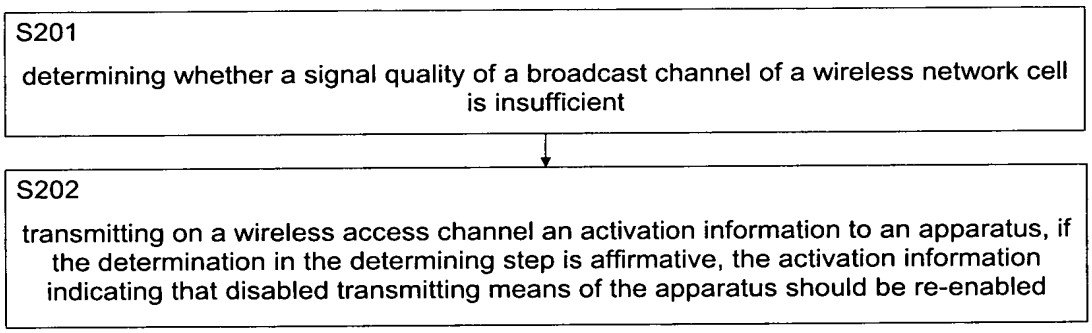
S201
determining whether a signal quality of a broadcast channel of a wireless network cell is insufficient
S202
transmitting on a wireless access channel an activation information to an apparatus, if the determination in the determining step is affirmative, the activation information indicating that disabled transmitting means of the apparatus should be re-enabled

Fig. 4

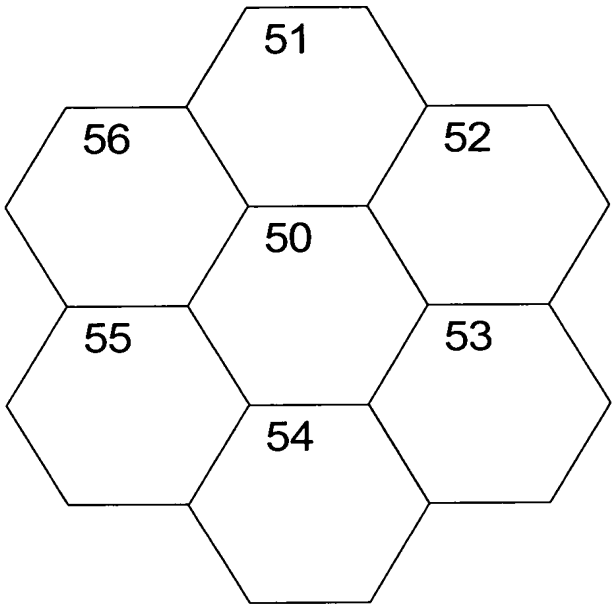

Fig. 5

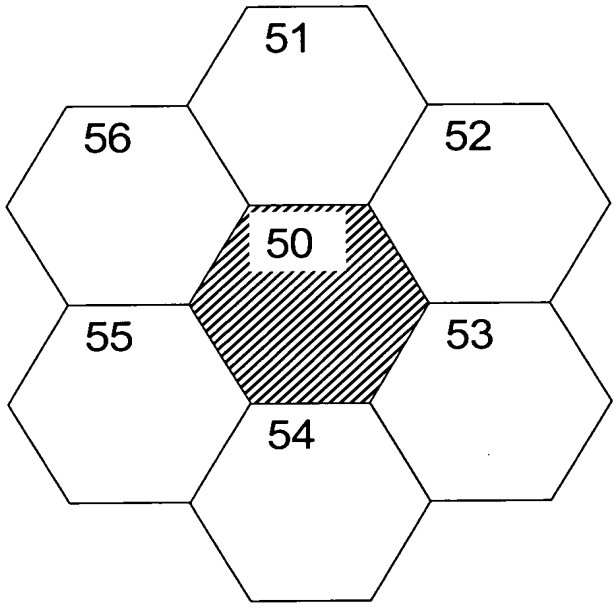

Fig. 6

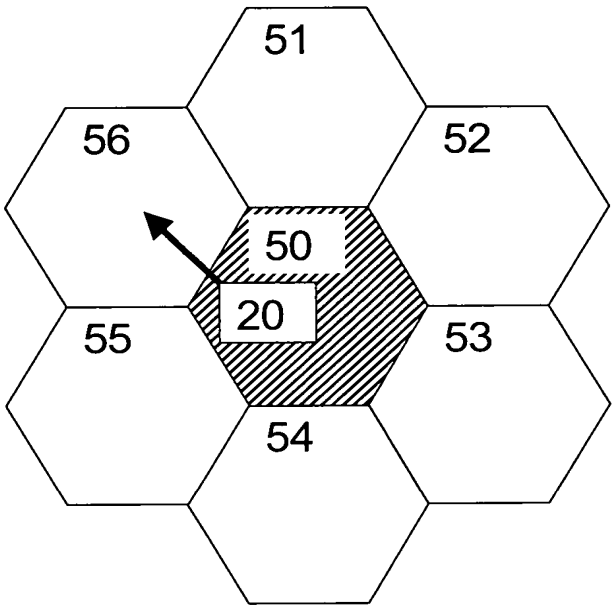

Fig. 7

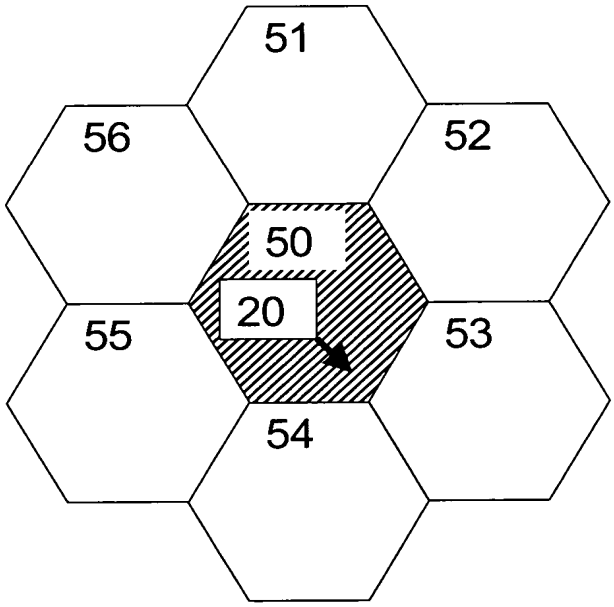

Fig. 8

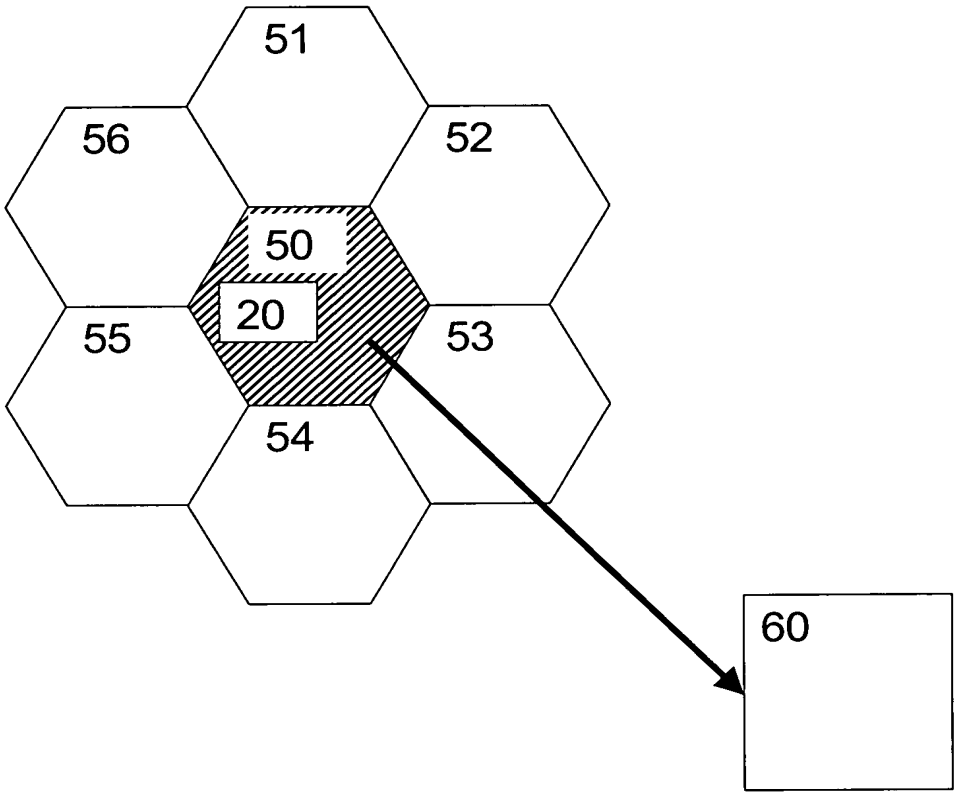

Fig. 9

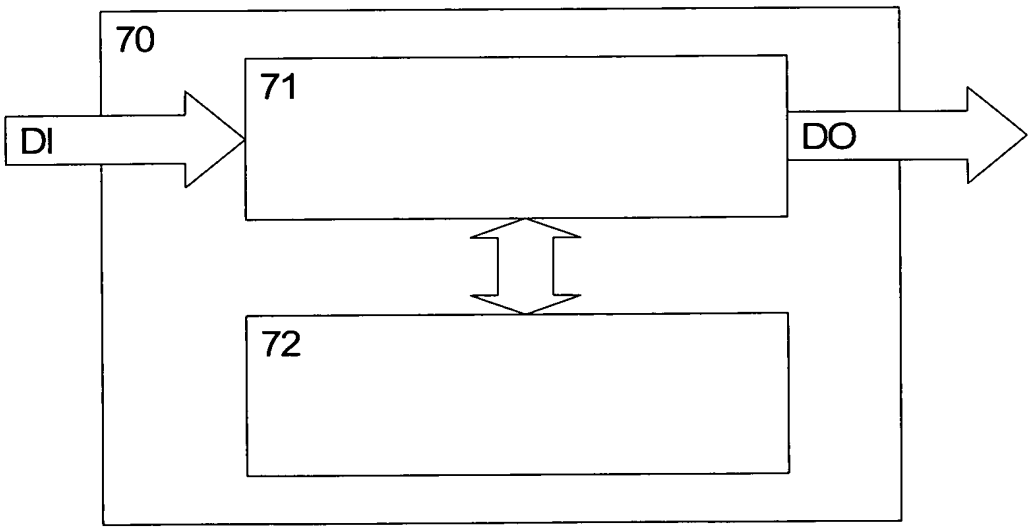

Fig. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/004688

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W52/02

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 practical, 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.
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Y	page 14, line 13 - page 15, line 23	2,3,5,6, 8-13, 15-19, 21,22, 24,25, 27-32, 34-38,40
Y	US 6 360 106 B1 (BESSON MARCUS [DE]) 19 March 2002 (2002-03-19)	40
A	column 2, line 12 - column 6, line 62	1-39, 41-43

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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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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
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 March 2009	12/03/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Fax: (+31–70) 340–3016	Goedhart, André

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ERICSSON EXHIBIT 1002, Page 256

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/004688

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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ERICSSON EXHIBIT 1002, Page 257

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2008/004688

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		JP 2007536865 T	13-12-2007
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(19) World Intellectual Property Organization
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(25) Filing Language: English

(26) Publication Language: English

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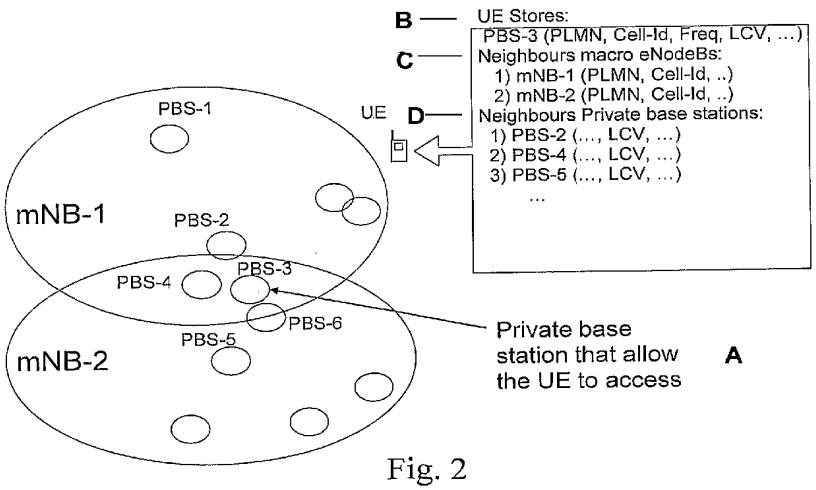

Fig. 2

(57) Abstract: The invention relates to a method for transmission mode change in a telecommunication network, said network having a public network comprising at least one public base station (NB) covering a public cell and a private network comprising at least one private base station (PBS) covering a private cell, wherein said at least one private base station has limited access rights for User Equipment (UE:s) in the private network, and where said UE:s are able to also communicate with the public network, comprising the step of: performing a private base station transmission mode change when the private base station is in an interference reduction transmission mode to an active transmission mode when an UE with access rights to said private base station is detected in proximity of said private base station, where a detection of said proximity is based on information being specific for said UE and its relation to said private base station. The invention also relates to a telecommunication network.

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METHOD AND SYSTEM FOR INTERFERENCE REDUCTION THROUGH PROXIMITY BASED TRANSMISSION MODE CHANGE

Field of the Technology

The present invention relates to a method and a system for interference reduction through proximity based transmission mode change in a telecommunication network.

Background of the Invention

The development of the wireless communication standards for UTRAN (Universal Terrestrial Radio Access Network) and enhanced UTRAN (also called LTE – Long Term Evolution) in 3GPP (3rd Generation Partnership Program) is progressing and during this time the need for small home premise equipments, i.e. private radio base stations containing at least Radio Base Station functionality, typically for very small cells, so called femto cells or pico cells, has emerged.

A problem when introducing private radio base stations in a telecommunication system is that the transmission of common channels such as BCH in the telecommunication system will result in interference between adjacent cells of adjacent radio base stations as the number of nodes in the system may increase to a point where the management of the system will not be possible to plan and control for a network operator, such as by having explicit neighbour lists sent down from a cell as it is done in UTRAN today. Also, in systems where a home owner may own a radio base station for a very small cell, the management of the system will be not possible to plan and control for a network operator as home owners cannot be expected to perform the same complex network planning and configuration of the radio base stations as a network operator would do. Further, in current systems the cells that are neighbouring to a specific cell are explicitly signalled to the UEs to enable the UEs to find suitable cells to measure and use for mobility. In current networks there is a neighbour cell list (NCL) that could also define this. In a system with a high density of small cells, the list of neighbouring cells will become too large to handle and especially with many small cells with limited access rights the list have to be different

ERICSSON EXHIBIT 1002, Page 260

for different UEs. It is therefore not feasible to identify the UE being close to a small base station by this means.

In GSM systems the Cordless Telephony System (CTS) system has been addressing the support for having small equipment for usage at home. However, the CTS-system has only one BCH transmission mode, i.e. the active mode.

Summary of the Invention

The primary object of the present invention is to provide a method and a telecommunication system where the interference to other base stations from a private base station without UEs connected thereto is reduced, thereby increasing the ability to read the cell information of the other base station cells when getting close to a non-used private base station.

The above mentioned object is achieved for a method having the features stated in claim 1, and a system having the features stated in claim 44.

These and other advantageous features will be apparent from the detailed description below.

The invention will now be described in more detail below with reference to the appended drawings which illustrate preferred embodiments of the method according to the invention.

Brief Description of the Drawings

Figure 1 shows schematically an example of a 3G eUTRAN architecture,

Figure 2 shows schematically an example of what cell relation information storage can look like,

Figure 3 shows schematically an example of when the cell relations between the cell(s) covered by the private base station and the cells in the public network changes,

Figure 4 shows schematically a difference in requirements depending on whether the private base station is covering the same area as the larger normal cells or if the coverage is completely separated, and

Figure 5 schematically shows an example of two-step BCH interference reduction mode change in case of neighbouring activity.

ERICSSON EXHIBIT 1002, Page 261

Detailed Description of the Invention

The same reference numerals are being used for similar features in the different drawings.

Although 3GPP UTRAN and eUTRAN are used as model technologies in this application, the embodiments described herein can be applied to any radio access technology.

The development of the wireless communication standards for UTRAN (Universal Terrestrial Radio Access Network) and enhanced UTRAN (eUTRAN, also called LTE – Long Term Evolution) in 3GPP (3rd Generation Partnership Program) is progressing and during this time the need for small home premise equipments, i.e. private radio base stations, has emerged. A private base station contains at least Radio Base Station functionality, typically for very small cells, so called femto cells (or pico cells). For the purpose of this application, the private base station concept includes all kinds of small Radio Base Station equipments (e.g. office) and secondarily it may include also traditional kind of Radio Base Station Equipments for wider area coverage.

As home owners cannot be expected to perform the same complex network planning and configuration of the radio base stations as a network operator would do it is required that the private base stations can be autonomously configured from the home owner's viewpoint.

Figure 1 shows schematically an example of a 3G eUTRAN architecture. The architecture of eUTRAN is simplified compared to UTRAN. In eUTRAN, as can be seen in the figure, a central RNC node controlling multiple NodeB:s does not exist. Instead, only two types of nodes are defined, eNodeB:s (Radio nodes) and MME/SAE Gateways (Access Gateways), where the eNodeB belongs to the evolved UTRAN (E-UTRAN) network and the MME/SAE Gateway belongs to the evolved packet core network (EPC) and where there exists a X2 interface between two eNodeB:s and a S1 interface between an eNodeB and an MME/SAE Gateway. A similar architecture is also used for UMTS, especially when looking at the evolution of the HSPA system where the RNC and NodeB are collapsed to one node.

ERICSSON EXHIBIT 1002, Page 262

When introducing private base stations in the system, possibly on the same carrier frequency as the normal cellular network, the interference will be more unplanned than in conventional cellular networks, since the interference situation will differ depending on where the private base station is placed in the home of the owner.

One common idea with private base stations is to have a limited access right to the private base station for the UEs defined by the user who owns the equipment or which UE belongs to a selected group of UEs. This is how it is done in the WLAN routers that are normally used in today's systems, where the owner selects who will be given access to its router by giving out ciphering keys to the invited UEs.

According to the invention, the private base station shall be able to adapt/minimise the output power of the radio transmitter depending on whether suitable UEs are in the vicinity, and/or whether to transmit common channels in the cell(s), e.g. whether to transmit the PCH (Paging Channel) or BCH (Broadcast Channel) in the cell. The BCH is used for the eNodeB in E-UTRAN to identify itself for UEs roaming in the area and contains information regarding the access information in the E-UTRAN cell. The BCH is transmitted on specific resources in E-UTRAN. There are no big differences for a UTRAN system, where the BCH is used in a similar way. The BCH is transmitted on a specific channelization code in UTRAN.

In UTRAN and E-UTRAN systems the network is aware of the presence of UEs in idle mode through Routing and Tracking Area respectively. This is used to find a suitable balance between the size of the area that a UE has to be paged in and the signalling load caused by the UE to make the network aware of the position. The signalling is done by a NAS (Non Access stratum) message called RAU (Random Access update) or TAU (Tracking Area update) in UTRAN and E-UTRAN respectively.

For UEs in active mode the network is aware of the presence of them on a cell basis.

According to the invention, it is assumed that if a private base station reduces its transmission in a cell, other nearby radio transmissions on same or overlapping frequencies can benefit from this, e.g. transmissions involving nearby private base stations, or involving overlaid public cells such as macro or umbrella cells. Benefits

ERICSSON EXHIBIT 1002, Page 263

would come in terms of higher spectrum efficiency or higher achievable data throughputs or better radio link robustness or a combination of these.

According to the preferred embodiment of the invention, the main problem & solution idea is to reduce private base station interference by reducing transmitted power for common channels such as BCH, PCH for said private base station when they are not needed. When reducing the transmission power of the common channels, such as BCH, the possibility for the UEs to find the cell will be decreased. This can be both a problem and a benefit. Specifically, that is one of the benefits when having restricted access groups of UEs to a specific private base station, as it is likely to exist long periods of time when there is no UE belonging to the said restricted access group present in the vicinity of the private base station during which the interference to the system can be minimized. When the BCH is put in interference reduction mode, the mobility control of the UEs in the system is limited or even disabled, as UEs can no longer receive mobility control information by the BCH of the private base station. However, in a UMTS system there will be UEs that only support earlier releases of the standards, i.e. which are not aware of any restricted access groups. These UEs will then camp on the private base station cell in idle mode, whether or not they are included in the restricted user group or not. When the BCH is put in interference reduction mode the cell will suddenly disappear as for these UEs and they will have to re-select to another cell.

In another case, if the operator wants to use the private base stations to de-load the public network, e.g. when no preferred UEs are in the private base station cell, the power of the BCH has to be turned on well in time for the UEs in public domain to measure the BCH of the cell.

A private base station uses a set of transmission modes, at least two – active mode and interference reduction mode. The private base station uses a proximity indication as input to switch between the different modes, which modes will be described more in detail below.

The benefit is a substantially reduced interference while still preserving the characteristics required to support mobility, reducing unnecessary overhead and improving the radio environment for other nearby radio transmissions on overlapping

ERICSSON EXHIBIT 1002, Page 264

frequencies, increasing total spectrum efficiency, and radio link characteristics for the other nearby radio transmissions.

In current systems the BCH has to be continuously transmitted from a base station. The transmission power of the BCH is defining how far away from the base station it can be heard by an UE, defining the control channel coverage in downlink. The BCH is the main source of interference from a cell where all UEs are idle. In this application, the definition of BCH comprises all logical control information broadcast and also broadcast pilot transmissions and broadcast synchronization information (sometimes referred to as SCH – synchronization channel), and any additional low level control broadcast needed to transmit/receive any of the former kinds of data.

The interference reduction of the different transmission modes can be obtained either by having a periodic interval between BCH transmissions, known as Discontinuous Transmission (DTX), or in a special case the transmission power may be completely turned off. The benefit of applying DTX is that the coverage of the private base station cell could be "normal", still reducing interference, at the low cost of longer times for a UE to reselect to the cell. Also, this could give very good interference reduction when no UE is in the cell, applying very long DTX idle periods. When UEs are using the cell, in active or idle mode, DTX intervals could be shortened, to limit the impact to mobility requirements.

In particular when UEs are using the cell, in idle or active modes, UE sleep periods (DRX – Discontinuous reception) could be synchronized with private base station DTX, in order to optimize both UE battery power and interference from private base station common channel transmission.

In particular, if the private base station DTX timing is known to a UE, it could detect the private base station cell by trying to receive private base station BCH only when this is sent. This is proposed to be achieved by the UE deducing private base station radio frame synchronization by synch information in neighbouring cells, either from neighbouring private base stations, or from an overlaid network. The synch information could be BCH information telling if the private base station is in synch with current cell or not, possibly providing offset information, in case the private base station is synchronized with the reference cell, but transmission frame boundaries are not aligned. Furthermore, in order to spread and randomize interference, the exact

ERICSSON EXHIBIT 1002, Page 265

private base station DTX timing could be determined by applying another offset from the synch reference, the offset being determined by a hash function on a known value that relates to the particular private base station or private base station cell, e.g. a unique Cell identity. This way, the interference can be randomized, without having to burden the BCH of the reference cell with this information (this could be a quite significant saving, as there could be 100's of private base stations within the coverage of a macro cell, which is the most obvious reference cell).

Alternatively, a UE having accessed the particular private base station could remember its frame synch offset, relating to e.g. an overlaid network.

The interference could also be reduced by a transmission mode that uses a different lower maximum transmission power on the BCH than in "normal", i.e. active, mode. The benefit of this approach could be that it works also with legacy UEs, i.e. UEs of previous versions of a standard, that assume that BCH is continuously transmitted. The private base station could be brought into "normal", i.e. active, transmission state, by simply having a UE placed very near the private base station, to select it, and to bring it into operation. Any combination of these methods, e.g. having DTX and power reduction is naturally also possible.

In particular, the private base station is proposed to have different transmission modes for interference reduction for legacy UEs, and other more efficient modes for newer UEs, i.e. UEs supporting the method according to the invention described herein. When using a restricted, or closed, user group, the private base station is proposed to apply different transmission modes depending on the capabilities and maturity of UEs of the restricted user group.

Furthermore, the private base station may store a history of which kind of UEs that are most frequently using the private base station, and select the most optimal transmission mode based on the capabilities and maturity of those UEs. This approach could be applied also for the non-closed user group case.

In one specific mode of the interference reduction states, the power of the BCH could be ramped up from its current power level during consecutive transmission occasions until a specific UE responds to the private base station or a maximum transmission power is reached. This is the same method as is used for RACH procedure in the uplink in UTRAN and E-UTRAN and it could be used for the UE

ERICSSON EXHIBIT 1002, Page 266

detecting the proximity of the private base station. It could also be used for measurements of the coverage situation in the network. When the UE detects the cell it informs the private base station either via a direct radio link or via the currently used cell which relays the information to the private base station.

The proximity could be detected by the UE, the private base station, the network or by other means. If not detected by the private base station itself, it needs to be indicated to the private base station.

A proximity indication is an indication that a UE that can use the private base station (in any way, for camping, for active mode sessions or both), is getting close to a private base station cell, or has entered the coverage of a private base station cell.

Different proximity detection mechanisms could be hierarchical, a coarse proximity mechanism could trigger the usage of a more fine-grained mechanism etc., for example, when recognizing a location area / tracking area / routing area, a GPS location application for fine-grained positioning could be started.

The UE could detect proximity to a private base station that it can use, based on storing and recognizing information regarding cells that are neighbours to or in the vicinity of the particular private base station cell, i.e. the UE would store cell information and cell relations between the private base station and other cells in the surroundings. This information can be stored in the SIM card of the UE or in another storage facility in the UE. The UE could build this information by reading information from the nearby cells, while camping on the private base station cell, or while leaving the private base station cell. Alternatively, the network could provide this information to the UE based on an O&M network model.

Alternatively, the UE could detect proximity to a private base station that it can use, by a location application, e.g. GPS location.

Alternatively, the UE could detect proximity by another UE application, such as recognizing a known short range radio network, e.g. Bluetooth or WLAN network, or by just running a particular UE application. This could be beneficial e.g. in cases when the UE is used also as a remote control to open garage or the front door etc.

Figure 2 shows schematically an example of how cell relation information storage can look like. When the UE detects proximity to a private base station PBS that it can access, e.g. by recognizing the surrounding cells, e.g. through the cell

ERICSSON EXHIBIT 1002, Page 267

identity or the logical cell value, that are near this particular private base station, the UE need to notify the private base station that it is nearby to trigger a private base station transmission mode change, to make it possible to find and access the particular private base station cell. This could be done through the wireless network, i.e. the UE doing a control plane procedure (e.g. a cell/tracking area update), towards a cell where the UE is when it detects the proximity, with a particular value of a particular information element, indicating proximity to a private base station that the UE can use. Also, for simple network implementation, the address of the particular private base station or private base station cell could be provided by the UE, e.g. a unique cell identity. The network would then in turn indicate to the private base station to change transmission mode.

Another alternative is that the UE indicates directly to the private base station that it is present, e.g. by a RACH procedure. This requires however that the UE can in some way detect, find and measure the private base station cell, despite the private base station being in a reduced interference transmission mode, possibly by knowing the timing details of the private base station DTX, as mentioned above, or by applying extremely long detection and measurement times, matching the private base station DTX. In this case, the proximity indication internally in the UE would trigger the UE to start looking for the private base station cell, when the UE gets near the private base station.

Cell relation information may, wherever it is stored, include information relating to at least one private cell covered by a private base station to which said UE has access rights, and optionally at least one neighboring private cell and/or at least one neighboring public cell, where cell information may include one of the following: a Logical Cell Value (LCV), a frequency, a Cell-ID, or a Public Land Mobil Network (PLMN).

Figure 3 shows schematically an example of when the cell relations between the private base station and the cells in the public network also changes whenever there is a need to update the cell plan of the public network, either due to additions of new cells or other cell layout reconfigurations. The UE uses the cell relation information to generate the proximity indication to the private base station, but since the cell layout has changed the UE never generates the proximity indication and the private base station is never activated.

ERICSSON EXHIBIT 1002, Page 268

In an embodiment of the invention the cell information broadcast from the cells after the cell layout reconfiguration is containing both the new cell information and also cell information about its previous information. This extra information could be used for a period of time, so that the UEs can understand that they should update their cell relation information.

In case the UE does not obtain the extra information during this period of time, it might have to manually select the private base station and then update the cell relation information. This could also be used when the owner has moved the private base station to another place in the home/building which also could change the cell relations.

As shown in figure 4, there is a difference in requirements depending on whether the private base station is covering the same area as the larger normal cells or if the coverage completely separate. An example of this is shown in the figure where there are two cells covered by private base stations (cell 1 and cell 2) and a public cell (cell 3). When a private base station is having no coverage relation to the surrounding cells (as cell 2), we call it "out of service". This could for example be a scenario where the private base station is placed in the basement of a house.

In the most common situation the private base station will have overlapping coverage with the surrounding cells (as cell 1). We call that "in service". This is the situation where the reduced interference from the common channels would be the most beneficial. A problem is when a cell is "out of service" and the UE is turned off, e.g. in a bedroom in the basement only covered by the private base station where the private base station would possibly go into interference reduction mode since no UE is available. When the UE is powered up in the morning there is no cell available to find and therefore it is suggested that the UE sends a wake up message directly to the private base station.

This message could be a normal random access burst, with a specific preamble, that the private base station shall be listening to and when received the private base station shall go in to normal operation. Another aspect of "out of service" is that the benefit of interference reduction is gone and therefore this information could be used to select if or which mode to apply.

ERICSSON EXHIBIT 1002, Page 269

UE based proximity detection and indication is particularly beneficial when UE is in Idle Mode, as UE mobility is anyway handled by the UE in Idle mode. The network knows the location of the Idle UE only on coarse granularity, on tracking area / routing area / location area basis, and cannot say very exactly when a UE is close to a private base station. There could be many private base stations in the geography of a tracking area that this particular UE can use. The UE on the other hand knows its "position" on finer granularity, on cell level and can provide a more accurate proximity indication.

UE based proximity detection could also be used in active mode, meaning that the UE would report detected proximity to the network, possibly by the same procedure as used in Idle mode, possibly by another procedure, e.g. a mobility measurement report, that is anyway sent regularly in Active Mode. The main benefit of using UE based proximity detection also in active mode would be reduced network complexity due to reusing the same functionality for active and Idle mode UEs.

In another embodiment of the invention, the proximity indication can be initiated by a node in the network. The network is then responsible for keeping the cell relations information table updated for each UE, meaning that the information about the private base station that the UE is allowed to access and the neighbouring cells is maintained. This could be stored in the Core Network CN or in the Radio Access Network RAN. The information about the cell relations would be similar as shown in the example in 2.

Other network elements - like a public NodeB - can ask the private base station to change interference reduction BCH mode. The reason may be that an active UE will soon start measuring for this private base station and it is therefore required to turn the BCH into normal mode. When the UE is in active mode, the position is known by the radio access network on a cell basis, and the proximity indication can be sent for example from the public eNodeB when the UE enters the cell that is in proximity of the private base station cell.

Another reason for having other network elements to change the interference reduction mode could be that the CN knows whether a UE is present in the network or not. If the UE is present in another TA/RA/LA than the TA/RA/LA where the private base station is, the network could ask the private base station to go into the maximum

ERICSSON EXHIBIT 1002, Page 270

interference reduction mode, e.g. turning the BCH completely off. When the UE is detached from the network, the private base station could be asked to ramp up the transmission power, in case the UE is trying to attach to the network again at home. For example, this could be the case when the UE is running out of battery power and is not recharged until getting home.

For UEs in idle mode the proximity indication could also be sent when a UE enters the RA or TA that is covering the same geographical area as the private base station is covering. Since the RA or TA can have a rather large coverage area this might not be so power efficient.

At TA/RA/LA update, when the UE enters a particular TA/RA/LA, the UE could be commanded to do a control plane procedure, e.g. a cell update either for every new cell or when entering a particular cell, or any cell in a list of particular cells., or a tracking area update. Thereby the radio access network could get better proximity detection when the UE is getting close to a private base station.

In an embodiment of the invention the macro NodeB sends a proximity indication to the private base station based on the presence indication of a specific UE.

In case of private base station for UTRAN there is a need for backwards compatibility to support UEs supporting earlier releases of the standards. These UEs cannot be aware of any restricted access permissions in idle mode and therefore we would have to make sure the mode change does not affect the UEs performance.

In active mode the UTRAN supports soft handover, so in the case of a public access to the private base station the BCH would have to be turned on whenever there is any UE activity in the neighbouring cells.

Figure 5 shows an example of two-step BCH interference reduction mode change in case of neighbouring activity here exemplified with seven private base station cells. This is useful when requiring soft-handover as the private base station is powered up before the UE enters its cell.

Firstly, when all private base stations have UEs active in their cell, all said private base stations are in a first state, i.e. all are in an active state.

Secondly, when there is no UE present in the centre private base station cell, said private base station will change the mode to an intermediate interference reduction

ERICSSON EXHIBIT 1002, Page 271

mode and inform its neighbouring cells about the state change as shown in the figure. Thus, when all the UEs leave or turn off for a while, the private base station enters this mode. This second state is characterized by an indicating phase where the neighbouring cells are informed about the lack of UEs.

Thirdly, when all other neighbour cells also have turned into said second state, the private base station can go into the next state of BCH interference reduction. Thus, when no private base station has any active UEs, i.e when the centre private cell has no neighbour cells in first state, then private base station in said centre private cell can turn to a third power reduction state. The third state is characterized by reduced BCH power.

In the opposite direction, the private base station would go from the interference reduction mode characterized by the third state when receiving an indication from any of its neighbouring cells that a UE is present in that cell. The private base station then turns on the BCH to ensure the UE in the other cell can read its information and sends an indication to all its neighbouring cells. If the UE enters the cell of the private base station it will go in to the active state and inform its neighbour cells about the mode change or it will go back to the interference reduction mode in case all the neighbouring cells are in the second state.

In another embodiment of the invention the private base station may detect that a UE that can use the private base station is within the private base station coverage area. The private base station thus has to detect and receive transmission from a particular UE. The benefit of this approach is that being a network implementation, it may also work for legacy UEs, and provide very good interference reduction, as the private base station can simply turn all its transmission off when no interesting UE is nearby.

In order to detect UE transmission, the private base station needs to receive information on what to listen to, and possibly when to listen (timing). This information could be provided from other network elements controlling a current radio transmission for the UE. This may contain information about time/frequency slot and/or UE specific scrambling codes, UE transmission of uplink reference symbols, pilots etc. The private base station can then determine if the UE is in the vicinity. The private base station could then change mode based on this. This

ERICSSON EXHIBIT 1002, Page 272

approach could be applied both in Idle mode and in active mode. In active mode, even when in UE power saving state with long DRX cycle, there is regular control signalling. In Idle mode there is usually also regular control signalling, e.g. periodic TA/LA/RA update for supervision. A complication for Idle mode is that the UE might be using an uplink common control channel, where the UE cannot be identified by the radio access network by physical layer addressing. In this case, anyway the private base station could have been provided the full configuration of the common control channel and in addition any UE specific information that is needed to identify a certain UE as a sender, and/or to decode any needed higher layer information in the UE transmission.

The private base station device may have its own presence detector, e.g. a motion detector or a sound detector - detecting that people are in the vicinity, alternatively it could have another wireless detection mechanism that correspond to a UE function, e.g. a short range radio, WiFi, Bluetooth, IR etc that can detect that a UE is nearby. The private base station may then also inform the other network element that it can hear this UE.

The network node generating the proximity indication could also be an external node, identifying the user presence in the coverage area of the private base station cell. Examples of these external proximity detectors could be burglar alarms, e.g. motion detectors, alarm activation/de-activation, garage port activation, electronic key system, car detection, refrigerator opening detector, plumbing/toilet activity detector, sound detector, Stereo/radio/pc/light on detector etc.

When a UE is using a cell of a private base station (in idle mode or in active mode) but there is no user data transmission ongoing, nor any other signalling the information about the presence of the UE can be unknown to the private base station, since there is no activity.

In one embodiment of the invention when the UE is camping on a cell of a private base station in idle mode, the UE periodically updates the private base station only (not the CN) to inform the private base station that this UE is still camping on this private base station. The UE may attach additional information about the radio environment to this message. This information could for example be measurements of neighbouring cells, which would enable the private base station to get a better

ERICSSON EXHIBIT 1002, Page 273

understanding of the coverage situations, since there is a difference in requirements depending on whether the private base station is covering the same area as the larger normal cells or if the coverage is completely separate, as described before.

A timer may also be used to step between states:

When not receiving a periodic update from any UE within a certain time the private base station can assume there is no UE there, after which it can increase the DTX period or switch off the BCH.

When not receiving an access from a specific UE within some time, increase power or reduce DTX period.

The private base station may inform other network elements (when changing, periodically or when asked) what the current mode is. This will be helpful for the other elements when setting up handover measurements. Information of a mode change in the private base station may be sent to other network nodes.

The invention thus relates to a method for transmission mode change in a telecommunication network, wherein a public network comprises at least one public base station (NB) covering a public cell and a private network comprises at least one private base station (PBS) covering a private cell, wherein said at least one private base station has limited access rights for User Equipments (UE:s) in the private network, and where said UE:s are able to also communicate with the public network, comprising the step of, when the private base station is in an interference reduction transmission mode,

- performing a private base station transmission mode change to an active transmission mode when an UE with access rights to said private base station is detected in proximity of said private base station, where a detection of said proximity is based on information being specific for said UE and its relation to said private base station. The invention also relates to a telecommunication network.

ERICSSON EXHIBIT 1002, Page 274

Claims

1. Method for transmission mode change in a telecommunication network, wherein a public network comprises at least one public base station (NB) covering a public cell and a private network comprises at least one private base station (PBS) covering a private cell, wherein said at least one private base station has limited access rights for User Equipments (UE:s) in the private network, and where said UE:s are able to also communicate with the public network,

comprising the step of, when the private base station is in an interference reduction transmission mode,

- performing a private base station transmission mode change to an active transmission mode when an UE with access rights to said private base station is detected in proximity of said private base station, where a detection of said proximity is based on information being specific for said UE and its relation to said private base station.

2. Method as claimed in claim 1, wherein said detection of said proximity, for a particular one of said at least one private base station, is based on a cell relation between a private cell, covered by said particular private base station, and other public or private cells in a vicinity of the private cell.

3. Method as claimed in claim 1, wherein the private base station when in active transmission mode performs a mode change to an interference reduction transmission mode when no UE with access rights to said private base station is detected in proximity of said private base station.

4. Method as claimed in claim 1, wherein the private base station when in active transmission mode performs a mode change to an interference reduction transmission mode when all UEs with access rights to said private base station are detected outside the private cell of the private base station.

5. Method as claimed in claim 1, wherein the private base station when in active transmission mode performs a multi-step mode change to an interference reduction transmission mode, wherein the private base station passes an intermediate interference reduction transmission mode.

ERICSSON EXHIBIT 1002, Page 275

6. Method as claimed in claim 1, where the private base station when in interference reduction transmission mode performs a mode change to another interference reduction transmission mode depending on UE capabilities.

7. Method as claimed in claim 1, wherein the private base station transmits common channels such as a Broadcast Channel (BCH) in active transmission mode only.

8. Method as claimed in claim 1, wherein the private base station transmits common channels such as a Broadcast Channel (BCH) with discontinuous transmission (DTX) pattern in interference reduction transmission mode.

9. Method as claimed in claim 8, wherein sleep periods for UEs with access rights to said private base station are synchronized with the DTX pattern of the private base station.

10. Method as claimed in claim 9, wherein said UE is triggered to trying to receive the BCH transmitted by said private base station only when this is sent.

11. Method as claimed in claim 10, wherein said UE deduces radio frame synchronization by synch information in neighbouring cells.

12. Method as claimed in claim 1, wherein the private base station transmits common channels such as a Broadcast Channel (BCH) with reduced power in interference reduction transmission mode.

13. Method as claimed in any of claims 1-12, wherein an UE with access rights to said private base station is detected in proximity of said private base station by said UE.

14. Method as claimed in claim 13, wherein the proximity is detected based on storing and recognizing information in the UE regarding cells that are neighbours to or in the vicinity of the particular private base station.

15. Method as claimed in claim 14, wherein said information is collected by the UE by reading information from the nearby cells while camping on the private base station.

16. Method as claimed in claim 14, wherein cell information broadcast from the cells after the cell layout reconfiguration is containing both the new cell information and also cell information about its previous information.

ERICSSON EXHIBIT 1002, Page 276

17. Method as claimed in claim 14, wherein said information is collected by the UE by receiving information from the network based on a network model.

18. Method as claimed in claim 17, wherein said information is sent to the UE from the network as a response to a tracking area update.

19. Method as claimed in claim 14, wherein said cell relation includes information of at least one of the entities or parameters in the group: at least one private base station to which said UE has access rights, and optionally at least one neighboring private cell and/or at least one neighboring public cell, where cell information may include one of the following: a Logical Cell Value (LCV), a frequency, a Cell-ID, or a Public Land Mobil Network (PLMN).

20. Method as claimed in claim 13, wherein said information is based on a location application in the UE.

21. Method as claimed in claim 20, wherein said location application is a Galileo application.

22. Method as claimed in claim 20, wherein said location application is a Global Positioning System (GPS) application.

23. Method as claimed in claim 13, wherein said information is based on detection of electronic equipment.

24. Method as claimed in claim 23, wherein said electronic equipment is any one of the electronic equipments in the group: a UE application; a local radio network, such as a Bluetooth network or WLAN.

25. Method as claimed in any of claims 1-12, wherein an UE with access rights to said private base station is detected in proximity of said private base station by the Network.

26. Method as claimed in claim 25, wherein the proximity to said private base station is detected by the Public base station.

27. Method as claimed in claim 25, wherein the proximity to said private base station is detected by a core network node.

28. Method as claimed in claim 25, wherein the proximity to said private base station is detected by another Private base station.

ERICSSON EXHIBIT 1002, Page 277

29. Method as claimed in claim 25, wherein the proximity is detected based on storing and recognizing information regarding the UE and cells that are neighbours to or in the vicinity of the particular private base station.

30. Method as claimed in claim 29, wherein the proximity is defined as the UE entering a cell being neighbour to or in the vicinity of the particular private base station.

31. Method as claimed in claim 29, wherein said information is stored in the Core Network or in the Radio Access Network.

32. Method as claimed in claim 25 wherein said cell relation includes information of at least one of the entities or parameters in the group: at least one private base station to which said UE has access rights, and optionally at least one neighboring private cell and/or at least one neighboring public cell, where cell information may include one of the following: a Logical Cell Value (LCV), a frequency, a Cell-ID, or a Public Land Mobil Network (PLMN).

33. Method as claimed in claim 29, wherein said UE is ordered by said network node to send an additional Tracking Area Update (TAU) message when said UE enters a particular cell in a Tracking Area (TA).

34. Method as claimed in claim 25, wherein the proximity to said private base station is detected by said Private base station.

35. Method as claimed in claim 34, wherein the UE sends periodic signalling to the Private base station.

36. Method as claimed in claim 35, wherein the periodic signalling comprises information of neighbouring cells.

37. Method as claimed in claim 34, wherein the proximity is detected based on recognizing a radio transmission comprising the UE and a cell being neighbour to or in the vicinity of the particular private base station.

38. Method as claimed in claim 34, wherein the proximity is defined as the UE being engaged in a radio transmission with a cell being neighbour to or in the vicinity of the particular private base station.

ERICSSON EXHIBIT 1002, Page 278

39. Method as claimed in claim 38, wherein information of the UE being engaged in a radio transmission with a cell being neighbour to or in the vicinity of the particular private base station is sent to said private base station by the network.

40. Method as claimed in claim 38, wherein the proximity is detected based on detection of the UE by a local radio network such as a Bluetooth network or WLAN, or electronic entity, on the private base station.

41. Method as claimed in claim 40, wherein said electronic entity is any one in the group of: alarm entities, such as burglar alarms, motion detectors, alarm activation, alarm deactivation; or electronic equipment activation.

42. Method as claimed in claim 1, wherein information of a proximity indication is signalled to the private base station.

43. Method as claimed in claim 42, wherein a mode change is effected in the private base station based on a proximity indication.

44. Method as claimed in claim 1, wherein information of a mode change in the private base station is sent to other network nodes.

45. Telecommunication network, said network having a public network comprising at least one public base station (NB) covering a public cell and a private network comprising at least one private base station (PBS) covering a private cell, wherein said at least one private base station has limited access rights for User Equipment (UE:s) in the system, and where said UE:s are able to also communicate with the public network,

and where the system has means for receiving a proximity indicator triggering a mode change of the private base station from an interference reduction transmission mode to an active transmission mode when an UE with access rights to said private base station is detected in proximity of said private base station, where a detection of said proximity is based on information being specific for said UE and its relation to said private base station.

46. Telecommunication network as claimed in claim 45, wherein said detection of said proximity, for a particular one of said at least one private base station, is based on a cell relation between a private cell, covered by said particular private base station, and other public or private cells in a vicinity of the private cell.

ERICSSON EXHIBIT 1002, Page 279

47. Telecommunication network as claimed in claim 46, wherein the system means for receiving a proximity indicator comprises at least one of the following: the private base station, another private base station, the network, a public base station, or a core network node.

48. Telecommunication network as claimed in claim 47, wherein the proximity indicator is sent to said receiving system means from an User Equipment (UE) arranged to have access rights to the private base station (PBS).

49. Telecommunication network as claimed in claim 48, wherein the proximity indicator is sent by the UE when the UE recognizes information regarding cells that are neighbours to or in the vicinity of the particular private base station.

50. Telecommunication network as claimed in claim 49, wherein the proximity indicator is sent by the UE when the UE detects proximity to the private base station based on a location application in the UE.

51. Telecommunication network as claimed in claim 50, wherein the proximity indicator is sent by the UE when the UE detects proximity to the private base station based on detection of electronic equipment.

52. Telecommunication network as claimed in claim 51, wherein the proximity indicator is an additional Tracking Area Update (TAU) message sent by the said UE when entering a particular cell in a Tracking Area (TA) comprising the private base station.

53. Computer program, **characterised in** code means, which when run in a computer causes the computer to execute the method as claimed in claim 1.

54. Computer program product including a computer readable medium and a computer program according to claim 53, wherein said computer program is included in the computer readable medium.

55. Computer program product according to claim 54, **characterised in** that said computer readable medium consists of one or more from the group: ROM (Read-Only Memory), PROM (Programmable Read-Only Memory), EPROM (Erasable PROM), Flash memory, EEPROM (Electrically Erasable PROM), hard disk drive.

ERICSSON EXHIBIT 1002, Page 280

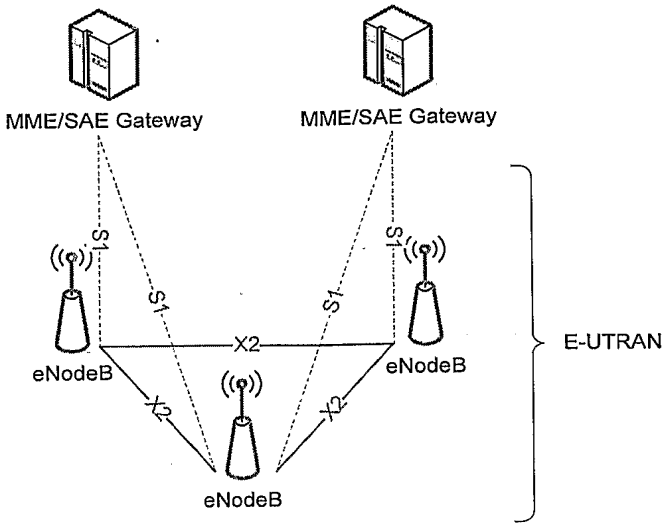
MME/SAE Gateway
MME/SAE Gateway
S1
S1
S1
S1
X2
eNodeB
eNodeB
X2
X2
eNodeB
E-UTRAN

Fig. 1

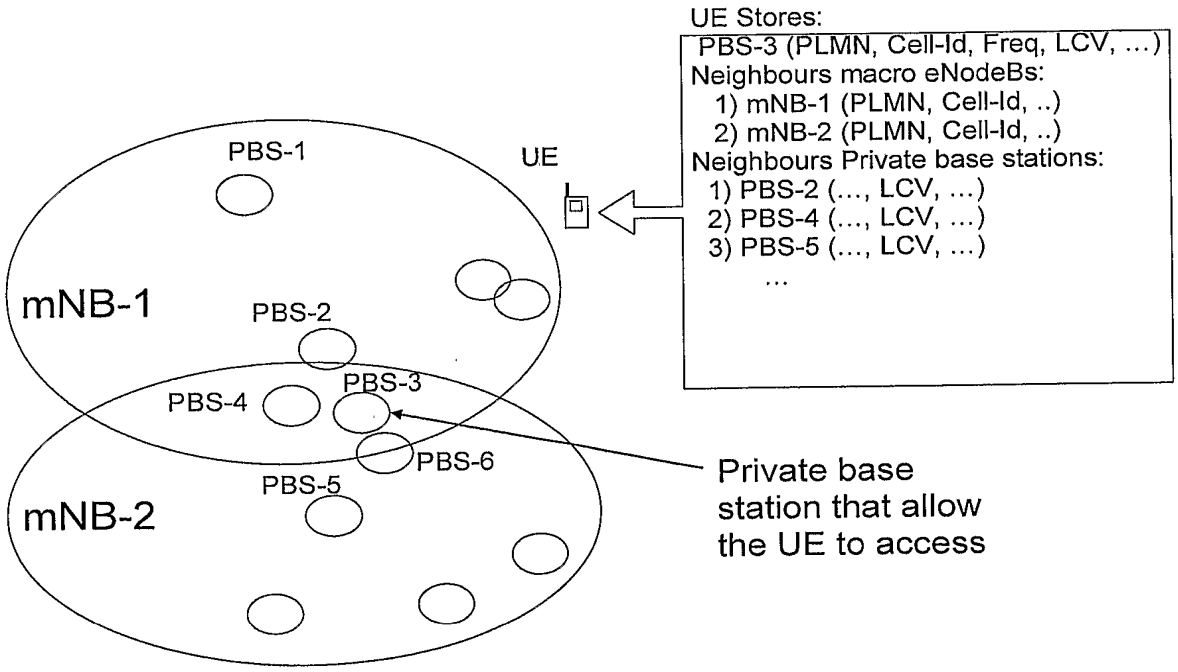
UE Stores:
PBS-3 (PLMN, Cell-Id, Freq, LCV, ...)
Neighbours macro eNodeBs:
1) mNB-1 (PLMN, Cell-Id, ..)
2) mNB-2 (PLMN, Cell-Id, ..)
Neighbours Private base stations:
1) PBS-2 (..., LCV, ...)
2) PBS-4 (..., LCV, ...)
3) PBS-5 (..., LCV, ...)
...
PBS-1
UE
mNB-1
PBS-2
PBS-4
PBS-3
PBS-6
PBS-5
mNB-2
Private base station that allow the UE to access

Fig. 2

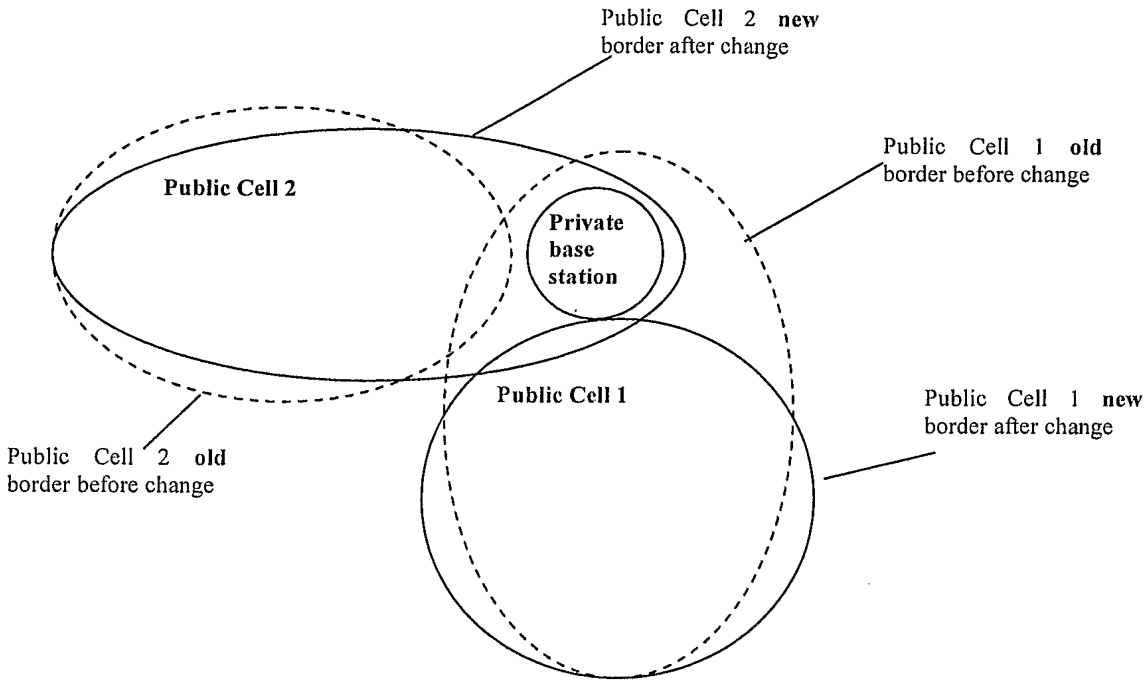
Public Cell 2 new border after change
Public Cell 1 old border before change
Public Cell 2
Private base station
Public Cell 1
Public Cell 1 new border after change
Public Cell 2 old border before change

Fig. 3

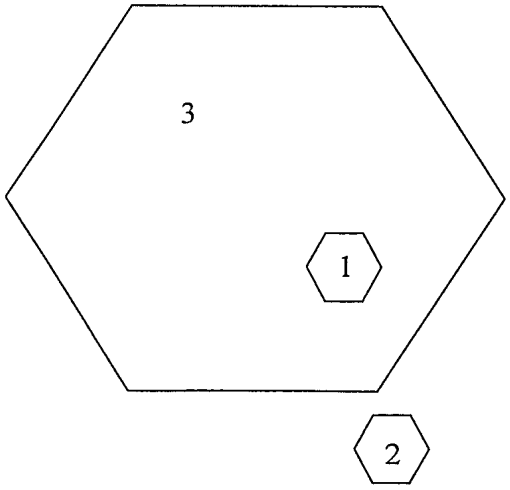
3
1
2

Fig. 4

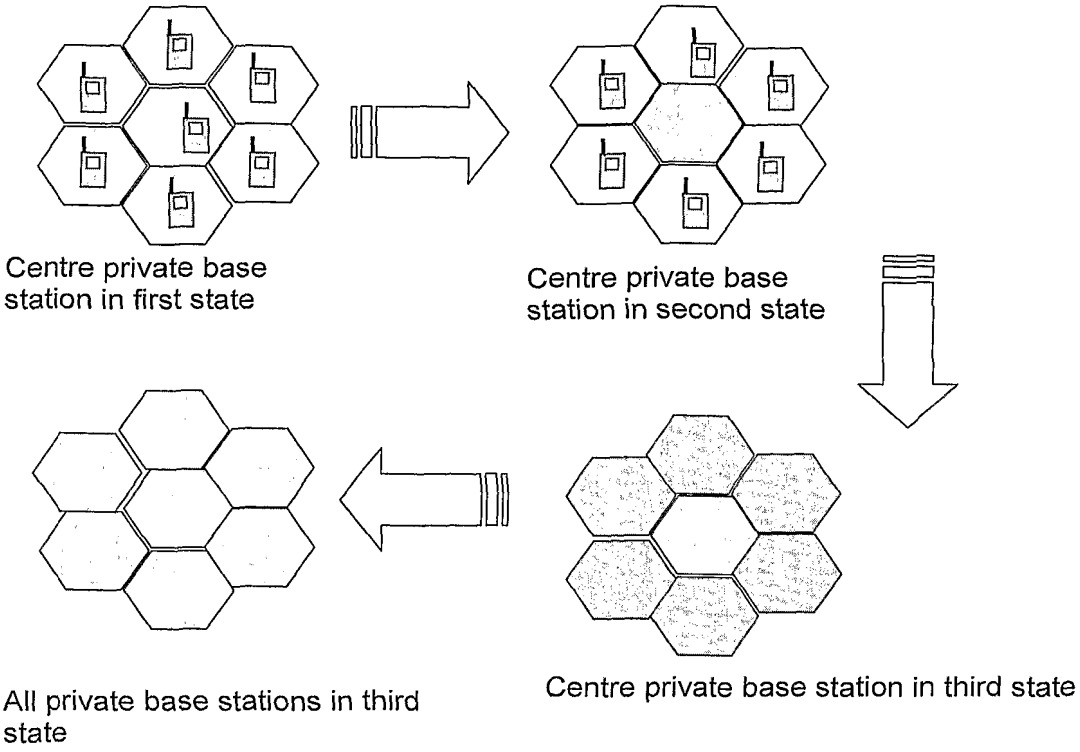
Centre private base station in first state
Centre private base station in second state
Centre private base station in third state
All private base stations in third state

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2007/001427

A. CLASSIFICATION OF SUBJECT MATTER

H04Q7/30 (2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04Q H04B H04M H04L

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)

WPI, EPODOC, PAJ, CNPAT private w network, private w base w station, mode? change handover, hand w off, private, wireless cellular mobile radio interference proximity adjacent neighboring individual dedicate communication access+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN1622677A (KONINK PHILIPS ELECTRONICS NV) 01 Jun. 2005 (01.06.2005), the whole document	1-55
A	CN1930793A (SAMSUNG ELECTRONICS CO LTD) 14 Mar. 2007 (14.03.2007), the whole document	1-55
A	WO0141478A1 (TELEFONAKTIEBOLAGET ERICSSON L M) 07 Jun. 2001 (07.06.2001), the whole document	1-55

☐ 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	Date of mailing of the international search report
14 Jan. 2008 (14.01 2008)	**14 Feb. 2008 (14.02.2008)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer WANG, Guomei Telephone No. (86-10)62411354

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2007/001427

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN1622677A	01.06.2005	WO2005053346A1	09.06.2005
		EP1692908A1	23.08.2006
		CN1887021A	27.12.2006
		JP2007512752TT	17.05.2007
		US2007115884A1	24.05.2007
		CN1887021A	27.12.2006
CN1930793A	14.03.2007	EP1571785A2	07.09.2005
		US2005197125A1	08.09.2005
		WO2005086379A1	15.09.2005
		US7039430B2	02.05.2006
		US2006189318A1	24.08.2006
		US2006194581A1	31.08.2006
		KR20060043401A	15.05.2006
		AU2005219898A1	15.09.2005
		INKOLNP200602481EE	25.05.2007
		BRPI0508406 A	17.07.2007
		JP2007525128T T	30.08.2007
		CA2556297A1	15.09.2005
WO0141478A1	07.06.2001	AU2033801A	12.06.2001

Form PCT/ISA/210 (patent family annex) (April 2007)

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:
Wuyts, Koenraad
KONINKLIJKE KPN N.V.
P.O. Box 95321
NL-2509 CH The Hague
PAYS-BAS

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 403543WO	Date of mailing *(day/month/year)* 8 June 2011 (08-06-2011)
International application No. PCT/EP2011/057093	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
Applicant KONINKLIJKE KPN N.V.	International filing date *(day/month/year)* 4 May 2011 (04-05-2011)

1. [X] The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the International Search Report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Fascimile No.: (41-22) 338.82.70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 - 9.011.

2. [ ] The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. [ ] **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   [ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   [ ] no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. Following the expiration of 30 months from the priority date, these comments will also be made available to the public.

Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

Name and mailing address of the International Searching Authority	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040 Fax: (+31-70) 340-3016	SCHUR, Marlene Tel: +49 (0)89 2399-2996

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
403543WO		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/EP2011/057093	04/05/2011	06/05/2010
Applicant		
KONINKLIJKE KPN N.V.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of:

   [X] the international application in the language in which it was filed

   [ ] a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

   b. [ ] This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

   c. [ ] With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. [ ] **Certain claims were found unsearchable** (See Box No. II)

3. [ ] **Unity of invention is lacking** (see Box No III)

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the **drawings,**

   a. the figure of the **drawings** to be published with the abstract is Figure No. 3

   [X] as suggested by the applicant

   [ ] as selected by this Authority, because the applicant failed to suggest a figure

   [ ] as selected by this Authority, because this figure better characterizes the invention

   b. [ ] none of the figures is to be published with the abstract

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/057093

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W24/02
ADD. H04W52/02 H04W48/20

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 practical, 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	WO 2008/131588 A1 (HUAWEI TECH CO LTD [CN]; QVARFORDT CHRISTER [SE]; OLOFSSON HENRIK [SE]) 6 November 2008 (2008-11-06) page 4 - page 12	1-3, 11-13,15
X	WO 2010/002991 A1 (QUALCOMM INC [US]; SUBRAHMANYA PARVATHANATHAN [US]) 7 January 2010 (2010-01-07) figure 7 paragraphs [0006], [0060] - paragraph [0070]	1,11-13, 15

-/--

[X] Further documents are listed in the continuation of Box C.

[X] 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 document 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	Date of mailing of the international search report
27 May 2011	08/06/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Tozlovanu, Ana-Delia

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/057093

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MITSUBISHI ELECTRIC: "Dynamic Setup of HNBs for Energy Savings and Interference Reduction", 3GPP DRAFT; R3-081949 (DYNAMIC SETUP HNBS), 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG3, no. Jeju Island; 20080813, 13 August 2008 (2008-08-13), XP050165010, section 1, 2.1 scenario 5, 2.2.B	1,4,5, 7-13,15
X	WO 2009/140988 A1 (NOKIA SIEMENS NETWORKS OY [FI]; DOETTLING MARTIN [DE]; FAERBER MICHAEL) 26 November 2009 (2009-11-26) page 7, line 30 - page 10, line 15	1,6, 11-15

1

ERICSSON EXHIBIT 1002, Page 289

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2011/057093

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2008131588 A1	06-11-2008	CN 101395935 A	25-03-2009
		EP 2149272 A1	03-02-2010
		US 2010061356 A1	11-03-2010
WO 2010002991 A1	07-01-2010	AU 2009266922 A1	07-01-2010
		CA 2728310 A1	07-01-2010
		CN 102077659 A	25-05-2011
		EP 2301282 A1	30-03-2011
		KR 20110039329 A	15-04-2011
		US 2010002614 A1	07-01-2010
WO 2009140988 A1	26-11-2009	EP 2316238 A1	04-05-2011
		US 2011076964 A1	31-03-2011

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY
(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/EP2011/057093	04.05.2011	06.05.2010

International Patent Classification (IPC) or both national classification and IPC
INV. H04W24/02 ADD. H04W52/02 H04W48/20

Applicant
KONINKLIJKE KPN N.V.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:

European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0
Fax: +49 89 2399 - 4465

Date of completion of this opinion
see form PCT/ISA/210

Authorized Officer
Tozlovanu, Ana-Delia
Telephone No. +49 89 2399-4864

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. (means)

   ☐ on paper

   ☐ in electronic form

   b. (time)

   ☐ in the international application as filed

   ☐ together with the international application in electronic form

   ☐ subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	2-5, 7-10
	No:	Claims	1, 6, 11-15
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-15
Industrial applicability (IA)	Yes:	Claims	1-15
	No:	Claims	

2. Citations and explanations

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Reference is made to the following documents; the numbering will be adhered to in the rest of the procedure.

D1 **WO 2008/131588** A1 (HUAWEI TECH CO LTD [CN]; QVARFORDT CHRISTER [SE]; OLOFSSON HENRIK [SE]) 6 November 2008

D2 **WO 2010/002991** A1 (QUALCOMM INC [US]; SUBRAHMANYA PARVATHANATHAN [US]) 7 January 2010

D3 MITSUBISHI ELECTRIC: "Dynamic Setup of HNBs for Energy Savings and Interference Reduction"3GPP DRAFT; R3-081949, 13 August 2008, **XP050165010**

D4 **WO 2009/140988** A1 (NOKIA SIEMENS NETWORKS OY [FI]; DOETTLING MARTIN [DE]; FAERBER MICHAEL) 26 November 2009

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

The present application does not meet the criteria of Article 33 PCT, because the subject-matter of independent claims **1** and **11-15** is **not new** in the sense of Article 33(2) PCT.

1 Document **D1** discloses all the features of claim 1 (the references in parentheses applying to this document):

A method for activating at least one inactive cell in a wireless telecommunications infrastructure (*D1, "active mode and interference reduction mode. The private base station uses a proximity indication as input to switch between the different modes", page 5, lines 25-27*), the telecommunications infrastructure comprising an active cell containing a plurality of terminals, the method comprising the steps of:

- transmitting a presence signal in the at least one inactive cell (*D1, "periodic interval between BCH transmission ... DTX ... coverage of the private base station cell could be normal", page 6, lines 12-15; "different lower maximum transmission power on the BCH than in the ... active mode", page 7, lines 11-12*);

- receiving reports from the plurality of terminals detecting the presence signal (*D1, "when the UE detects the cell it informs ... via the currently used cell", page 8, lines 2-4; "the UE indicates directly to the private base station that it is present", page 9, lines 12-13*);

- processing information contained in the reports received from the plurality of terminals in a processing system of the telecommunications infrastructure to provide a processing result (*D1, "the private base station may store a history of which kind of UEs that are most frequently using the private base station, and select the most optimal transmission mode", page 7, lines 24-26*); and

- activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell (*D1, "by simply having a UE placed very near the private base station ... to bring it into operation", page 7, lines 15-16; "UE sends a wake up message directly to the private base station", page 10, lines 25-26).*

D1 thus discloses all features of independent claim 1. Subject-matter of claim 1 lacks novelty in the sense of the Article 33(2) PCT.

2 It is further noted that also the above-cited documents **D2-D4** aim at the same object and disclose all features of independent claim 1. Claim 1 does therefore also not appear to be new in the sense of the Article 33(2) PCT vis-à-vis the disclosure of **D2-D4**. Reference is made to the following passages:

***D2**: Abstract; Figure 7;paragraphs [0060], [0063, [0067], [0070];*

***D3**: Introduction; Discussion, Scenario 5;*

***D4**: Figure 3; page 7, line 30-page 10, line 8.*

3 The same considerations as made in paragraphs 1 and 2 above regarding claim 1 also apply to independent claims 11-15 since these claims include the same feature combinations as claim 1 in terms of claims relating to a computer program, infrastructure, signal and terminal respectively.

The additional feature introduced in claim **14**, i.e. "*reporting identifier indicating that the cell is an inactive cell*", is disclosed in **D4**, "*a capability information indicating that the transmitting unit is capable of being disabled may be broadcasted*", *page 7, lines 36-37.*

As a consequence, the subject-matter of claims **11-15** is **not new**, Article 33 (2) PCT, in view of **D1-D4**.

4 Dependent claims **2-10** appear to add nothing of inventive significance in the sense of Article 33(3) PCT to those independent claims to which they are appended, as the additional features introduced by said dependent claims

refer only to minor implementing details which are disclosed or obviously derivable from the cited documents **D1-D4**, or fall within the general knowledge of a person skilled in the art.

Particularly, the subject-matter of:

- claim **2** relating to sending the presence signal at a later time if the activation condition is not satisfied is disclosed in **D1**, *"periodic interval ... DTX", page 8, line 12;*

- claim **3** relating to providing the reporting terminals of the active cell with measurement parameters so that they can receive the presence signal sent by the inactive cell is disclosed in **D1**, *"if the private base station DTX timing is known to a UE, it could detect the private base station cell by trying to receive private base station BCH only when this is sent", page 6, lines 24-26;*

- claims **4** and **5** relating to a plurality of inactive cells wherein the activation condition is energy reduction is common knowledge of the skilled person, see also **D3**;

- claim **6** relating to the reporting identifier is disclosed in **D4**, *page 7, lines 36-37*;

- claims **7-10** relating to idle mode terminals is disclosed in **D3**, *Scenario 1 and section 2.2.D.*

Due to the above reasons, said claims 2-10 do not meet the requirements of Article 33(1) and (3) PCT.

5 The subject-matter of claims **1-15 is industrially applicable**, see Article 33(4) PCT.

Re Item VII

Certain defects in the international application (form and content)

In case of submitting amendments -e.g. in the PCT Chapter II or in the regional phase- the following remarks should be noted:

1 Independent claims should have been drafted in a proper **two-part form** in accordance with Rule 6.3(b) PCT, having a preamble that correctly reflects the nearest prior art represented by document **D1**.

2 To increase the intelligibility, all the claims should have included **reference signs** in parentheses where features shown in the drawings are referred to, Rule 6.2b PCT. This applies both to the preamble and characterising portion, PCT Guidelines 5.11.

3 Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents **D1-D4** is not mentioned in the description. Documents **D1-D4** should have been acknowledged by reference and briefly discussed in the introductory part of the description, preferably in such a way that the inventive merit of what is claimed can be readily understood.

4 The relevant part of the description should have been brought into agreement with the wording thereof (Rule 5.1(a)(iii) PCT).

Re Item VIII

Certain observations on the international application

1 Claims **1, 12** and **14** are **unclear**, Article 6 PCT, because the expression "*inactive cell*" is vague and unclear and leaves the reader in doubt of the technical features it refers to. It is clear from the description on page 7, lines 1-3 that the "*an inactive cell is considered a cell that is not intended to carry any voice or data traffic but may transmit a presence signal*".

Moreover, said claims are construed broader that the subject-matter as originally filed because there is no detail on the sender of the presence signal. With the current wording of said claims it could also be understood that the presence signal is sent by the active base station who's coverage includes the one of the inactive cell. This scenario is however not disclosed in the description and therefore said independent claims should be amended in order to overcome this clarity objection.

2 The application does not meet the requirements of Article 6 PCT, because independent claims **1** and **12** are missing **essential features**.

It is clear from the description page 7, last three lines that the following features are essential:

"*the plurality of inactive cells may have an aggregated estimated coverage area that at least partially overlaps the coverage area of the active cell*".

Since said independent claims do not contain this feature they do not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.

3 Although claims **12** and **13** have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only in regard to the definition of the subject-matter to which the protection is sought and in respect of the terminology used for the

features of that subject-matter. In the present case, the use of **only one independent** claim relating to a system appears appropriate. Therefore, the aforementioned claims **lack conciseness** and as such do not meet the requirements of Article 6 PCT.

4 Independent claim **14** is **unclear**, Article 6 PCT, as it is not clear to which category said claim belongs to, see also PCT Guidelines II-5.12.

5 Independent claims **1** and **12** are **unclear**, Article 6 PCT, because the term "*activated cell*" is vague and and leaves the reader in doubt of its meaning.

While filing amended claims, the applicant is requested to take into consideration comments comprised in all sections of this communication. The applicant is requested to clearly identify the amendments carried out, no matter whether whether they concern amendments by addition, replacement or deletion, and to indicate the passages of the application as filed on which these amendments are based (Rule 66.8(a)PCT). This is necessary to ensure that no subject-matter has been added that extends beyond the content of the application as originally filed, Article 34(2)(b) PCT, rendering all amendments made valid.

The applicant's attention is drawn to the fact that, as a consequence of Rule 66.8(a) PCT, the examiner is not permitted to carry out any amendments under the PCT procedure, however minor these may be.

Possible steps after receipt of the international search report (ISR) and written opinion of the International Searching Authority (WO-ISA)

General information	For all international applications filed on or after 01/01/2004 the competent ISA will establish an ISR. It is accompanied by the WO-ISA. Unlike the former written opinion of the IPEA (Rule 66.2 PCT), the WO-ISA is not meant to be responded to, but to be taken into consideration for further procedural steps. This document explains about the possibilities.
Amending claims under Art. 19 PCT	Within 2 months after the date of mailing of the ISR and the WO-ISA the applicant may file amended claims under Art. 19 PCT directly with the International Bureau of WIPO. The PCT reform of 2004 did not change this procedure. For further information please see Rule 46 PCT as well as form PCT/ISA/220 and the corresponding Notes to form PCT/ISA/220.
Filing a demand for international preliminary examination	In principle, the WO-ISA will be considered as the written opinion of the IPEA. This should, in many cases, make it unnecessary to file a demand for international preliminary examination. If the applicant nevertheless wishes to file a demand this must be done before expiry of 3 months after the date of mailing of the ISR/WO-ISA or 22 months after priority date, whichever expires later (Rule 54bis PCT). Amendments under Art. 34 PCT can be filed with the IPEA as before, normally at the same time as filing the demand (Rule 66.1 (b) PCT). If a demand for international preliminary examination is filed and no comments/amendments have been received the WO-ISA will be transformed by the IPEA into an IPRP (International Preliminary Report on Patentability) which would merely reflect the content of the WO-ISA. The demand can still be withdrawn (Art. 37 PCT).
Filing informal comments	After receipt of the ISR/WO-ISA the applicant may file informal comments on the WO-ISA directly with the International Bureau of WIPO. These will be communicated to the designated Offices together with the IPRP (International Preliminary Report on Patentability) at 30 months from the priority date. Please also refer to the next box.
End of the international phase	At the end of the international phase the International Bureau of WIPO will transform the WO-ISA or, if a demand was filed, the written opinion of the IPEA into the IPRP, which will then be transmitted together with possible informal comments to the designated Offices. The IPRP replaces the former IPER (international preliminary examination report).
Relevant PCT Rules and more information	Rule 43 PCT, Rule 43bis PCT, Rule 44 PCT, Rule 44bis PCT, PCT Newsletter 12/2003, OJ 11/2003, OJ 12/2003

BNSDOCID: <XS 20070401OCK 1 >

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2012-11-05
First Named Inventor	Ljupco JORGUSESKI
Art Unit	TBA
Examiner Name	TBA
Attorney Docket Number	12-1172-WO-US

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	WO2010/002991	WO	A1	2010-01-07	Qualcomm Incorporated		☐
	2	WO2009/140988	WO	A1	2009-11-26	Nokia Siemens Networks OY		☐
	3	WO2008131588	WO	A1	2008-11-06	Huawei Technologies Co., Ltd.		☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2012-11-05
	First Named Inventor	Ljupco JORGUSESKI
	Art Unit	TBA
	Examiner Name	TBA
	Attorney Docket Number	12-1172-WO-US

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	PCT International Search Report and Written Opinion, PCT International Application No. PCT/EP2011/057093 dated June 8, 2011.	☐
	2	"Self Organizing Network - NEC's Proposals for Next-Generation Radio Network Management", White Paper, February 2009, NEC Corporation, pp. 1-5.	☐
	3	"3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Universal Terrestrial Radio Access (UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Measurement Collection for Minimization of Drive Tests (MDT); Overall Description; Stage 2 (Release 10)", 3GPP TS 37.320, V10.0.0, December 2010, pp. 1-17.	☐
	4	"3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Self-Configuring and Self-Optimizing Network (SON) Use Cases and Solutions (Release 9)", 3GPP TR 36.902 V9.1.0 (March 2010), pp. 1-23.	☐
	5	European Search Report, European Patent Application No. 10162192.8, dated December 15, 2010.	☐
	6	Mitsubishi Electric, "Dynamic Setup of HNBs for Energy Savings and Interference Reduction", 3GPP TSG RAN WG3 Meeting #61, Jeju Island, Korea, 18th-22nd August 2008, 7 pages.	☐
	7	Ericsson, "Sustainable Energy for Mobile Communications", White Paper, June 2007, pp. 1-23.	☐

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2012-11-05
	First Named Inventor	Ljupco JORGUSESKI
	Art Unit	TBA
	Examiner Name	TBA
	Attorney Docket Number	12-1172-WO-US

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2012-11-05
	First Named Inventor	Ljupco JORGUSESKI
	Art Unit	TBA
	Examiner Name	TBA
	Attorney Docket Number	12-1172-WO-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Christian B. Hines/	Date (YYYY-MM-DD)	2012-11-05
Name/Print	Christian B. Hines	Registration Number	65892

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PCT REQUEST

Print Out (Original in Electronic Form)

VIII-4-1	**Declaration: Inventorship (only for the purposes of the designation of the United States of America)** Declaration of Inventorship (Rules 4.17(iv) and 51bis.1(a)(iv)) for the purposes of the designation of the United States of America:	I hereby declare that I believe I am the original, first and sole (if only one inventor is listed below) or joint (if more than one inventor is listed below) inventor of the subject matter which is claimed and for which a patent is sought. This declaration is directed to the international application of which it forms a part (if filing declaration with application). This declaration is directed to international application No. PCT/ . . . . . (if furnishing declaration pursuant to Rule 26ter). I hereby declare that my residence, mailing address, and citizenship are as stated next to my name. I hereby state that I have reviewed and understand the contents of the above-identified international application, including the claims of said application. I have identified in the request of said application, in compliance with PCT Rule 4.10, any claim to foreign priority, and I have identified below, under the heading "Prior Applications", by application number, country or Member of the World Trade Organization, day, month, and year of filing, any application for a patent or inventor's certificate filed in a country other than the United States of America, including any PCT international application designating at least one country other than the United States of America, having a filing date before that of the application on which foreign priority is claimed.
VIII-4-1-1	Prior applications:	

		I hereby acknowledge the duty to disclose information that is known by me to be material to patentability as defined by 37 C.F.R. § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the PCT international filing date of the continuation-in-part application. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.
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VIII-4-1-3-6	Date	04 May 2011 (04.05.2011)

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Patentanmeldung Nr.	**Patent application No.**	**Demande de brevet n°**

10162192.8 / EP10162192

The organization code and number of your priority application, to be used for filing abroad under the Paris Convention, is EP10162192.

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le President de l'Office européen des brevets
p.o.

R.C. van Dijk

ERICSSON EXHIBIT 1002, Page 309

Anmeldung Nr:
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Bezeichnung der Erfindung / Title of the invention / Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se référer à la description.)

Method and telecommunications infrastructure for activating an inactive cell

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Method and telecommunications infrastructure for activating an inactive cell

FIELD OF THE INVENTION

The invention relates to the field of telecommunications infrastructures. More specifically, the invention relates to the field of activating inactive cells of a telecommunications infrastructure for purposes such as controlling energy consumption and electromagnetic radiation, particularly reducing energy consumption or electromagnetic radiation.

BACKGROUND OF THE INVENTION

The operation of wireless access networks for enabling wireless communication is highly energy consuming. In view of current environmental concerns, increased attention is paid recently to the energy consumption of telecommunications networks.

Various studies have been performed to reduce conventional energy consumption in wireless access networks, e.g. by exploring the option of using sustainable energy sources (Ericsson AB White Paper "Sustainable energy use in mobile communications, June 2007).

With the development of the 3GGP Long Term Evolution (LTE) network, energy saving for the network is also approached in the context of self organizing networks (SON). In a White Paper of NEC, dated February 2009, "NEC's proposals for next-generation radio network management", energy is considered as a significant part of the operation expenses of a cellular network. It is recognized that the main saving potential resides in using variations in load over time, that allows to switch off parts of the resources, for example during the night. When a complete base station is switched off, other base stations of the access network need to make up for the reduction in coverage area and capacity. This requires coordination between the nodes. A similar use case is described in 3GGP TR 36.902 v9.1.0 "Self-

configuring and self-optimizing network(SON) use cases and solutions".

Once base stations (or one or more cells thereof) have been deactivated, at some point in time these base stations (or cells) may have to be reactivated again. Thus, a decision is required when and/or which base stations or cells need to be activated.

A first solution would be to activate the base stations or cells at a predetermined time. As an example, it can be imagined that fewer base stations need to be active during night time and more base stations need to be active during the day.

Another solution would be to activate all inactive cells adjacent to (i.e. relevant for) a currently active cell when the currently active cell detects a certain traffic load exceeding a threshold or detects a rising traffic load.

There is a need in the art to improve these solutions by determining more accurately which base stations and/or cells should be activated.

SUMMARY OF THE INVENTION

A method for activating at least one inactive cell in a wireless telecommunications infrastructure is disclosed. The telecommunications infrastructure comprises an active cell containing a plurality of terminals. A presence signal is transmitted in the at least one inactive cell. The plurality of terminals in the active cell (which are not necessarily all terminals in the active cell) detect the presence signal(s) of the one or more inactive cells to gather information about the inactive cell. The information is reported to and received at the telecommunications infrastructure. The information received from the plurality of terminals is processed in a processing system of the telecommunications infrastructure to provide a processing result. It should be appreciated that the information contained in some reports from some terminals need not necessarily be processed. The inactive cell is activated when the processing result fulfils at least one activation condition such that at

least one of the plurality of terminals is within a coverage area of the activated cell.

A computer program containing software code portions (possibly distributed over several components in the telecommunications infrastructure) for performing the method when executed by a processing system is also disclosed.

A wireless access telecommunications infrastructure comprising an active cell and at least one inactive cell is also disclosed. The active cell can contain a plurality of terminals is also disclosed. The infrastructure comprises a presence signal generator configured for generating a presence signal to be transmitted in the at least one inactive cell. The infrastructure further comprises a receiver configured for receiving reports from the plurality of terminals detecting the presence signal and a processor system configured for processing information contained in the reports received from the plurality of terminals to provide a processing result. The processing system may be part of the telecommunications infrastructure or be (partly) connected to the telecommunications infrastructure in which case the processing system is considered part of the telecommunications infrastructure. The infrastructure further comprises an activator configured for activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell. By using the (partly) existing capabilities of terminals to measure and report information received from neighbouring cells (typically applied for e.g. handover operations), the transmission of the presence signal in the currently inactive cell enables the telecommunications infrastructure to assess whether the terminals recognize this cell as an appropriate target, i.e. whether the terminals currently connected to or camping on the active cell are likely able to be connected to or camp on a currently inactive cell. The telecommunications infrastructure is configured to receive and process the information relating to the inactive cell(s) from the reports of various terminals within the active cell (possibly, but not necessarily, all terminals in the active

cell). The reported information forms the basis to decide whether or not to actually activate the currently inactive cell (i.e. to change the network configuration of the telecommunications infrastructure) in order for the terminal to connect to or camp on the activated cell via a handover operation or cell re-selection, respectively.

The information can be used by an energy evaluation algorithm for determining whether energy consumption of the telecommunications infrastructure can be reduced or used in an efficient manner, e.g. by efficiently controlling activation of cells in the telecommunications infrastructure if required.

The method and telecommunications infrastructure may, in addition or alternatively, also be applied for other purposes. As an example, similar considerations apply to the reduction of electromagnetic radiation produced by a base station. For example, for health reasons it is advisable to limit the amount and duration of electromagnetic radiation to a level that is strictly necessary for the operation of the base station. When the level of electromagnetic radiation can be reduced or when a base station can be switched off, this may be well-appreciated by the population in the vicinity of the base station. Considerations may either apply to the complete telecommunications infrastructure or to a part of the infrastructure, e.g. for a plurality of cells. For example, heavily populated areas may be selected to have low electromagnetic radiation density, whereas in less densely populated areas, the electromagnetic radiation levels can be higher. In addition to health concerns, there may also be technical reasons to restrict the electromagnetic radiation, and therewith the possibility and level of interference experienced in adjacent areas.

It should be appreciated that the active cell and inactive cell may relate to any type of radio access technology (RAT) including, but not limited to GSM, UMTS, LTE, Wimax etc.

It should further be appreciated that the measurements for information on the inactive cell(s) of terminals in the active cell may relate to a single radio access technology (intra-RAT) or multiple different radio access technologies (inter-

RAT). An example of inter-RAT includes a terminal in an active UMTS cell performing measurements on an inactive GSM cell.

The method and telecommunications infrastructure also allow taking account of the distribution of terminals in the active cell. For example, if the analysis reveals that a considerable number of terminals served by the active cell finds themselves near the edge of the active cell (i.e. the reported measurement information indicates a high signal level or signal quality for the presence signal of neighbouring inactive cells and much lower levels for the active cell for a considerable number of terminals), the total energy for the telecommunications infrastructure may be reduced by activating one or more inactive cells and hand over these terminals to these cells.

In the present application, an active cell is considered a cell enabling connection of a terminal to the base station responsible for the cell. In other words, the cell is fully operational.

An inactive cell is considered a cell that is not intended to carry any voice or data traffic but may transmit a presence signal during particular time intervals or continuously. A presence signal may comprise a beacon signal, such as BCCH in GSM network, CPICH in UMTS network or reference symbols in LTE in order to indicate the presence of the cell. In addition, the inactive cell may at least transmit some system information (e.g. cell identity, power level of its beacon signal, etc.), depending on its level of functionality. The inactive cell can become an active cell by applying the method disclosed herein. The inactive cell may be an inactive cell because it does not accept handover for active terminals to the inactive cell or because it redirects connections to an active cell once a connection is requested from a terminal in the inactive cell.

The main purpose of the inactive cells to transmit the presence signal is to allow the terminals in the active cell to perform measurements on these inactive cells and to report such measurements to the network. Terminals in the active cell can be distinguished between terminals in the active mode (active ter-

minals) and terminals in the idle mode (idle terminals). A terminal with an active connection (e.g. a voice call or data being exchanged) is said to be in 'active mode' or 'connected mode'. When the terminal is in active mode (active terminal), the network has detailed knowledge about the terminal and knows by which cell it is served. A terminal which is powered on but without an active connection is said to be in 'idle mode'. When the terminal is in idle mode (idle terminal), the network has limited knowledge about the mobile station and only knows in which paging or location area the terminal may be paged. In idle mode the terminal listens to e.g. a broadcast channel or a paging channel of a particular cell. It is said that the terminal 'camps on' that cell.

The method for assessing whether activation of the inactive cell is possible or required can be performed during subsequent time intervals (e.g. periodic time intervals), as defined in claim 2 in order to not bother the terminals (battery saving) and the network (reduction of network load) continuously. However, (semi-) continuous performance of the method when one or more cells are currently inactive may be an attractive alternative for rapid assessment of opportunities to change the configuration of the telecommunications infrastructure.

In an embodiment of the invention, defined in claim 3, the terminals may be provided with measurement and/or reporting parameters in order to control measurement and reporting operations by the terminals in the active cell. The parameters may e.g. be provided over a connection via the active cell to a terminal that is in the active mode or broadcasted in the active cells to terminals in the active or idle mode. The measurement parameters trigger terminals to perform measurements. The reporting parameters instruct terminals (when) to report measurements to the network.

In existing wireless access telecommunications networks, terminals usually already perform measurements in certain conditions and may report measurement results in certain other conditions. For example, active terminals in handover regions between adjacent cells usually already report measurement infor-

mation from the adjacent cells to the network in order for the network to perform a handover decision for each individual terminal. The measurement parameters provided to the terminals as defined in claim 3 not only allow to obtain measurement information from active terminals in the handover region but also allow to obtain information about neighbour inactive cells from active terminals outside the handover region and from idle terminals within the active cell. These terminals may report that information to the telecommunications infrastructure.

As a first example, a reporting threshold usually applied in the terminal to prevent reporting measurements about neighbour signals with a signal level which is insufficient compared to the signal from the serving cell to be relevant for a possible handover may be adjusted temporarily to allow also reporting signal levels which would otherwise be considered insufficient. As a second example, a signal level threshold usually applied in the idle terminals to prevent performing measurements on neighbour cells when the signal level from the serving cell is more than adequate, may be adjusted (e.g. increased) temporarily to allow measurements on neighbour cells. Providing the measurement and/or reporting parameters to the terminals in the active cell enables more terminals and enables terminals at more locations in the active cell (e.g. not only in what would normally be considered the handover region between two cells) to perform measurements and/or to provide reports to the network.

The telecommunications infrastructure may comprise several inactive cells that may concurrently or sequentially transmit the presence signal, enabling the terminals to measure signals from a plurality of cells concurrently or sequentially to allow the network to obtain a more complete picture of the possibilities for a network configuration change (claim 4). The inactive cells may be located in the active cells (e.g. micro cells), may be adjacent to the active cell or may be located further away from the active cell. The plurality of inactive cells may have an aggregated estimated coverage area that at least partially overlaps the coverage area of the active cell.

Concurrent transmission of a presence signal by several inactive cells may be time efficient and may provide a slightly different picture of the network situation. For example, in a situation with overlapping inactive cells, a sequential transmission of the presence signal could indicate that a particular user device would select more than one inactive cell if only a single of these inactive cells would be activated, whereas concurrent transmission of the presence signal would indicate which of these inactive cells the same user device would select if all these inactive cells would be activated. Sequential transmission of a presence signal may be work load efficient as it allows to refrain from completing the entire envisaged sequence, for example if the thus far collected information appears to be satisfactory. Sequential transmission of a presence signal may involve the sequential transmission in groups of inactive cells to assess the best combination. The sequential variant may use history information to first transmit a presence signal in inactive cells that previously turned out successful candidates for activation.

In the embodiment of claim 6, a reporting identifier is transmitted in the inactive cell. The present application also discloses a signal transmitted in a cell of the infrastructure, wherein the signal comprises the reporting identifier.

Active terminals in the active cell may receive the reporting identifier and transmit the reporting identifier with the report in order to enable the telecommunications infrastructure to distinguish between reports from terminals related to normal handover (to an active cell) and reports from terminals reporting information about the inactive cells for assessing whether the inactive cell should be activated.

Idle terminals detecting the reporting identifier from the inactive cell may be configured to use this identifier to prevent cell reselection by the idle terminal to the inactive cell, to report the information about the inactive cell to the telecommunications infrastructure via the active cell before reselection to the inactive cell, or to report information about

the inactive cell to the inactive cell when the inactive cell is configured to receive such reports.

The embodiment defined in claim 7 is advantageous for the reason that the number of idle terminals is normally much greater than the number of active terminals. Having a plurality of idle terminals reporting information on the presence signal(s) from the inactive cell(s) may greatly contribute to the complete picture of opportunities for reconfiguration of the telecommunications infrastructure and also may indicate possible traffic load in the near future. For the idle terminals to transmit reports to the telecommunications infrastructure, these terminals should temporarily become active.

Apart from the mechanism for idle terminals as described above in relation to claim 6, the embodiments of claims 8-10 provide several other mechanisms for participation of idle terminals in the method according to the invention. These embodiments are described in further detail in the detailed description.

Briefly, the embodiment of claim 8 comprises temporarily decreasing a location area update period (or a similar period) in at least one of the active cell and the inactive cell. The embodiment is advantageous as it may require no or only few modifications to currently existing networks.

The embodiment of claim 9 comprises the idle terminals to report measurement information to the telecommunications infrastructure via the active cell, whereas these terminals would otherwise reselect to the inactive cell and attempt reporting to the inactive cell. This embodiment allows the inactive cells to maintain a status wherein these cells are not able or are configured not to be able to receive reports.

The embodiment of claim 10 comprises transmitting a paging message in the active cell instructing the idle terminals to obtain and/or report the information. The idle terminals listen to broadcast and paging channels and can be triggered to detect information from inactive cells using these channels. Using such paging message, less need exists to temporarily reconfigure the system information of the active cell different

from the normal operation. This is particularly true if the paging messages carry configuration parameters for the idle terminals, such as the measurement and/or reporting parameters defined in claim 3.

The embodiments of claims 6 and 10 require modifications to the processing capabilities of currently existing wireless terminals. The present application discloses a wireless terminal for use in these embodiments.

Hereinafter, embodiments of the invention will be described in further detail. It should be appreciated, however, that these embodiments may not be construed as limiting the scope of protection for the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIGS. 1A and 1B are schematic illustrations of base stations in a wireless access telecommunications infrastructure providing active cells and inactive cells;

FIG. 2 is a schematic illustration of a telecommunications infrastructure comprising a base station defining an active cell containing a plurality of terminals and a base station providing an inactive cell transmitting a presence signal;

FIG. 3 is a flow chart illustrating various steps of a method according to an embodiment of the invention;

FIG. 4 is a flow chart illustrating the information processing step in further detail;

FIGS. 5-8 are flow chart illustrating steps of a method for participation of idle terminals and

FIG. 9 is a schematic illustration of a wireless terminal configured for being operable in the telecommunication infrastructure of FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1A is a schematic illustration of base stations BS A – BS G in a wireless access telecommunications infrastructure providing a plurality of active cells. Each base station location comprises three sectors, thus covering an area around the

base station location. For example, cell A1 of base station location BS A serves its best server area marked ‘a1’. Similarly, cell A2 and A3 of the same location serve their best server area marked ‘a2’ and ‘a3’ respectively. A same set-up is shown for the other base station locations BS B to BS G. In FIG. 1A, the regular pattern of base stations and sectors leads to the commonly known hexagonal pattern of coverage areas.

FIG. 1B shows the same areas in a light grey colour. For example for energy saving reasons, some cells at base station locations B and C have been switched off and cell A1, together with some other cells (not shown) now provides service to some of BS B and BS C’s best server areas. In FIG. 1B, a darker gray shading illustrates that cell A1 provides service not only in its ‘own’ or ‘native’ area a1, but also in areas b2 and c3 and in part of the areas b3 and c2. Other cells may similarly have been switched off and service in their (‘native’) areas may be provided by one or more of the surrounding cells.

FIG. 2 is a schematic illustration of a wireless access telecommunications infrastructure 1 comprising a base station BS A defining an active cell A1 containing a plurality of active terminals Ta and idle terminals Ti. Base station BS B provides an inactive cell B1 wherein it transmits a presence signal P.

Telecommunications infrastructure 1 comprises a presence signal generator 2 for generating the presence signal P via interface 3. The telecommunications infrastructure 1 further comprises a receiver 4 configured for receiving reports from the plurality of terminals Ta, Ti detecting the presence signal P. A processor system 5 is configured for processing information contained in the reports received from the plurality of terminals Ta, Ti to provide a processing result. The processor system 5 has an activation module 6 configured for activating the inactive cell of BS B when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals Ta, Ti is within a coverage area of the activated cell B1 of base station BS B.

Various events may trigger the telecommunications system 1 to operate the method as illustrated in the flow chart of

FIG. 3. The method may be performed periodically or continuously, wherein generator 2 periodically or continuously generates the presence signal P in inactive cell B1. In at least some situations, it is advantageous to transmit the presence signal P concurrently by several related cells (rather than transmitting the presence signal P for separate cells, e.g. one-by-one). For example, in FIG. 1B, it may be advantageous to perform the method and evaluation concurrently for cells B3, B2, C3 and C2. A same or similar advantage may apply to cells which otherwise provide mutual coverage or are in close proximity of each other. Alternatively or in addition, the transmission of the presence signal P may be initiated by a predetermined condition in an active cell A1 verified by processing system 5, e.g. a traffic load exceeding a threshold or a traffic load showing a substantial increase.

The method as illustrated in the flow chart of FIG. 3 may be performed as follows. In step 3-I, a presence signal P is generated by generator 2 and transmitted in the at least one inactive cell of base station BS B. The plurality of terminals Ta, Ti in the active cell A1 (which are not necessarily all terminals in the active cell) detect and measure the presence signal P of the inactive cell B1 and gather information about the inactive cell (e.g. signal level/quality of presence signal P and cell identity of inactive cell B1). The information is reported to and received at the telecommunications network via the active cell A1 and receiver 4 (step 3-II). Alternatively, some of the information, in particular from idle terminals Ti, may be also reported via inactive cells, presuming these are configured for at least receiving such reports. The information received from the plurality of terminals Ta, Ti is processed in processing system 5 to provide a processing result (step 3-III). It should be appreciated that the information contained in some reports from some terminals need not be processed by processing system 5 and that processing system 5 may use additional information not received from the terminals (e.g. information typically available from a management system such as the location and configuration of the base stations etc.). The inactive cell B1

is activated in step 3-IV when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals Ta, Ti is within a coverage area of the activated cell B1.

FIG. 4 shows a flow chart exemplifying some steps of processing step 3-III in further detail. The telecommunications infrastructure 1 allows to take account of the distribution of terminals Ta and Ti in the active cell A1. The information obtained from the terminals Ta (such as measured signal level/quality or path loss) can be applied for energy reduction purposes. For example, if the analysis (e.g. based on the reported signal level measurements) reveals that a considerable number of active terminals Ta served by the active cell A1 finds themselves near the edge of the active cell A1 as shown in FIG. 2 and is transferable to inactive cell B1 (step 4-I), a reconfiguration of the network can be analysed (step 4-II) wherein the inactive cell B1 is activated (step 4-II). The activation condition wherein the total energy for the telecommunications infrastructure 1 can be reduced (step 4-III) may be fulfilled since the power reduction estimated to be obtained by transferring these terminals away from active cell A1 may be more than the power estimated to be required for an activated cell B1 and for serving these terminals by cell B1.

The analysis as depicted in FIG. 4 may also be used for increasing the energy consumption of the telecommunications network in an efficient manner. As an example, if the load in active cell A1 increases, at some point in time additional cells need to be activated. Reports from the active terminals Ta may indicate (e.g. from the signal levels / signal quality reported about the presence signal P of cell B1) that cell B1 is a suitable candidate for activation.

As an alternative or in addition, triggered reports from idle terminals Ti may be considered in the decision which cell is most suitably reactivated to alleviate the effects of the local traffic overload. Note that the number of idle terminals in a cell is usually much larger than the number of active terminals. Reports from such idle terminal typically indicate

the best cell as selected by each triggered idle terminal, choosing from both active and inactive cells that transmit a presence signal P. Counting for each inactive cell transmitting presence signal P how many idle terminals Ti (optionally: how many idle terminals that currently camp on the overloaded active cell) would prefer that inactive cell, provides an indication of the near-future traffic load that can be absorbed by the inactive cell when fully reactivated, thus relaxing the currently overloaded active cell from that (potential) 'burden'. Instead or along with the information on the active terminals Ta, the information on the idle terminals Ti can be considered in the decision process regarding which inactive cell to activate.

Several methods of triggering active user terminals Ta and idle terminals Ti to obtain information on the inactive cell(s) and to report this information will now be discussed in further detail.

Generally, the terminals may be provided with measurement and/or reporting parameters in order to control measurement and reporting operations by the terminals in the active cell A1. The parameters may e.g. be provided over a connection via the active cell to an active terminal Ta or broadcasted in the active cell A1 to active and idle terminals Ta, Ti using e.g. system information blocks SIB.

An active terminal Ta receives instructions from the network about which measurements to perform and which events to report to the network (e.g. the event that a neighbour inactive cell B1 is detected with a signal strength/quality that is better by x dB than that of the currently serving active cell A1). When a measurement leads to one of the specified events, the terminal Ta reports the relevant information (e.g. an identification of the detected neighbour inactive cell B1, its measured present signal level/quality and the measured signal level/quality of the active cell A1) over the existing connection to the telecommunications infrastructure 1. Either in response to a report from a terminal Ta or autonomously, the telecommunications infrastructure 1 may instruct the terminal Ta

to perform additional measurements of a same or different kind and to report the results.

Base station BS B may transmit a reporting identifier, hereinafter also referred to as 'probing flag', in the inactive cell B1. Active terminals Ta in the active cell A1 may receive the reporting identifier and transmit the reporting identifier with the report containing information regarding inactive cell B1. The active terminal Ta is thus configured to recognize the reporting identifier and to include this reporting identifier in the report containing the information on the inactive cell B1. This facilitates the processing system 5 of telecommunications infrastructure 1 to more easily distinguish between terminals Ta-ho (see FIG. 2) reporting in the context of a normal handover to another active cell (not shown in FIG. 2) and terminals Ta reporting information from the inactive cell B for assessing whether the inactive cell should be activated. An alternative for enabling the telecommunications infrastructure 1 to distinguish between reports relating to normal handovers and reports to be analyzed towards a decision whether to activate an inactive cell is to inform the base station BS A (or at least the associated entity normally handling the handover-related reports) of the identity of the inactive cells transmitting presence signals, such that reports related to an identity of an inactive cell can be excluded from being processed towards a handover decision and can be forwarded to processing system 5.

In order for idle terminals in active cell A1 to be triggered to obtain information about inactive neighbour cell B1, various parameters may be broadcasted in the active cell A1 in the system information block SIB for cell reselection. One example of such a parameter is an absolute signal level threshold Ts,search. This threshold is used by idle terminals as a reference for the received signal level Srxlev, measured by the terminals, from the active cell A1 and to decide if neighbour measurements for cell reselection are needed. If Srxlev < Ts,search, the terminal will search for neighbour cells and measure the received signal level Nrxlev and/or Nqual. Nrxlev is the received signal level of the presence signal from a

neighbour cell, e.g. from the inactive cell B1. Nqual is the received signal quality from a neighbour cell, e.g. from inactive cell B1 (e.g. E_c/I_0 of the CPICH for UMTS cells or RSRQ of the reference symbols for LTE cells). Hysteresis parameter Qhyst for the active cell A1 and offset parameters Qoffset,n to be applied to each neighbour *n* specifically, can also be broadcasted in the active cell A1.

Next, exemplary methods will be discussed for instructing idle terminals Ti to perform measurements on inactive cells and to report this information to the telecommunications infrastructure 1.

In a first method, illustrated in the flow chart of FIG. 5, a location area update period (or a similar period) is decreased in the active cell A1 and the inactive cell B1. The embodiment is advantageous as it requires no modifications to currently existing networks.

In the active cell A1, in the system information (SIB) to be broadcast on the broadcast channel of the active cell A1, a relatively short value (e.g. 30 s, 1 min) is set for the periodic location area (LA) update (instead of a nominal value, e.g. 30 min, 1 hour, infinite). This is illustrated in step 5-I. A paging message may be issued in the cell A1 indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1.

As a consequence, an idle terminal Ti camping on the active cell A1 reads the modified SIB and starts providing frequent (e.g. every 30 s, 1 min) periodic LA updates. An LA Update message also includes information about the identity of the terminal. The telecommunications infrastructure 1 (more particularly processing system 5) receives the LA Update messages and may derive (e.g. every 30 s, 1 min) how many and which terminals Ti are currently camping on the active cell A1. This provides information about the initial situation regarding idle terminals in the active cell.

In step 5-II, the inactive cell(s) B1 set a periodic LA update value to a similarly short (e.g. 30 s, 1 min) value as

used for the active cell A1. The presence signal P is transmitted in the inactive cell B1.

In the active cell A1, in the system information (SIB) to be broadcast on the broadcast channel of the cell, the absolute signal level threshold parameter Ts,search is set higher than nominal (e.g. nominal value +[5,10] dBm), step 5-III. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells B1. In the cell, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselection evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal Ti for which the received signal level of the active cell A1 is below the adjusted (increased) threshold Ts,search measures the neighbour cells, for example including inactive neighbour B1. For some RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active) neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell.

An idle terminal Ti persisting to camping on the active cell A1 continues providing frequent LA Updates messages to the active cell A1. An idle terminal Ti which has reselected to an inactive cell B1 (which is assumed to be configured for frequent LA Updates as indicated above) will provide its frequent LA Update messages to the relevant inactive cell B1. An idle terminal Ti which has reselected another active cell will adhere to the

LA Update regime as broadcast by that cell (which may be a nominal value, e.g. 30 min, 1 hour, etc.)

After a transitional period (whose length may depend on the duration of the cell reselection procedure and the LA Update period), the processing system 5 may derive in step 5-IV from the received LA Update messages how many and which idle terminals remain camped on the active cell, how many and which idle terminals have reselected an inactive cell (and which cell) and how many and, possibly, which idle terminals have reselected from the active cell to other cells. This analysis provides an estimate about the situation regarding idle terminals Ti when each of the inactive cells B1 would be activated.

The information obtained from step 5-IV may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 5-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions. A paging message may be issued indicating modified system information. This paging message is also received by idle terminals still camping on the active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision obtained from the processing of step 5-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions. In these cells, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on any of the cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 5-V in FIG. 5 for both the active cell A1 and the activated cell B1.

Still further, after the decision obtained from the processing of step 5-IV, the inactive cells that are decided to

be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped on such a cell will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read modified system information is RAT dependent.

In a second method, illustrated in the flow chart of FIG. 6, a location area update period (or a similar period) is decreased in the active cell A1 and a reporting identifier, also referred to here below as probing flag, is broadcast in the inactive cell B1 during a time interval.

The first step, indicated by 6-I, is equivalent to step 5-I in FIG. 5.

Different from the first method, the LA update period is not changed in the inactive cells B1. A reporting identifier is transmitted in the inactive cells B1 (step 6-II). The presence signal P, possibly including the probing flag, is transmitted in the inactive cells B1.

In the active cell A1, the absolute signal level threshold parameter Ts,search is set higher than nominal (e.g. nominal value +[5,10] dBm) in step 6-III and is broadcasted in the system information (SIB) on the broadcast channel of the cell. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells. A paging message may be issued indicating modified system information. This paging message is also received by idle terminals Ti camping on the cell. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselection evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal Ti for which the absolute received signal level of the active cell A1 is below the adjusted threshold Ts,search measures the neighbours. For some

RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active) neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell.

An idle terminal Ti persisting to camping on the active cell A1 continues providing frequent LA Updates messages to the active cell A1. An idle terminal Ti which reselects to an inactive cell B1 (the terminal Ti may detect this from the probing flag in the inactive cell's broadcast channel) is configured to, shortly after performing the reselection, send a LA Update message to the selected inactive cell B1. This first LA Update message is sent, regardless the setting of the LA Update period in the inactive cell B1. An idle terminal reporting a cell reselection to an inactive neighbour cell may be further configured to also report the presence of the probing flag in its LA Update message. This could ease bookkeeping at the processing system 5 regarding the neighbour state (inactive or active).

Different from the first method, the inactive cells B1 are configured with a nominal period for LA Updates. Consequently an idle terminal camping on an inactive cell provides (subsequent to the first LA Update message sent shortly after camping on a cell with its probing flag set) only nominal LA Update messages (e.g. 30 min, 1 hour, etc.) to the cell. An idle terminal Ti which has reselected another active cell will adhere to the LA Update regime as broadcast by that cell (which may be a nominal value, e.g. 30 min, 1 hour, etc.).

After of transitional period (whose length may depend on the duration of the cell reselection procedure and the selected LA Update period in the cell A1), the telecommunications infrastructure 1 (more specifically, the processing system 5) may derive from the received LA Update messages how many and

which idle terminals remain camped on the active cell A1, how many and which idle terminals Ti have reselected an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals have reselected from the active cell A1 to other cells. This provides an estimate about the situation regarding idle terminals when each of the inactive cells B1 will be activated (step 6-IV).

It should be noted that in the second method, the LA area update messages used to obtain the processing result are reported to the inactive cell B1 (and then via interface 3 to processing system 5, see FIG. 2).

In order to decrease the burden on the inactive cell B1, a first alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, does not perform cell reselection to that cell as long as it has its probing flag set; it sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on (see the box beside 6-IV in FIG. 6). Different from the first method illustrated in FIG. 5, and different from the second method's basis described above, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, an inactive cell in this first alternative needs not to support reception of LA Update messages as described above. Also different from the first method illustrated in FIG. 5, an idle terminal Ti in this first alternative of the second method does not reselect to an inactive cell (comparable to active terminals Ta not being handed over to inactive cell B1).

A second alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, first sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on and only subsequently performs cell reselec-

tion to the best cell (see the box beside 6-IV in FIG. 6). Different from the first method illustrated in FIG. 5, and different from the second method's basis described above, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, again, an inactive cell needs not to support reception of LA Update messages.

Different from the first method, the inactive cells are configured with a nominal period for LA Updates. In this case, to prevent that LA Updates are sent to the inactive cell, the inactive cell may be configured with an infinite LA Update period during the period(s) wherein the presence signal P is transmitted in the inactive cell.

The information obtained from step 6-IV (and possibly step 6-I) may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 6-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions. A paging message may be issued indicating modified system information. This paging message is also received by idle terminals still camping on the original active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision in step 6-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions including removal of the probing flag. This system information modification may, but not necessarily needs be announced in the activated cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 6-V, including a reset to the nominal LA update value for cell A1 and to remove the probing flag in activated cell(s) B1 in FIG. 6.

Still further, after the decision obtained from the processing of step 6-IV, the inactive cells that are decided to be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped on such a cell will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read system information is RAT dependent.

In a third method, illustrated in the flow chart of FIG. 7, the reporting identifier, also referred to as probing flag, is broadcasted in both the active cell A1 and the inactive cell B1. This third method does not rely on frequent periodic LA updates.

In step 7-I, the system information (SIB) to be broadcasted on the broadcast channel of the active cell A1 comprises a probing flag. In the active cell, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1.

An idle terminal Ti, detecting the probing flag, is configured (see FIG. 9) to report information about its identity (e.g. IMSI) and best cell (in this case, likely the active cell A1) to the cell it camps on. The information about the cell identity is not necessarily included in the report but may be added by the cell via which the report is sent. The report is sent once, on first detection of the probing flag being set. It is an option that an idle terminal Ti which has reselected another active cell will not send a report, which would prevent unnecessary reports to be received in other active cells. The telecommunications infrastructure (more precisely the processing system 5) receives the reports and may derive how many and which terminals Ti are currently camping on the active cell. This provides the information about the situation regarding idle terminals before the probing period starts.

Then, in step 7-II, a probing flag is also transmitted in the inactive cell(s) B1 and the presence signal P is transmitted as well.

In the active cell A1, the absolute signal level threshold Ts,search parameter is set higher than nominal (e.g. nominal value +[5,10] dBm) and in step 7-III is broadcast in the system information (SIB) on the broadcast channel of the cell. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells. A paging message may be issued indicating modified system information. This paging message is also received by idle terminals Ti camping on the cell. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselection evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal for which the absolute received signal level of the active cell A1 is below the adjusted threshold Ts,search measures the neighbours. For some RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active) neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell.

An idle terminal persisting to camping on the active cell A1 sends a report as described above for step 7-I regarding the active cell A1 to the active cell A1. An idle terminal Ti which reselects to an inactive cell (the terminal may detect this from the probing flag in the inactive cell’s broadcast channel) is configured to, shortly after performing the reselection, send a report as described for step 7-I to the selected inactive cell (see FIG. 9). The report is sent once, on first

detection of the probing flag being set in the cell it is camped on and to the cell it is camped on. It is an option that an idle terminal which has reselected another active cell will not send a report, which would prevent unnecessary reports to be received in other active cells. An idle terminal reporting a cell reselection to an inactive neighbour cell may be further configured to also report the presence of the probing flag in its report. This could ease bookkeeping at the processing system 5 regarding the neighbour state (probing or nominal).

After a transitional period (whose length may depend on the duration of the cell reselection procedure and time to send the associated reports), the telecommunications infrastructure 1 (more precisely, the processing system 5) may derive from the received reports how many and which idle terminals remain camped on the active cell A1, how many and which idle terminals have reselected an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals have reselected from the active cell to other cells. This provides an estimate about the situation regarding idle terminals when each of the inactive cells B1 will be activated.

Again, in order to decrease the burden on the inactive cell B1, a first alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, does not perform cell reselection to that cell as long as it has its probing flag set, yet may remain camping on such a cell; it sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on (see the box beside 7-IV in FIG. 7). Comparable to the second method's first alternative, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, an inactive cell in this first alternative needs not to support reception of reports as described above.

A second alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects

the highest-ranking cell (best cell) to have its probing flag set, first sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on and only subsequently performs cell reselection to the best cell (see the box beside 7-IV in FIG. 7). Comparable to the second method's second alternative, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, again, an inactive cell B1 needs not to support reception of reports as described above.

The information obtained from step 7-IV (and possibly step 7-I) may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 7-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions (which also includes removal of the probing flag). A paging message may be issued indicating modified system information. This paging message is also received by idle terminals still camping on the original active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision in step 7-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions including removal of the probing flag. This system information modification may, but not necessarily needs be announced in the activated cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 7-V including a removal of the probing flags in active cell A1 and activated cell(s) B1.

Still further, after the decision obtained from the processing of step 7-IV, the inactive cells that are decided to be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped

on such a cell will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read system information is RAT dependent.

Finally, in a fourth method, illustrated in the flow chart of FIG. 8, a measurement-and-report paging message, hereinafter denoted as paging message, is transmitted in the active cell A1 instructing the idle terminals Ti to obtain and report information on the inactive cells B1. The idle terminals Ti listen to broadcast and paging channels and can be triggered, using these channel(s), to obtain information on the inactive cells B1. The method may be combined with probing flags transmitted in the inactive cells.

In a first optional step 8-I, a paging message is transmitted in the active cell A1. The paging message may optionally comprise configuration parameters (see below), which configuration parameters are to be applied by the idle terminal Ti.

In response to step 8-I, an idle terminal receiving the paging message is configured (see FIG. 9) to perform measurements on the serving cell (in this case the active cell A1) and on its neighbour cells, regardless the criterion settings for initiating a search (such as parameter Ts,search), and to subsequently send a report, by default to the cell that issued the paging message (in this case the active cell A1). After sending the report, a cell reselection may be performed. The idle terminal can be configured to not performing cell reselection as long as the highest-ranked cell has the probing flag set (comparable to the first alternative of the second or third method).

As indicated above, the paging message may optionally comprise configuration parameters. Examples are parameters that further specify the measurements to be made (which terminals should measure, which cell(s) to be measured, which RAT to be measured, which characteristics, etc.), parameters that further

specify the subsequent reselection (such as offset or hysteresis parameters) and parameters that further specify the report to be provided (whether or not to provide a report, how many of the best cells to be reported, which quantities – e.g. signal level/quality, path loss estimates – to be reported, destination of the report, etc.). The paging parameters may alternatively or in addition, include a reference where the (further) parameters may be obtained, e.g. a reference (link) to a broadcast channel or the like, for example when the set of parameters is impractically large to be sent in the paging message itself.

A terminal receiving configuration parameter values in (or associated with) the paging message applies the received values when performing the measurements, the cell reselection procedure and the reporting as commanded by the paging message. It may be that in case of a conflict with an existing parameter having been assigned a value, the value received in the paging message is only applied for the measurements etc. related to the present method. Other procedures continue to apply the already assigned value and are not affected by the value in the paging message.

The reported information includes at least an indication about the terminal identity (e.g. IMSI) and about the identity of the best cell. The report is sent once, on detection of the paging message, and by default (unless instructed otherwise) to the cell that issued the paging message, regardless the cell reselection that may be the result of the search.

The telecommunications infrastructure 1 (more precisely, the processing system 5) receives the reports and may derive how many and which terminals were camping on the active cell A1 and received the paging message and also may derive how many and which terminals are likely to remain camping on the active cell A1 after the paging message. This provides the information about the situation regarding idle terminals before the probing period starts.

Step 8-I is an optional step that may e.g. be omitted if the processing system 5 has no particular interest in obtaining information about the situation regarding idle terminals Ti

in the active cell A1 before the start of transmitting the presence signal P in the inactive cell(s) B1.

Step 8-II involves the transmission of the presence signal P in the inactive cell(s). A probing flag may also be transmitted. Optionally, one or more of the inactive cells may be configured with system information parameters different from the normal operating conditions, e.g. values set specifically for the method.

Optionally, as described for previous methods illustrated in FIGS. 5-7, the active cell A1 may be configured with system information parameters different from the normal operating conditions, e.g. values set specifically for the probing phase. It is, however, envisaged that the possibility to specify configuration parameters in (or associated with) the paging message, has advantages over making temporary modifications to system information parameters.

In step 8-III, again a paging message is transmitted in the active cell A1. The paging message may optionally comprise configuration parameters as described above. The values of these parameters may be different from those in the paging message optionally transmitted in step 8-I in active cell A1.

In order to decrease the load of reports, the paging message may also instruct only a fraction f of the idle terminals Ti in the active cell A1 to perform measurements and to provide a report. Mechanisms, such a paging groups, can be used to address or to instruct a particular fraction f (subset) of the idle terminals Ti. A fraction f of the idle terminals may also be established by configuring the idle terminal Ti to, randomly or deterministically determined, only provide the requested reports for a fraction f of the requests.

In response to step 8-III, an idle terminal receiving a paging message is configured to perform measurements on the serving cell (in this case the active cell A1) and on its neighbour cells, regardless the criterion settings for initiating a search, and to subsequently send a report (in this case to the default which is the cell that issued the paging message, i.e. active cell A1). The report is sent once, on detection of

the paging message. After sending the report a cell reselection may be performed. The idle terminal can be configured to not performing cell reselection as long as the highest-ranked cell has the probing flag set.

The report includes at least an indication about the identity of the best cell and preferably an indication about the terminal identity (e.g. IMSI). The report may additionally include the status of the probing flag, if any, of the reported best cell.

The telecommunications infrastructure 1 (or more precisely, the processing system 5) receives the reports and may derive from the received reports how many and which idle terminals are likely to remain camped on the active cell, how many and which idle terminals are likely to reselect to an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals are likely to reselect to another cell (and which other cell). This provides an estimate about the situation regarding idle terminals when each of the inactive cells will be activated (step 8-IV).

The information obtained from step 8-IV (and possibly step 8-I, when performed) may be taken into account in the evaluation by the telecommunications infrastructure 1 (more precisely processing system 5) about which of the inactive cells to activate and which not.

If the system information of the active cell A1 has been set differently for the execution of the method than during normal operating conditions, then the system information for the active cell may be reverted back to normal operating conditions (not shown in FIG. 8).

If the inactive cell B1 is activated the following applies. If a probing flag was set, the probing flag may be removed. This system information change need not be announced by a paging message in the relevant cell(s). If the system information of the inactive cell has been set differently for the probing phase than during normal operating conditions, then the system information for the cell may be reverted back to normal

operating conditions. If a probing flag was not set, an idle terminal camped there, will remain camped there.

If the inactive cell B1 is decided to not be activated, it may be switched off. If a probing flag was not set in the cell, an idle terminal camped there will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells, possibly reselecting another neighbour cell).

A paging message may be transmitted again after activating inactive cells wherein a probing flag was transmitted. In this case a primary objective is to actually let an idle terminal camped on the active cell A1 perform a reselection to one of the activated neighbour cells B1, when such reselection is still applicable. The processing system 5 may choose to either ignore the reports or to process the reports to assess the final configuration or to have it confirmed. If the system has no interest in assessing / confirming the final configuration, this paging message may advantageously specify a configuration parameter indicating that no reports are to be sent.

In some of the methods and alternatives for triggering idle terminals Ti as described above, it may occur that an idle terminal Ti which camps on an inactive cell B1 initiates a session (e.g. initiates a voice or a data call). There are various ways to handle this situation.

When the inactive cell, despite its 'inactive' status, is to a sufficiently large extent operational, it may choose to accept the request and to support the call in the normal way, at least temporarily. Subsequently, the inactive cell may attempt to handover the call to an active cell; alternatively it may continue serving the call until a decision has been taken about the activation (or not) of that cell. If activated, it may continue to serve the call as an active cell; if not activated, it may handover the call to an active cell before the inactive cell is switched off.

When the inactive cell has insufficient capabilities to accept and/or support a call, or when it is otherwise undesirable to do so, the inactive cell may deny the call request.

Various wireless access technologies provide a mechanism to elegantly and quickly refer a refused caller to an alternative, e.g. 'directed retry'. In that case, the inactive cell only needs to support the corresponding signalling.

Finally, note that by using a probing flag in an inactive cell and by using an idle terminal configured to not actually reselect to or camp on a cell which has its probing flag set (also see the first alternative of the second and third method and see the fourth method), it can be prevented that idle terminals actually camp on an inactive cell.

In each of the above methods, the process of counting how many idle terminals will perform cell reselection may use a hysteresis Qhyst in the terminal for the measurement result.

Similarly, a neighbour-specific offset Qoffset,n can be applied to (e.g. added to) the measurement result in the terminal. By means of these cell-specific offsets a cell may be either be promoted or demoted in the ranking of cells for cell reselection.

In the above-described methods, conditions for cell reselection have been frequently addressed. In addition to these conditions, there may be various other conditions that determine whether a cell is suitable to be camped on by the idle terminal. It is assumed that all inactive neighbours are classified as a 'suitable cell', e.g. their Nrxlev and Nqual are sufficiently high to consider them for camping. It is also assumed that suitable averaging is applied to the measurements. Additionally, it is assumed that a (minimum) period is taken into account for which a highest-ranked cell has to be different from the current (active) cell before actually performing a cell reselection. This minimum period (timer) may also broadcasted via the broadcast channel of the cell in the same SIB.

Whereas the disclosed method and telecommunications infrastructure use existing measurement and reporting capabilities of wireless terminals, in at least some of the above-described embodiments the capabilities of wireless terminals should be adapted to participate in these embodiments. Examples have been indicated above and include the recognition, processing and ac-

tions performed for cell reselection, in response to the reporting identifier (probing flag) and/or the measurement-and-reporting paging message of the above-described fourth method. Most of these enhanced capabilities will be obtained by software modifications in the wireless terminals. Therefore, FIG. 9 is a highly schematic illustration of a wireless terminal T comprising storage S and processor uP configured for storing and operating the modified software. For a base station BS A, BS B similar consideration apply.

CLAIMS

1. A method for activating at least one inactive cell in a wireless telecommunications infrastructure, the telecommunications infrastructure comprising an active cell containing a plurality of terminals, the method comprising the steps of:

- transmitting a presence signal in the at least one inactive cell;
- receiving reports from the plurality of terminals detecting the presence signal;
- processing information contained in the reports received from the plurality of terminals in a processing system of the telecommunications infrastructure to provide a processing result; and
- activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

2. The method according to claim 1, further comprising the steps of:

- terminating transmission of the presence signal in the at least one inactive cell when the processed information does not fulfil the at least one activation condition
- transmitting the presence signal in the at least one inactive cell again at a later time.

3. The method according to claim 1 or 2, further comprising the step of providing the terminals in the active cell with measurement parameters and/or reporting parameters to obtain the information regarding the presence signal from the inactive cell.

4. The method according to one or more of the preceding claims, wherein the telecommunications infrastructure contains a plurality of inactive cells, the method comprising

the step of concurrently or sequentially transmitting the presence signal in the plurality of inactive cells

5. The method according to one or more of the preceding claims, wherein the at least one activation condition includes at least one of energy reduction for the telecommunications infrastructure, load reduction for the active cell or reduction of electromagnetic radiation from the telecommunications infrastructure or from a particular set of cells in the infrastructure.

6. The method according to one or more of the preceding claims, comprising the step of transmitting a reporting identifier in at least one of the active cell and the inactive cell.

7. The method according to one or more of the preceding claims, wherein at least some of the plurality of terminals in the active cell are idle terminals when gathering information for the report.

8. The method according to claim 7, further comprising the step of temporarily decreasing a location area update period in at least one of the active cell and the inactive cell.

9. The method according to claim 7 or 8, wherein the reports are received via the active cell.

10. The method according to claim 7, further comprising the step of transmitting a paging message in the active cell instructing the idle terminals to obtain and/or report the information.

11. A computer program comprising software code portions configured, when executed on one or more processing units, to perform the method according to one more of the claims 1-10.

12. A wireless access telecommunications infrastructure comprising an active cell and at least one inactive cell,

the active cell containing a plurality of terminals, wherein the infrastructure comprises:

- a presence signal generator configured for transmitting a presence signal in the at least one inactive cell;
- a receiver configured for receiving reports from the plurality of terminals detecting the presence signal;
- a processor system configured for processing information contained in the reports received from the plurality of terminals to provide a processing result; and
- an activator configured for activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

13. The wireless access telecommunications infrastructure configured for performing the method according to one or more of the claims 1-10.

14. A signal transmitted in a cell of the wireless access telecommunication of claim 12 or 13, wherein the signal contains a reporting identifier indicating that the cell is an inactive cell.

15. A terminal configured for operating in the wireless access telecommunications infrastructure of claim 12 or 13 and for processing the signal according to claim 14 or operating in the method according to claim 10.

ABSTRACT

The invention relates to a method for activating at least one inactive cell in a wireless telecommunications infrastructure. The telecommunications infrastructure comprises an active cell containing a plurality of terminals. A presence signal is transmitted in the at least one inactive cell. The plurality of terminals in the active cell detect the presence signal(s) of the one or more inactive cells to gather information from the inactive cell. The information is reported to and received at the telecommunications infrastructure. The information received from the plurality of terminals is processed in a processing system of the telecommunications infrastructure to provide a processing result. The inactive cell is activated when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

+ FIG. 3

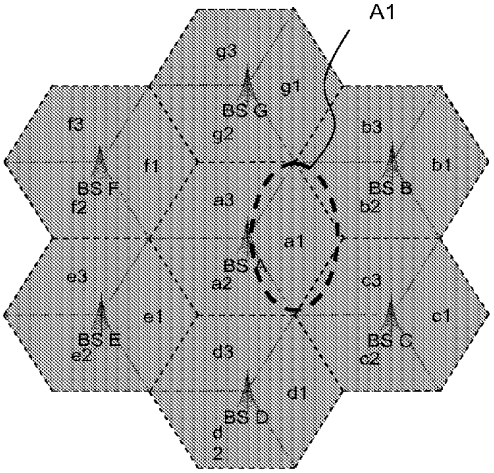

FIG. 1A

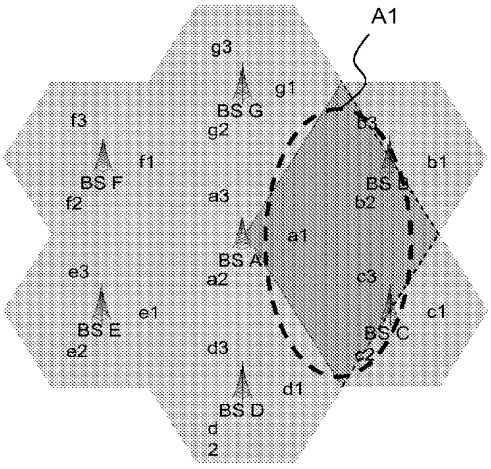

FIG. 1B

1/6

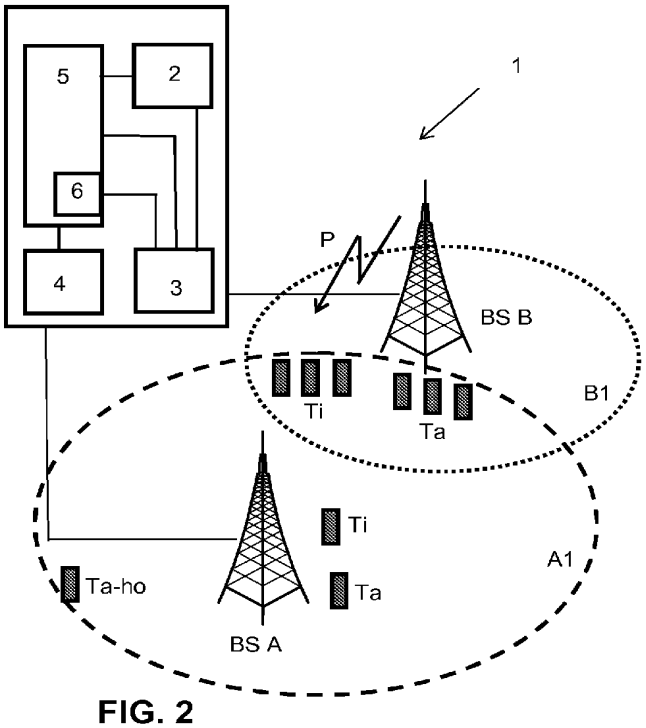
5
2
6
4
3
1
P
BS B
B1
Ti
Ta
Ti
Ta
A1
Ta-ho
BS A

FIG. 2

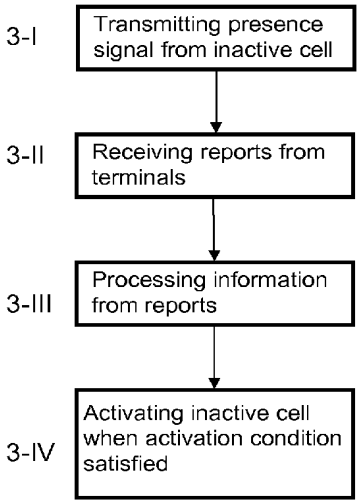
3-I
Transmitting presence signal from inactive cell
3-II
Receiving reports from terminals
3-III
Processing information from reports
3-IV
Activating inactive cell when activation condition satisfied

FIG. 3

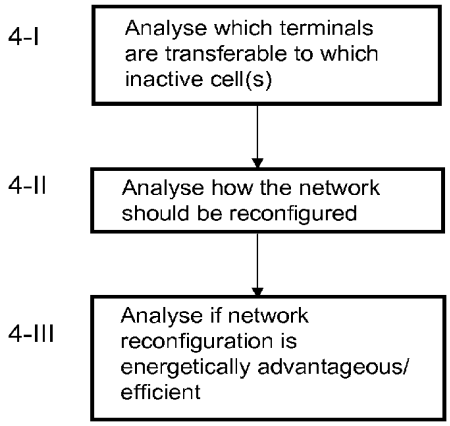
4-I
Analyse which terminals are transferable to which inactive cell(s)
4-II
Analyse how the network should be reconfigured
4-III
Analyse if network reconfiguration is energetically advantageous/ efficient

FIG. 4

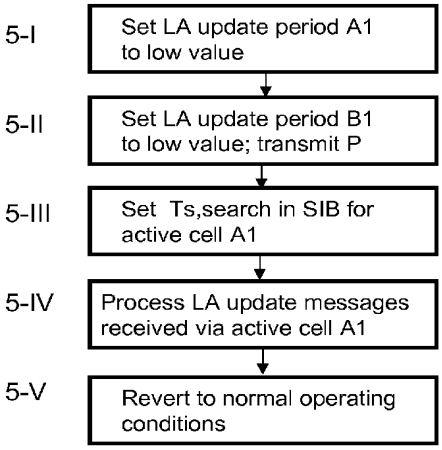
5-I
Set LA update period A1 to low value
5-II
Set LA update period B1 to low value; transmit P
5-III
Set Ts,search in SIB for active cell A1
5-IV
Process LA update messages received via active cell A1
5-V
Revert to normal operating conditions

FIG. 5

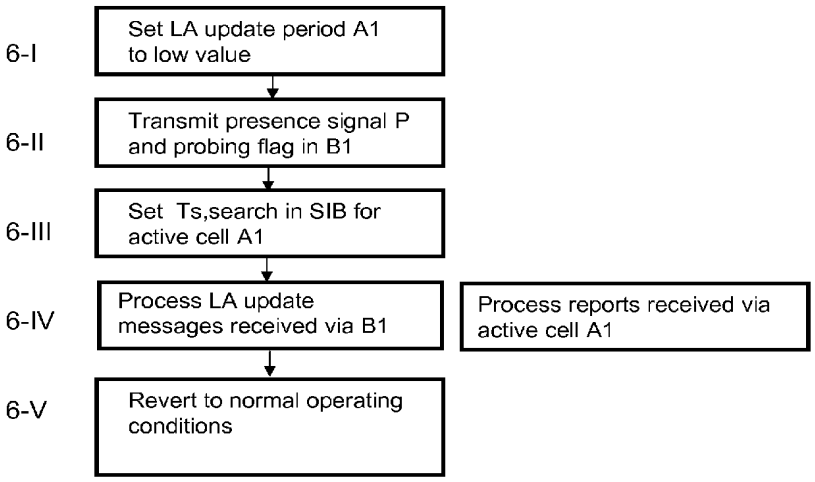
6-I
Set LA update period A1 to low value
6-II
Transmit presence signal P and probing flag in B1
6-III
Set Ts,search in SIB for active cell A1
6-IV
Process LA update messages received via B1
Process reports received via active cell A1
6-V
Revert to normal operating conditions

FIG. 6

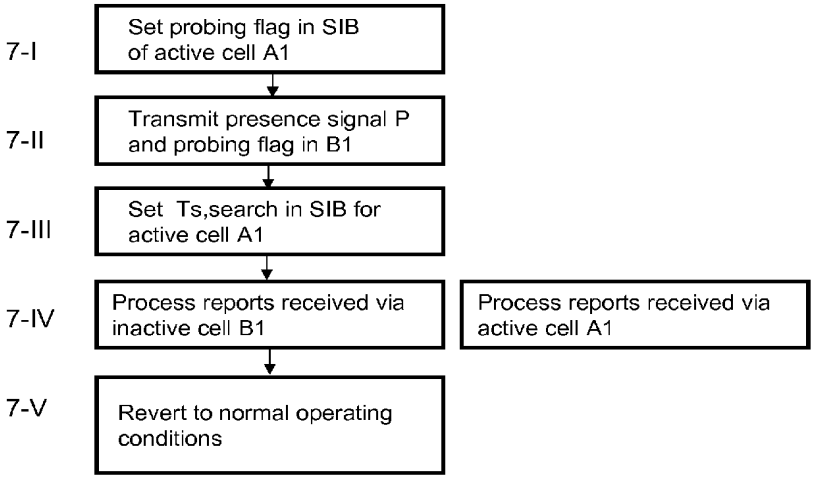
7-I
Set probing flag in SIB of active cell A1
7-II
Transmit presence signal P and probing flag in B1
7-III
Set Ts,search in SIB for active cell A1
7-IV
Process reports received via inactive cell B1
Process reports received via active cell A1
7-V
Revert to normal operating conditions

FIG. 7

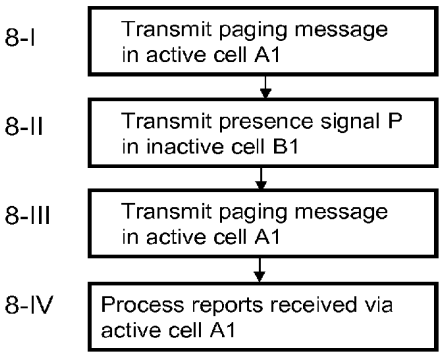
8-I
Transmit paging message in active cell A1
8-II
Transmit presence signal P in inactive cell B1
8-III
Transmit paging message in active cell A1
8-IV
Process reports received via active cell A1

FIG. 8

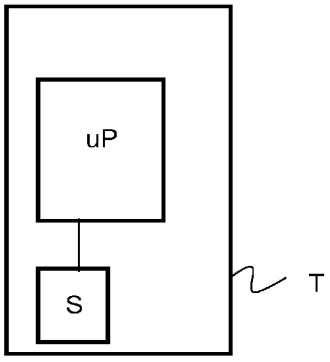
uP
S
T

FIG. 9

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DOCUMENT MADE AVAILABLE UNDER THE PATENT COOPERATION TREATY (PCT)

International application number:		**PCT/EP2011/057093**
International filing date:		**04 May 2011 (04.05.2011)**
Document type:		**Certified copy of priority document**
Document details:	Country/Office:	**EP**
	Number:	**10162192.8**
	Filing date:	**06 May 2010 (06.05.2010)**
Date of receipt at the International Bureau:		**06 June 2011 (06.06.2011)**

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a),(b) or (b-*bis*)

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1211 Geneva 20, Switzerland
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PCT REQUEST

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0	**For receiving Office use only**	
0-1	International Application No.	**PCT/EP2011/057093**
0-2	International Filing Date	**04 MAY 2011 (04.05.2011)**
0-3	Name of receiving Office and "PCT International Application"	**RO/EP**

0-4	**Form PCT/RO/101 PCT Request**	
0-4-1	Prepared Using	PCT Online Filing Version 3.5.000.221 MT/FOP 20020701/0.20.5.9
0-5	**Petition** The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	European Patent Office (EPO) (RO/EP)
0-7	**Applicant's or agent's file reference**	403543WO
I	**Title of Invention**	METHOD AND TELECOMMUNICATIONS INFRASTRUCTURE FOR ACTIVATING AN INACTIVE CELL
II	**Applicant**	
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II-9	Facsimile No.	+31 70 385 54 37
II-10	e-mail	dieneke.vandertoorn-dejager@kpn.com
II-10(a)	E-mail authorization The receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority are authorized to use this e-mail address, if the Office or Authority so wishes, to send notifications issued in respect of this international application:	exclusively in electronic form (no paper notifications will be sent)

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III-1	**Applicant and/or inventor**	
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III-2-7	State of residence	NL
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III-3-5	Address	Van Kempenstraat 22 2352 VH Voorschoten Netherlands
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III-3-7	State of residence	NL
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III-4-2	Applicant for	US only
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III-4-5	Address	Usselincxstraat 142 2593 VP The Hague Netherlands
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III-4-7	State of residence	NL

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IV-1	**Agent or common representative; or address for correspondence**	
	The person identified below is hereby/ has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	Agent
IV-1-1	Name (LAST, First)	WUYTS, Koenraad
IV-1-2	Address	95321 P.O. Box 95321 2509 CH The Hague Netherlands
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IV-1-4	Facsimile No.	+31 70 385 54 37
IV-1-5	e-mail	dieneke.vandertoorn-dejager@kpn.com
IV-1-5(a)	E-mail authorization The receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority are authorized to use this e-mail address, if the Office or Authority so wishes, to send notifications issued in respect of this international application:	exclusively in electronic form (no paper notifications will be sent)
IV-1-6	Agent's registration No.	100754124
V	**DESIGNATIONS**	
V-1	**The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.**	
VI-1	**Priority claim of earlier regional application**	
VI-1-1	Filing date	06 May 2010 (06.05.2010)
VI-1-2	Number	10162192.8
VI-1-3	Regional Office	EP
VI-2	**Priority claim of earlier regional application**	
VI-2-1	Filing date	11 October 2010 (11.10.2010)
VI-2-2	Number	10187119.2
VI-2-3	Regional Office	EP
VI-3	**Priority claim of earlier regional application**	
VI-3-1	Filing date	24 December 2010 (24.12.2010)
VI-3-2	Number	10196958.2
VI-3-3	Regional Office	EP
VI-4	**Priority document request**	
	The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1, VI-2, VI-3

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VI-5	**Incorporation by reference :** where an element of the international application referred to in Article 11(1)(iii)(d) or (e) or a part of the description, claims or drawings referred to in Rule 20.5(a) is not otherwise contained in this international application but is completely contained in an earlier application whose priority is claimed on the date on which one or more elements referred to in Article 11(1)(iii) were first received by the receiving Office, that element or part is, subject to confirmation under Rule 20.6, incorporated by reference in this international application for the purposes of Rule 20.6.		
VII-1	**International Searching Authority Chosen**	European Patent Office (EPO) (ISA/EP)	
VII-2	**Request to use results of earlier search; reference to that search**		
VII-2-1	Filing date	06 May 2010 (06.05.2010)	
VII-2-2	Application Number	10162192.8	
VII-2-3	Country (or regional Office)	EP	
VII-2-5	Documents are available to the ISA in a form and manner acceptable to it and therefore do not need to be submitted by the applicant to the ISA (Rule 12bis.1(f)):	A copy of the results of the earlier search A copy of the earlier application A copy of any document cited in the results of the earlier search	
VIII	**Declarations**	Number of declarations	
VIII-1	Declaration as to the identity of the inventor	-	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	-	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	-	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	1	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	-	

PCT REQUEST

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IX	Check list	Number of sheets	Electronic file(s) attached
IX-1	Request (including declaration sheets)	8	✓
IX-2	Description	39	✓
IX-3	Claims	3	✓
IX-4	Abstract	1	✓
IX-5	Drawings	6	✓
IX-7	TOTAL	57	
	Accompanying Items	Paper document(s) attached	Electronic file(s) attached
IX-8	Fee calculation sheet	–	✓
IX-18	PCT-SAFE physical media	–	–
IX-20	**Figure of the drawings which should accompany the abstract**	3	
IX-21	**Language of filing of the international application**	English	
X-1	**Signature of applicant, agent or common representative**	(PKCS7 Digital Signature)	
X-1-1	Name (LAST, First)	WUYTS, Koenraad	
X-1-2	Name of signatory	NL, Koninklijke KPN N.V., K. Wuyts 16870	
X-1-3	Capacity	(Representative)	

FOR RECEIVING OFFICE USE ONLY

10-1	**Date of actual receipt of the purported international application**	**04 MAY 2011 (04.05.2011)**
10-2	**Drawings:**	✓
10-2-1	Received	
10-2-2	Not received	
10-3	**Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application**	
10-4	**Date of timely receipt of the required corrections under PCT Article 11(2)**	
10-5	**International Searching Authority**	ISA/EP
10-6	**Transmittal of search copy delayed until search fee is paid**	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	**Date of receipt of the record copy by the International Bureau**	

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European Patent Office
Office européen des brevets

Bescheinigung	Certificate	Attestation
Die angehefteten Unterlagen stimmen mit der als ursprünglich eingereicht geltenden Fassung der auf dem nächsten Blatt bezeichneten europäischen Patentanmeldung überein.	The attached documents are exact copies of the text in which the European patent application described on the following page is deemed to have been filed.	Les documents joints à la présente attestation sont conformes au texte, considéré comme initialement déposé, de la demande de brevet européen qui est spécifiée à la page suivante.

Patentanmeldung Nr.	**Patent application No.**	**Demande de brevet n°**

10187119.2 / EP10187119

The organization code and number of your priority application, to be used for filing abroad under the Paris Convention, is EP10187119.

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le President de l'Office européen des brevets
p.o.

R.C. van Dijk

EPA/EPO/OEB Form 1014 12.08

Anmeldung Nr:
Application no.: 10187119.2
Demande no :

Anmeldetag:
Date of filing: 11.10.10
Date de dépôt :

Anmelder / Applicant(s) / Demandeur(s):

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Nederlandse Organisatie voor Toegepast
-Natuurwetenschappelijk Onderzoek TNO
Schoemakerstraat 97
2628 VK Delft/NL

Bezeichnung der Erfindung / Title of the invention / Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se référer à la description.)

Method and telecommunications infrastructure for activating an inactive cell

In Anspruch genommene Priorität(en) / Priority(Priorities) claimed / Priorité(s) revendiquée(s)
Staat/Tag/Aktenzeichen / State/Date/File no. / Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation / International Patent Classification / Classification internationale de brevets:

H04W24/02

Am Anmeldetag benannte Vertragstaaten / Contracting States designated at date of filing / Etats contractants désignées lors du dépôt:

AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

Method and telecommunications infrastructure for activating an inactive cell

FIELD OF THE INVENTION

The invention relates to the field of telecommunications infrastructures. More specifically, the invention relates to the field of activating inactive cells of a telecommunications infrastructure for purposes such as controlling energy consumption and electromagnetic radiation, particularly reducing energy consumption or electromagnetic radiation.

BACKGROUND OF THE INVENTION

The operation of wireless access networks for enabling wireless communication is highly energy consuming. In view of current environmental concerns, increased attention is paid recently to the energy consumption of telecommunications networks.

Various studies have been performed to reduce conventional energy consumption in wireless access networks, e.g. by exploring the option of using sustainable energy sources (Ericsson AB White Paper "Sustainable energy use in mobile communications, June 2007).

With the development of the 3GGP Long Term Evolution (LTE) network, energy saving for the network is also approached in the context of self organizing networks (SON). In a White Paper of NEC, dated February 2009, "NEC's proposals for next-generation radio network management", energy is considered as a significant part of the operation expenses of a cellular network. It is recognized that the main saving potential resides in using variations in load over time, that allows to switch off parts of the resources, for example during the night. When a complete base station is switched off, other base stations of the access network need to make up for the reduction in coverage area and capacity. This requires coordination between the nodes. A similar use case is described in 3GGP TR 36.902 v9.1.0 "Self-

configuring and self-optimizing network(SON) use cases and solutions".

Once base stations (or one or more cells thereof) have been deactivated, at some point in time these base stations (or cells) may have to be reactivated again. Thus, a decision is required when and/or which base stations or cells need to be activated.

A first solution would be to activate the base stations or cells at a predetermined time. As an example, it can be imagined that fewer base stations need to be active during night time and more base stations need to be active during the day.

Another solution would be to activate all inactive cells adjacent to (i.e. relevant for) a currently active cell when the currently active cell detects a certain traffic load exceeding a threshold or detects a rising traffic load.

There is a need in the art to improve these solutions by determining more accurately which base stations and/or cells should be activated.

SUMMARY OF THE INVENTION

A method for activating at least one inactive cell in a wireless telecommunications infrastructure is disclosed. The telecommunications infrastructure comprises an active cell containing a plurality of terminals. A presence signal is transmitted in the at least one inactive cell. The plurality of terminals in the active cell (which are not necessarily all terminals in the active cell) detect the presence signal(s) of the one or more inactive cells to gather information about the inactive cell. The information is reported to and received at the telecommunications infrastructure. The information received from the plurality of terminals is processed in a processing system of the telecommunications infrastructure to provide a processing result. It should be appreciated that the information contained in some reports from some terminals need not necessarily be processed. The inactive cell is activated when the processing result fulfils at least one activation condition such that at

least one of the plurality of terminals is within a coverage area of the activated cell.

A computer program containing software code portions (possibly distributed over several components in the telecommunications infrastructure) for performing the method when executed by a processing system is also disclosed.

A wireless access telecommunications infrastructure comprising an active cell and at least one inactive cell is also disclosed. The active cell can contain a plurality of terminals is also disclosed. The infrastructure comprises a presence signal generator configured for generating a presence signal to be transmitted in the at least one inactive cell. The infrastructure further comprises a receiver configured for receiving reports from the plurality of terminals detecting the presence signal and a processor system configured for processing information contained in the reports received from the plurality of terminals to provide a processing result. The processing system may be part of the telecommunications infrastructure or be (partly) connected to the telecommunications infrastructure in which case the processing system is considered part of the telecommunications infrastructure. The infrastructure further comprises an activator configured for activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell. By using the (partly) existing capabilities of terminals to measure and report information received from neighbouring cells (typically applied for e.g. handover operations), the transmission of the presence signal in the currently inactive cell enables the telecommunications infrastructure to assess whether the terminals recognize this cell as an appropriate target, i.e. whether the terminals currently connected to or camping on the active cell are likely able to be connected to or camp on a currently inactive cell. The telecommunications infrastructure is configured to receive and process the information relating to the inactive cell(s) from the reports of various terminals within the active cell (possibly, but not necessarily, all terminals in the active

cell). The reported information forms the basis to decide whether or not to actually activate the currently inactive cell (i.e. to change the network configuration of the telecommunications infrastructure) in order for the terminal to connect to or camp on the activated cell via a handover operation or cell re-selection, respectively.

The information can be used by an energy evaluation algorithm for determining whether energy consumption of the telecommunications infrastructure can be reduced or used in an efficient manner, e.g. by efficiently controlling activation of cells in the telecommunications infrastructure if required.

The method and telecommunications infrastructure may, in addition or alternatively, also be applied for other purposes. As an example, similar considerations apply to the reduction of electromagnetic radiation produced by a base station. For example, for health reasons it is advisable to limit the amount and duration of electromagnetic radiation to a level that is strictly necessary for the operation of the base station. When the level of electromagnetic radiation can be reduced or when a base station can be switched off, this may be well-appreciated by the population in the vicinity of the base station. Considerations may either apply to the complete telecommunications infrastructure or to a part of the infrastructure, e.g. for a plurality of cells. For example, heavily populated areas may be selected to have low electromagnetic radiation density, whereas in less densely populated areas, the electromagnetic radiation levels can be higher. In addition to health concerns, there may also be technical reasons to restrict the electromagnetic radiation, and therewith the possibility and level of interference experienced in adjacent areas.

It should be appreciated that the active cell and inactive cell may relate to any type of radio access technology (RAT) including, but not limited to GSM, UMTS, LTE, Wimax etc.

It should further be appreciated that the measurements for information on the inactive cell(s) of terminals in the active cell may relate to a single radio access technology (intra-RAT) or multiple different radio access technologies (inter-

RAT). An example of inter-RAT includes a terminal in an active UMTS cell performing measurements on an inactive GSM cell.

The method and telecommunications infrastructure also allow taking account of the distribution of terminals in the active cell. For example, if the analysis reveals that a considerable number of terminals served by the active cell finds themselves near the edge of the active cell (i.e. the reported measurement information indicates a high signal level or signal quality for the presence signal of neighbouring inactive cells and much lower levels for the active cell for a considerable number of terminals), the total energy for the telecommunications infrastructure may be reduced by activating one or more inactive cells and hand over these terminals to these cells.

In the present application, an active cell is considered a cell enabling connection of a terminal to the base station responsible for the cell. In other words, the cell is fully operational.

An inactive cell is considered a cell that is not intended to carry any voice or data traffic but may transmit a presence signal during particular time intervals or continuously. A presence signal may comprise a beacon signal, such as BCCH in GSM network, CPICH in UMTS network or reference symbols in LTE in order to indicate the presence of the cell. In addition, the inactive cell may at least transmit some system information (e.g. cell identity, power level of its beacon signal, etc.), depending on its level of functionality. The inactive cell can become an active cell by applying the method disclosed herein. The inactive cell may be an inactive cell because it does not accept handover for active terminals to the inactive cell or because it redirects connections to an active cell once a connection is requested from a terminal in the inactive cell.

The main purpose of the inactive cells to transmit the presence signal is to allow the terminals in the active cell to perform measurements on these inactive cells and to report such measurements to the network. Terminals in the active cell can be distinguished between terminals in the active mode (active ter-

minals) and terminals in the idle mode (idle terminals). A terminal with an active connection (e.g. a voice call or data being exchanged) is said to be in 'active mode' or 'connected mode'. When the terminal is in active mode (active terminal), the network has detailed knowledge about the terminal and knows by which cell it is served. A terminal which is powered on but without an active connection is said to be in 'idle mode'. When the terminal is in idle mode (idle terminal), the network has limited knowledge about the mobile station and only knows in which paging or location area the terminal may be paged. In idle mode the terminal listens to e.g. a broadcast channel or a paging channel of a particular cell. It is said that the terminal 'camps on' that cell.

The method for assessing whether activation of the inactive cell is possible or required can be performed during subsequent time intervals (e.g. periodic time intervals), as defined in claim 2 in order to not bother the terminals (battery saving) and the network (reduction of network load) continuously. However, (semi-) continuous performance of the method when one or more cells are currently inactive may be an attractive alternative for rapid assessment of opportunities to change the configuration of the telecommunications infrastructure.

In an embodiment of the invention, defined in claim 3, the terminals may be provided with measurement and/or reporting parameters in order to control measurement and reporting operations by the terminals in the active cell. The parameters may e.g. be provided over a connection via the active cell to a terminal that is in the active mode or broadcasted in the active cells to terminals in the active or idle mode. The measurement parameters trigger terminals to perform measurements. The reporting parameters instruct terminals (when) to report measurements to the network.

In existing wireless access telecommunications networks, terminals usually already perform measurements in certain conditions and may report measurement results in certain other conditions. For example, active terminals in handover regions between adjacent cells usually already report measurement infor-

mation from the adjacent cells to the network in order for the network to perform a handover decision for each individual terminal. The measurement parameters provided to the terminals as defined in claim 3 not only allow to obtain measurement information from active terminals in the handover region but also allow to obtain information about neighbour inactive cells from active terminals outside the handover region and from idle terminals within the active cell. These terminals may report that information to the telecommunications infrastructure.

As a first example, a reporting threshold usually applied in the terminal to prevent reporting measurements about neighbour signals with a signal level which is insufficient compared to the signal from the serving cell to be relevant for a possible handover may be adjusted temporarily to allow also reporting signal levels which would otherwise be considered insufficient. As a second example, a signal level threshold usually applied in the idle terminals to prevent performing measurements on neighbour cells when the signal level from the serving cell is more than adequate, may be adjusted (e.g. increased) temporarily to allow measurements on neighbour cells. Providing the measurement and/or reporting parameters to the terminals in the active cell enables more terminals and enables terminals at more locations in the active cell (e.g. not only in what would normally be considered the handover region between two cells) to perform measurements and/or to provide reports to the network.

The telecommunications infrastructure may comprise several inactive cells that may concurrently or sequentially transmit the presence signal, enabling the terminals to measure signals from a plurality of cells concurrently or sequentially to allow the network to obtain a more complete picture of the possibilities for a network configuration change (claim 4). The inactive cells may be located in the active cells (e.g. micro cells), may be adjacent to the active cell or may be located further away from the active cell. The plurality of inactive cells may have an aggregated estimated coverage area that at least partially overlaps the coverage area of the active cell.

Concurrent transmission of a presence signal by several inactive cells may be time efficient and may provide a slightly different picture of the network situation. For example, in a situation with overlapping inactive cells, a sequential transmission of the presence signal could indicate that a particular user device would select more than one inactive cell if only a single of these inactive cells would be activated, whereas concurrent transmission of the presence signal would indicate which of these inactive cells the same user device would select if all these inactive cells would be activated. Sequential transmission of a presence signal may be work load efficient as it allows to refrain from completing the entire envisaged sequence, for example if the thus far collected information appears to be satisfactory. Sequential transmission of a presence signal may involve the sequential transmission in groups of inactive cells to assess the best combination. The sequential variant may use history information to first transmit a presence signal in inactive cells that previously turned out successful candidates for activation.

In the embodiment of claim 6, a reporting identifier is transmitted in the inactive cell. The present application also discloses a signal transmitted in a cell of the infrastructure, wherein the signal comprises the reporting identifier.

Active terminals in the active cell may receive the reporting identifier and transmit the reporting identifier with the report in order to enable the telecommunications infrastructure to distinguish between reports from terminals related to normal handover (to an active cell) and reports from terminals reporting information about the inactive cells for assessing whether the inactive cell should be activated.

Idle terminals detecting the reporting identifier from the inactive cell may be configured to use this identifier to prevent cell reselection by the idle terminal to the inactive cell, to report the information about the inactive cell to the telecommunications infrastructure via the active cell before reselection to the inactive cell, or to report information about

the inactive cell to the inactive cell when the inactive cell is configured to receive such reports.

The embodiment defined in claim 7 is advantageous for the reason that the number of idle terminals is normally much greater than the number of active terminals. Having a plurality of idle terminals reporting information on the presence signal(s) from the inactive cell(s) may greatly contribute to the complete picture of opportunities for reconfiguration of the telecommunications infrastructure and also may indicate possible traffic load in the near future. For the idle terminals to transmit reports to the telecommunications infrastructure, these terminals should temporarily become active.

Apart from the mechanism for idle terminals as described above in relation to claim 6, the embodiments of claims 8-10 provide several other mechanisms for participation of idle terminals in the method according to the invention. These embodiments are described in further detail in the detailed description.

Briefly, the embodiment of claim 8 comprises temporarily decreasing a location area update period (or a similar period) in at least one of the active cell and the inactive cell. The embodiment is advantageous as it may require no or only few modifications to currently existing networks.

The embodiment of claim 9 comprises the idle terminals to report measurement information to the telecommunications infrastructure via the active cell, whereas these terminals would otherwise reselect to the inactive cell and attempt reporting to the inactive cell. This embodiment allows the inactive cells to maintain a status wherein these cells are not able or are configured not to be able to receive reports.

The embodiment of claim 10 comprises transmitting a paging message in the active cell instructing the idle terminals to obtain and/or report the information. The idle terminals listen to broadcast and paging channels and can be triggered to detect information from inactive cells using these channels. Using such paging message, less need exists to temporarily reconfigure the system information of the active cell different

from the normal operation. This is particularly true if the paging messages carry configuration parameters for the idle terminals, such as the measurement and/or reporting parameters defined in claim 3.

The embodiments of claims 6 and 10 require modifications to the processing capabilities of currently existing wireless terminals. The present application discloses a wireless terminal for use in these embodiments.

Hereinafter, embodiments of the invention will be described in further detail. It should be appreciated, however, that these embodiments may not be construed as limiting the scope of protection for the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIGS. 1A and 1B are schematic illustrations of base stations in a wireless access telecommunications infrastructure providing active cells and inactive cells;

FIG. 2 is a schematic illustration of a telecommunications infrastructure comprising a base station defining an active cell containing a plurality of terminals and a base station providing an inactive cell transmitting a presence signal;

FIG. 3 is a flow chart illustrating various steps of a method according to an embodiment of the invention;

FIG. 4 is a flow chart illustrating the information processing step in further detail;

FIGS. 5-8 are flow chart illustrating steps of a method for participation of idle terminals and

FIG. 9 is a schematic illustration of a wireless terminal configured for being operable in the telecommunication infrastructure of FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1A is a schematic illustration of base stations BS A – BS G in a wireless access telecommunications infrastructure providing a plurality of active cells. Each base station location comprises three sectors, thus covering an area around the

base station location. For example, cell A1 of base station location BS A serves its best server area marked ‘a1’. Similarly, cell A2 and A3 of the same location serve their best server area marked ‘a2’ and ‘a3’ respectively. A same set-up is shown for the other base station locations BS B to BS G. In FIG. 1A, the regular pattern of base stations and sectors leads to the commonly known hexagonal pattern of coverage areas.

FIG. 1B shows the same areas in a light grey colour. For example for energy saving reasons, some cells at base station locations B and C have been switched off and cell A1, together with some other cells (not shown) now provides service to some of BS B and BS C’s best server areas. In FIG. 1B, a darker gray shading illustrates that cell A1 provides service not only in its ‘own’ or ‘native’ area a1, but also in areas b2 and c3 and in part of the areas b3 and c2. Other cells may similarly have been switched off and service in their (‘native’) areas may be provided by one or more of the surrounding cells.

FIG. 2 is a schematic illustration of a wireless access telecommunications infrastructure 1 comprising a base station BS A defining an active cell A1 containing a plurality of active terminals Ta and idle terminals Ti. Base station BS B provides an inactive cell B1 wherein it transmits a presence signal P.

Telecommunications infrastructure 1 comprises a presence signal generator 2 for generating the presence signal P via interface 3. The telecommunications infrastructure 1 further comprises a receiver 4 configured for receiving reports from the plurality of terminals Ta, Ti detecting the presence signal P. A processor system 5 is configured for processing information contained in the reports received from the plurality of terminals Ta, Ti to provide a processing result. The processor system 5 has an activation module 6 configured for activating the inactive cell of BS B when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals Ta, Ti is within a coverage area of the activated cell B1 of base station BS B.

Various events may trigger the telecommunications system 1 to operate the method as illustrated in the flow chart of

FIG. 3. The method may be performed periodically or continuously, wherein generator 2 periodically or continuously generates the presence signal P in inactive cell B1. In at least some situations, it is advantageous to transmit the presence signal P concurrently by several related cells (rather than transmitting the presence signal P for separate cells, e.g. one-by-one). For example, in FIG. 1B, it may be advantageous to perform the method and evaluation concurrently for cells B3, B2, C3 and C2. A same or similar advantage may apply to cells which otherwise provide mutual coverage or are in close proximity of each other. Alternatively or in addition, the transmission of the presence signal P may be initiated by a predetermined condition in an active cell A1 verified by processing system 5, e.g. a traffic load exceeding a threshold or a traffic load showing a substantial increase.

The method as illustrated in the flow chart of FIG. 3 may be performed as follows. In step 3-I, a presence signal P is generated by generator 2 and transmitted in the at least one inactive cell of base station BS B. The plurality of terminals Ta, Ti in the active cell A1 (which are not necessarily all terminals in the active cell) detect and measure the presence signal P of the inactive cell B1 and gather information about the inactive cell (e.g. signal level/quality of presence signal P and cell identity of inactive cell B1). The information is reported to and received at the telecommunications network via the active cell A1 and receiver 4 (step 3-II). Alternatively, some of the information, in particular from idle terminals Ti, may be also reported via inactive cells, presuming these are configured for at least receiving such reports. The information received from the plurality of terminals Ta, Ti is processed in processing system 5 to provide a processing result (step 3-III). It should be appreciated that the information contained in some reports from some terminals need not be processed by processing system 5 and that processing system 5 may use additional information not received from the terminals (e.g. information typically available from a management system such as the location and configuration of the base stations etc.). The inactive cell B1

is activated in step 3-IV when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals Ta, Ti is within a coverage area of the activated cell B1.

FIG. 4 shows a flow chart exemplifying some steps of processing step 3-III in further detail. The telecommunications infrastructure 1 allows to take account of the distribution of terminals Ta and Ti in the active cell A1. The information obtained from the terminals Ta (such as measured signal level/quality or path loss) can be applied for energy reduction purposes. For example, if the analysis (e.g. based on the reported signal level measurements) reveals that a considerable number of active terminals Ta served by the active cell A1 finds themselves near the edge of the active cell A1 as shown in FIG. 2 and is transferable to inactive cell B1 (step 4-I), a reconfiguration of the network can be analysed (step 4-II) wherein the inactive cell B1 is activated (step 4-II). The activation condition wherein the total energy for the telecommunications infrastructure 1 can be reduced (step 4-III) may be fulfilled since the power reduction estimated to be obtained by transferring these terminals away from active cell A1 may be more than the power estimated to be required for an activated cell B1 and for serving these terminals by cell B1.

The analysis as depicted in FIG. 4 may also be used for increasing the energy consumption of the telecommunications network in an efficient manner. As an example, if the load in active cell A1 increases, at some point in time additional cells need to be activated. Reports from the active terminals Ta may indicate (e.g. from the signal levels / signal quality reported about the presence signal P of cell B1) that cell B1 is a suitable candidate for activation.

As an alternative or in addition, triggered reports from idle terminals Ti may be considered in the decision which cell is most suitably reactivated to alleviate the effects of the local traffic overload. Note that the number of idle terminals in a cell is usually much larger than the number of active terminals. Reports from such idle terminal typically indicate

the best cell as selected by each triggered idle terminal, choosing from both active and inactive cells that transmit a presence signal P. Counting for each inactive cell transmitting presence signal P how many idle terminals Ti (optionally: how many idle terminals that currently camp on the overloaded active cell) would prefer that inactive cell, provides an indication of the near-future traffic load that can be absorbed by the inactive cell when fully reactivated, thus relaxing the currently overloaded active cell from that (potential) 'burden'. Instead or along with the information on the active terminals Ta, the information on the idle terminals Ti can be considered in the decision process regarding which inactive cell to activate.

Several methods of triggering active user terminals Ta and idle terminals Ti to obtain information on the inactive cell(s) and to report this information will now be discussed in further detail.

Generally, the terminals may be provided with measurement and/or reporting parameters in order to control measurement and reporting operations by the terminals in the active cell A1. The parameters may e.g. be provided over a connection via the active cell to an active terminal Ta or broadcasted in the active cell A1 to active and idle terminals Ta, Ti using e.g. system information blocks SIB.

An active terminal Ta receives instructions from the network about which measurements to perform and which events to report to the network (e.g. the event that a neighbour inactive cell B1 is detected with a signal strength/quality that is better by x dB than that of the currently serving active cell A1). When a measurement leads to one of the specified events, the terminal Ta reports the relevant information (e.g. an identification of the detected neighbour inactive cell B1, its measured present signal level/quality and the measured signal level/quality of the active cell A1) over the existing connection to the telecommunications infrastructure 1. Either in response to a report from a terminal Ta or autonomously, the telecommunications infrastructure 1 may instruct the terminal Ta

to perform additional measurements of a same or different kind and to report the results.

Base station BS B may transmit a reporting identifier, hereinafter also referred to as 'probing flag', in the inactive cell B1. Active terminals Ta in the active cell A1 may receive the reporting identifier and transmit the reporting identifier with the report containing information regarding inactive cell B1. The active terminal Ta is thus configured to recognize the reporting identifier and to include this reporting identifier in the report containing the information on the inactive cell B1. This facilitates the processing system 5 of telecommunications infrastructure 1 to more easily distinguish between terminals Ta-ho (see FIG. 2) reporting in the context of a normal handover to another active cell (not shown in FIG. 2) and terminals Ta reporting information from the inactive cell B for assessing whether the inactive cell should be activated. An alternative for enabling the telecommunications infrastructure 1 to distinguish between reports relating to normal handovers and reports to be analyzed towards a decision whether to activate an inactive cell is to inform the base station BS A (or at least the associated entity normally handling the handover-related reports) of the identity of the inactive cells transmitting presence signals, such that reports related to an identity of an inactive cell can be excluded from being processed towards a handover decision and can be forwarded to processing system 5.

In order for idle terminals in active cell A1 to be triggered to obtain information about inactive neighbour cell B1, various parameters may be broadcasted in the active cell A1 in the system information block SIB for cell reselection. One example of such a parameter is an absolute signal level threshold Ts,search. This threshold is used by idle terminals as a reference for the received signal level Srxlev, measured by the terminals, from the active cell A1 and to decide if neighbour measurements for cell reselection are needed. Different values might be assigned to Ts,search for the measurement of intra-frequency, inter-frequency and inter-RAT neighbours. If Srxlev < Ts,search, the terminal will search for corresponding (intra-

frequency, inter-frequency or inter-RAT) neighbour cells and measure the received signal level Nrxlev and/or Nqual. Nrxlev is the received signal level of the presence signal from a neighbour cell, e.g. from the inactive cell B1. Nqual is the received signal quality from a neighbour cell, e.g. from inactive cell B1 (e.g. E_c/I_0 of the CPICH for UMTS cells or RSRQ of the reference symbols for LTE cells). Hysteresis parameter Qhyst for the active cell A1 and offset parameters Qoffset,n to be applied to each neighbour *n* specifically, can also be broadcasted in the active cell A1.

Next, exemplary methods will be discussed for instructing idle terminals Ti to perform measurements on inactive cells and to report this information to the telecommunications infrastructure 1.

In a first method, illustrated in the flow chart of FIG. 5, a location area update period (or a similar period) is decreased in the active cell A1 and the inactive cell B1. The embodiment is advantageous as it requires no modifications to currently existing networks.

In the active cell A1, in the system information (SIB) to be broadcast on the broadcast channel of the active cell A1, a relatively short value (e.g. 30 s, 1 min) is set for the periodic location area (LA) update (instead of a nominal value, e.g. 30 min, 1 hour, infinite). This is illustrated in step 5-I. A paging message may be issued in the cell A1 indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1.

As a consequence, an idle terminal Ti camping on the active cell A1 reads the modified SIB and starts providing frequent (e.g. every 30 s, 1 min) periodic LA updates. An LA Update message also includes information about the identity of the terminal. The telecommunications infrastructure 1 (more particularly processing system 5) receives the LA Update messages and may derive (e.g. every 30 s, 1 min) how many and which terminals Ti are currently camping on the active cell A1. This provides information about the initial situation regarding idle terminals in the active cell.

In step 5-II, the inactive cell(s) B1 set a periodic LA update value to a similarly short (e.g. 30 s, 1 min) value as used for the active cell A1. The presence signal P is transmitted in the inactive cell B1.

In the active cell A1, in the system information (SIB) to be broadcast on the broadcast channel of the cell, the absolute signal level threshold parameter Ts,search is set higher than nominal (e.g. nominal value +[5,10] dBm), step 5-III. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells B1. In the cell, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselection evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal Ti for which the received signal level of the active cell A1 is below the adjusted (increased) threshold Ts,search measures the neighbour cells, for example including inactive neighbour B1. For some RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active) neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell. The ranking mechanism may be dependent on the radio access technologies of the involved cells and possibly also on other conditions like environment characteristics. In the existing art it is for instance known that cell reselection in a network consisting of cells with different radio access technologies may be organised in a 2-step manner: For instance in a network consisting of both

UMTS (UTRAN) and GSM (GERAN) cells, first a ranking based on received signal level (Srxlev for the serving cell and Nrxlev for the neighbour cells) may be performed, taking account of corresponding Qhyst and Qoffset,n (noted as Qhyst(1) and Qoffset,n(1)). If the highest ranked cell is a GSM cell, the terminal will reselect to this cell. However, for the ranking of the UMTS cells, received signal quality (e.g. E_c/I_0) is a better indicator of the suitability of a cell for cell reselection. Therefore, if a UMTS cell is the highest ranked in the first step, a second step follows, in which the UMTS cells are ranked based on received signal quality, still taking Qhyst and Qoffset,n (noted as Qhyst(2) and Qoffset,n(2)) into account. The terminal then reselects to the highest ranked UMTS cell in this second ranking.

Similarly, for different combinations of RATs different ranking methods may be devised.

It is also known from the existing art that differences in certain geographical environments may be used to select a ranking mechanism form a set of implemented ranking mechanisms.

The remainder of this text is based on applying the example of cell-ranking based on received signal level. It should however be understood that also other cell ranking mechanisms can be applied.

An idle terminal Ti persisting to camping on the active cell A1 continues providing frequent LA Updates messages to the active cell A1. An idle terminal Ti which has reselected to an inactive cell B1 (which is assumed to be configured for frequent LA Updates as indicated above) will provide its frequent LA Update messages to the relevant inactive cell B1. An idle terminal Ti which has reselected another active cell will adhere to the LA Update regime as broadcast by that cell (which may be a nominal value, e.g. 30 min, 1 hour, etc.)

After a transitional period (whose length may depend on the duration of the cell reselection procedure and the LA Update period), the processing system 5 may derive in step 5-IV from the received LA Update messages how many and which idle terminals remain camped on the active cell, how many and which idle

terminals have reselected an inactive cell (and which cell) and how many and, possibly, which idle terminals have reselected from the active cell to other cells. This analysis provides an estimate about the situation regarding idle terminals Ti when each of the inactive cells B1 would be activated.

The information obtained from step 5-IV may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 5-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions. A paging message may be issued indicating modified system information. This paging message is also received by idle terminals still camping on the active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision obtained from the processing of step 5-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions. In these cells, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on any of the cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 5-V in FIG. 5 for both the active cell A1 and the activated cell B1.

Still further, after the decision obtained from the processing of step 5-IV, the inactive cells that are decided to be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped on such a cell will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read modified system information is RAT dependent.

In a second method, illustrated in the flow chart of FIG. 6, a location area update period (or a similar period) is decreased in the active cell A1 and a reporting identifier, also referred to here below as probing flag, is broadcast in the inactive cell B1 during a time interval.

The first step, indicated by 6-I, is equivalent to step 5-I in FIG. 5.

Different from the first method, the LA update period is not changed in the inactive cells B1. A reporting identifier is transmitted in the inactive cells B1 (step 6-II). The presence signal P, possibly including the probing flag, is transmitted in the inactive cells B1.

In the active cell A1, the absolute signal level threshold parameter Ts,search is set higher than nominal (e.g. nominal value +[5,10] dBm) in step 6-III and is broadcasted in the system information (SIB) on the broadcast channel of the cell. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells. A paging message may be issued indicating modified system information. This paging message is also received by idle terminals Ti camping on the cell. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselection evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal Ti for which the absolute received signal level of the active cell A1 is below the adjusted threshold Ts,search measures the neighbours. For some RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active)

neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell.

An idle terminal Ti persisting to camping on the active cell A1 continues providing frequent LA Updates messages to the active cell A1. An idle terminal Ti which reselects to an inactive cell B1 (the terminal Ti may detect this from the probing flag in the inactive cell's broadcast channel) is configured to, shortly after performing the reselection, send a LA Update message to the selected inactive cell B1. This first LA Update message is sent, regardless the setting of the LA Update period in the inactive cell B1. An idle terminal reporting a cell reselection to an inactive neighbour cell may be further configured to also report the presence of the probing flag in its LA Update message. This could ease bookkeeping at the processing system 5 regarding the neighbour state (inactive or active).

Different from the first method, the inactive cells B1 are configured with a nominal period for LA Updates. Consequently an idle terminal camping on an inactive cell provides (subsequent to the first LA Update message sent shortly after camping on a cell with its probing flag set) only nominal LA Update messages (e.g. 30 min, 1 hour, etc.) to the cell. An idle terminal Ti which has reselected another active cell will adhere to the LA Update regime as broadcast by that cell (which may be a nominal value, e.g. 30 min, 1 hour, etc.).

After of transitional period (whose length may depend on the duration of the cell reselection procedure and the selected LA Update period in the cell A1), the telecommunications infrastructure 1 (more specifically, the processing system 5) may derive from the received LA Update messages how many and which idle terminals remain camped on the active cell A1, how many and which idle terminals Ti have reselected an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals have reselected from the active cell A1 to other cells. This provides an estimate about the situation regarding

idle terminals when each of the inactive cells B1 will be activated (step 6-IV).

It should be noted that in the second method, the LA area update messages used to obtain the processing result are reported to the inactive cell B1 (and then via interface 3 to processing system 5, see FIG. 2).

In order to decrease the burden on the inactive cell B1, a first alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, does not perform cell reselection to that cell as long as it has its probing flag set; it sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on (see the box beside 6-IV in FIG. 6). Different from the first method illustrated in FIG. 5, and different from the second method's basis described above, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, an inactive cell in this first alternative needs not to support reception of LA Update messages as described above. Also different from the first method illustrated in FIG. 5, an idle terminal Ti in this first alternative of the second method does not reselect to an inactive cell (comparable to active terminals Ta not being handed over to inactive cell B1).

A second alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, first sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on and only subsequently performs cell reselection to the best cell (see the box beside 6-IV in FIG. 6). Different from the first method illustrated in FIG. 5, and different from the second method's basis described above, terminals Ti will send their reports via active cell A1, instead of via

inactive cell B1. Thus, again, an inactive cell needs not to support reception of LA Update messages.

Different from the first method, the inactive cells are configured with a nominal period for LA Updates. In this case, to prevent that LA Updates are sent to the inactive cell, the inactive cell may be configured with an infinite LA Update period during the period(s) wherein the presence signal P is transmitted in the inactive cell.

The information obtained from step 6-IV (and possibly step 6-I) may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 6-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions. A paging message may be issued indicating modified system information. This paging message is also received by idle terminals still camping on the original active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision in step 6-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions including removal of the probing flag. This system information modification may, but not necessarily needs be announced in the activated cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 6-V, including a reset to the nominal LA update value for cell A1 and to remove the probing flag in activated cell(s) B1 in FIG. 6.

Still further, after the decision obtained from the processing of step 6-IV, the inactive cells that are decided to be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped on such a cell will perform cell selection and find a suitable

cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read system information is RAT dependent.

In a third method, illustrated in the flow chart of FIG. 7, the reporting identifier, also referred to as probing flag, is broadcasted in both the active cell A1 and the inactive cell B1. This third method does not rely on frequent periodic LA updates.

In step 7-I, the system information (SIB) to be broadcasted on the broadcast channel of the active cell A1 comprises a probing flag. In the active cell, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1.

An idle terminal Ti, detecting the probing flag, is configured (see FIG. 9) to report information about its identity (e.g. IMSI) and best cell (in this case, likely the active cell A1) to the cell it camps on. The information about the cell identity is not necessarily included in the report but may be added by the cell via which the report is sent. The report is sent once, on first detection of the probing flag being set. It is an option that an idle terminal Ti which has reselected another active cell will not send a report, which would prevent unnecessary reports to be received in other active cells. The telecommunications infrastructure (more precisely the processing system 5) receives the reports and may derive how many and which terminals Ti are currently camping on the active cell. This provides the information about the situation regarding idle terminals before the probing period starts.

Then, in step 7-II, a probing flag is also transmitted in the inactive cell(s) B1 and the presence signal P is transmitted as well.

In the active cell A1, the absolute signal level threshold Ts,search parameter is set higher than nominal (e.g.

nominal value +[5,10] dBm) and in step 7-III is broadcast in the system information (SIB) on the broadcast channel of the cell. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells. A paging message may be issued indicating modified system information. This paging message is also received by idle terminals Ti camping on the cell. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselection evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal for which the absolute received signal level of the active cell A1 is below the adjusted threshold Ts,search measures the neighbours. For some RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active) neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell.

An idle terminal persisting to camping on the active cell A1 sends a report as described above for step 7-I regarding the active cell A1 to the active cell A1. An idle terminal Ti which reselects to an inactive cell (the terminal may detect this from the probing flag in the inactive cell's broadcast channel) is configured to, shortly after performing the reselection, send a report as described for step 7-I to the selected inactive cell (see FIG. 9). The report is sent once, on first detection of the probing flag being set in the cell it is camped on and to the cell it is camped on. It is an option that an idle terminal which has reselected another active cell will not send a report, which would prevent unnecessary reports to be received in other active cells. An idle terminal reporting a cell rese-

lection to an inactive neighbour cell may be further configured to also report the presence of the probing flag in its report. This could ease bookkeeping at the processing system 5 regarding the neighbour state (probing or nominal).

After a transitional period (whose length may depend on the duration of the cell reselection procedure and time to send the associated reports), the telecommunications infrastructure 1 (more precisely, the processing system 5) may derive from the received reports how many and which idle terminals remain camped on the active cell A1, how many and which idle terminals have reselected an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals have reselected from the active cell to other cells. This provides an estimate about the situation regarding idle terminals when each of the inactive cells B1 will be activated.

Again, in order to decrease the burden on the inactive cell B1, a first alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, does not perform cell reselection to that cell as long as it has its probing flag set, yet may remain camping on such a cell; it sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on (see the box beside 7-IV in FIG. 7). Comparable to the second method's first alternative, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, an inactive cell in this first alternative needs not to support reception of reports as described above.

A second alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, first sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on and only subsequently performs cell reselection to the best cell (see the box beside 7-IV in FIG. 7).

Comparable to the second method's second alternative, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, again, an inactive cell B1 needs not to support reception of reports as described above.

The information obtained from step 7-IV (and possibly step 7-I) may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 7-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions (which also includes removal of the probing flag). A paging message may be issued indicating modified system information. This paging message is also received by idle terminals still camping on the original active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision in step 7-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions including removal of the probing flag. This system information modification may, but not necessarily needs be announced in the activated cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 7-V including a removal of the probing flags in active cell A1 and activated cell(s) B1.

Still further, after the decision obtained from the processing of step 7-IV, the inactive cells that are decided to be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped on such a cell will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read system information is RAT dependent.

Finally, in a fourth method, illustrated in the flow chart of FIG. 8, a measurement-and-report paging message, hereinafter denoted as paging message, is transmitted in the active cell A1 instructing the idle terminals Ti to obtain and report information on the inactive cells B1. The idle terminals Ti listen to broadcast and paging channels and can be triggered, using these channel(s), to obtain information on the inactive cells B1. The method may be combined with probing flags transmitted in the inactive cells.

In a first optional step 8-I, a paging message is transmitted in the active cell A1. The paging message may optionally comprise configuration parameters (see below), which configuration parameters are to be applied by the idle terminal Ti.

In response to step 8-I, an idle terminal receiving the paging message is configured (see FIG. 9) to perform measurements on the serving cell (in this case the active cell A1) and on its neighbour cells, regardless the criterion settings for initiating a search (such as parameter Ts,search), and to subsequently send a report, by default to the cell that issued the paging message (in this case the active cell A1). After sending the report, a cell reselection may be performed. The idle terminal can be configured to not performing cell reselection as long as the highest-ranked cell has the probing flag set (comparable to the first alternative of the second or third method).

As indicated above, the paging message may optionally comprise configuration parameters. Examples are parameters that further specify the measurements to be made (which terminals should measure, which cell(s) to be measured, which RAT to be measured, which characteristics, etc.), parameters that further specify the subsequent reselection (such as offset or hysteresis parameters) and parameters that further specify the report to be provided (whether or not to provide a report, how many of the best cells to be reported, which quantities – e.g. signal lev-

el/quality, path loss estimates – to be reported, destination of the report, etc.). The paging parameters may alternatively or in addition, include a reference where the (further) parameters may be obtained, e.g. a reference (link) to a broadcast channel or the like, for example when the set of parameters is impractically large to be sent in the paging message itself.

A terminal receiving configuration parameter values in (or associated with) the paging message applies the received values when performing the measurements, the cell reselection procedure and the reporting as commanded by the paging message. It may be that in case of a conflict with an existing parameter having been assigned a value, the value received in the paging message is only applied for the measurements etc. related to the present method. Other procedures continue to apply the already assigned value and are not affected by the value in the paging message.

The reported information includes at least an indication about the terminal identity (e.g. IMSI) and about the identity of the best cell. The report is sent once, on detection of the paging message, and by default (unless instructed otherwise) to the cell that issued the paging message, regardless the cell reselection that may be the result of the search.

The telecommunications infrastructure 1 (more precisely, the processing system 5) receives the reports and may derive how many and which terminals were camping on the active cell A1 and received the paging message and also may derive how many and which terminals are likely to remain camping on the active cell A1 after the paging message. This provides the information about the situation regarding idle terminals before the probing period starts.

Step 8-I is an optional step that may e.g. be omitted if the processing system 5 has no particular interest in obtaining information about the situation regarding idle terminals Ti in the active cell A1 before the start of transmitting the presence signal P in the inactive cell(s) B1.

Step 8-II involves the transmission of the presence signal P in the inactive cell(s). A probing flag may also be

transmitted. Optionally, one or more of the inactive cells may be configured with system information parameters different from the normal operating conditions, e.g. values set specifically for the method.

Optionally, as described for previous methods illustrated in FIGS. 5-7, the active cell A1 may be configured with system information parameters different from the normal operating conditions, e.g. values set specifically for the probing phase. It is, however, envisaged that the possibility to specify configuration parameters in (or associated with) the paging message, has advantages over making temporary modifications to system information parameters.

In step 8-III, again a paging message is transmitted in the active cell A1. The paging message may optionally comprise configuration parameters as described above. The values of these parameters may be different from those in the paging message optionally transmitted in step 8-I in active cell A1.

In order to decrease the load of reports, the paging message may also instruct only a fraction f of the idle terminals Ti in the active cell A1 to perform measurements and to provide a report. Mechanisms, such a paging groups, can be used to address or to instruct a particular fraction f (subset) of the idle terminals Ti. A fraction f of the idle terminals may also be established by configuring the idle terminal Ti to, randomly or deterministically determined, only provide the requested reports for a fraction f of the requests.

In response to step 8-III, an idle terminal receiving a paging message is configured to perform measurements on the serving cell (in this case the active cell A1) and on its neighbour cells, regardless the criterion settings for initiating a search, and to subsequently send a report (in this case to the default which is the cell that issued the paging message, i.e. active cell A1). The report is sent once, on detection of the paging message. After sending the report a cell reselection may be performed. The idle terminal can be configured to not performing cell reselection as long as the highest-ranked cell has the probing flag set.

The report includes at least an indication about the identity of the best cell and preferably an indication about the terminal identity (e.g. IMSI). The report may additionally include the status of the probing flag, if any, of the reported best cell.

The telecommunications infrastructure 1 (or more precisely, the processing system 5) receives the reports and may derive from the received reports how many and which idle terminals are likely to remain camped on the active cell, how many and which idle terminals are likely to reselect to an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals are likely to reselect to another cell (and which other cell). This provides an estimate about the situation regarding idle terminals when each of the inactive cells will be activated (step 8-IV).

The information obtained from step 8-IV (and possibly step 8-I, when performed) may be taken into account in the evaluation by the telecommunications infrastructure 1 (more precisely processing system 5) about which of the inactive cells to activate and which not.

If the system information of the active cell A1 has been set differently for the execution of the method than during normal operating conditions, then the system information for the active cell may be reverted back to normal operating conditions (not shown in FIG. 8).

If the inactive cell B1 is activated the following applies. If a probing flag was set, the probing flag may be removed. This system information change need not be announced by a paging message in the relevant cell(s). If the system information of the inactive cell has been set differently for the probing phase than during normal operating conditions, then the system information for the cell may be reverted back to normal operating conditions. If a probing flag was not set, an idle terminal camped there, will remain camped there.

If the inactive cell B1 is decided to not be activated, it may be switched off. If a probing flag was not set in the cell, an idle terminal camped there will perform cell selection

and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells, possibly reselecting another neighbour cell).

A paging message may be transmitted again after activating inactive cells wherein a probing flag was transmitted. In this case a primary objective is to actually let an idle terminal camped on the active cell A1 perform a reselection to one of the activated neighbour cells B1, when such reselection is still applicable. The processing system 5 may choose to either ignore the reports or to process the reports to assess the final configuration or to have it confirmed. If the system has no interest in assessing / confirming the final configuration, this paging message may advantageously specify a configuration parameter indicating that no reports are to be sent.

In some of the methods and alternatives for triggering idle terminals Ti as described above, it may occur that an idle terminal Ti which camps on an inactive cell B1 initiates a session (e.g. initiates a voice or a data call). There are various ways to handle this situation.

When the inactive cell, despite its 'inactive' status, is to a sufficiently large extent operational, it may choose to accept the request and to support the call in the normal way, at least temporarily. Subsequently, the inactive cell may attempt to handover the call to an active cell; alternatively it may continue serving the call until a decision has been taken about the activation (or not) of that cell. If activated, it may continue to serve the call as an active cell; if not activated, it may handover the call to an active cell before the inactive cell is switched off.

When the inactive cell has insufficient capabilities to accept and/or support a call, or when it is otherwise undesirable to do so, the inactive cell may deny the call request. Various wireless access technologies provide a mechanism to elegantly and quickly refer a refused caller to an alternative, e.g. 'directed retry'. In that case, the inactive cell only needs to support the corresponding signalling.

Finally, note that by using a probing flag in an inactive cell and by using an idle terminal configured to not actually reselect to or camp on a cell which has its probing flag set (also see the first alternative of the second and third method and see the fourth method), it can be prevented that idle terminals actually camp on an inactive cell.

In each of the above methods, the process of counting how many idle terminals will perform cell reselection may use a hysteresis Qhyst in the terminal for the measurement result.

Similarly, a neighbour-specific offset Qoffset,n can be applied to (e.g. added to) the measurement result in the terminal. By means of these cell-specific offsets a cell may be either be promoted or demoted in the ranking of cells for cell reselection.

In the above-described methods, conditions for cell reselection have been frequently addressed. In addition to these conditions, there may be various other conditions that determine whether a cell is suitable to be camped on by the idle terminal. It is assumed that all inactive neighbours are classified as a 'suitable cell', e.g. their Nrxlev and Nqual are sufficiently high to consider them for camping. It is also assumed that suitable averaging is applied to the measurements. Additionally, it is assumed that a (minimum) period is taken into account for which a highest-ranked cell has to be different from the current (active) cell before actually performing a cell reselection. This minimum period (timer) may also broadcasted via the broadcast channel of the cell in the same SIB.

For the measurement of inter-frequency or inter-RAT neighbour cells, active terminals Ta need some (measurement) time gaps to carry out the measurement. This might be managed by using the idle period provided by discontinuous reception (DRX) or radio resource scheduling. One example is the so called "compressed mode" in UMTS networks, where the data rate (and also transmit power) is temporarilly doubled, so the data can be sent twice as fast and the resulting time gap could be used for inter-frequency of inter-RAT measurement.

Whereas the disclosed method and telecommunications infrastructure use existing measurement and reporting capabilities of wireless terminals, in at least some of the above-described embodiments the capabilities of wireless terminals should be adapted to participate in these embodiments. Examples have been indicated above and include the recognition, processing and actions performed for cell reselection, in response to the reporting identifier (probing flag) and/or the measurement-and-reporting paging message of the above-described fourth method. Most of these enhanced capabilities will be obtained by software modifications in the wireless terminals. Therefore, FIG. 9 is a highly schematic illustration of a wireless terminal T comprising storage S and processor uP configured for storing and operating the modified software. For a base station BS A, BS B similar considerations apply.

Other network elements and signalling may also be affected, depending on how and where the modules 2~6 (as shown in Fig.2) are deployed. One option is that the modules are deployed in a centralized fashion in the operation and management centre (OMC), the main impact may then be to the signalling messages that are carried between the OMC and base stations BS A and BS B.

Another option is that the modules are deployed in a distributed fashion in the radio network, e.g. in RNC (Radio Network Controller) of UMTS or eNodeB (LTE term for base station) of LTE. Then, additional signalling between these network nodes is required. For example, if BS A is an UMTS base station and BS B is an LTE base station, additional signalling between RNC and eNodeB is required for the purpose of this invention.

CLAIMS

1. A method for activating at least one inactive cell in a wireless telecommunications infrastructure, the telecommunications infrastructure comprising an active cell containing a plurality of terminals, the method comprising the steps of:

- transmitting a presence signal in the at least one inactive cell;
- receiving reports from the plurality of terminals detecting the presence signal;
- processing information contained in the reports received from the plurality of terminals in a processing system of the telecommunications infrastructure to provide a processing result; and
- activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

2. The method according to claim 1, further comprising the steps of:

- terminating transmission of the presence signal in the at least one inactive cell when the processed information does not fulfil the at least one activation condition
- transmitting the presence signal in the at least one inactive cell again at a later time.

3. The method according to claim 1 or 2, further comprising the step of providing the terminals in the active cell with measurement parameters and/or reporting parameters to obtain the information regarding the presence signal from the inactive cell.

4. The method according to one or more of the preceding claims, wherein the telecommunications infrastructure contains a plurality of inactive cells, the method comprising

CLAIMS

1. A method for activating at least one inactive cell in a wireless telecommunications infrastructure, the telecommunications infrastructure comprising an active cell containing a plurality of terminals, the method comprising the steps of:

- transmitting a presence signal in the at least one inactive cell;
- receiving reports from the plurality of terminals detecting the presence signal;
- processing information contained in the reports received from the plurality of terminals in a processing system of the telecommunications infrastructure to provide a processing result; and
- activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

2. The method according to claim 1, further comprising the steps of:

- terminating transmission of the presence signal in the at least one inactive cell when the processed information does not fulfil the at least one activation condition
- transmitting the presence signal in the at least one inactive cell again at a later time.

3. The method according to claim 1 or 2, further comprising the step of providing the terminals in the active cell with measurement parameters and/or reporting parameters to obtain the information regarding the presence signal from the inactive cell.

4. The method according to one or more of the preceding claims, wherein the telecommunications infrastructure contains a plurality of inactive cells, the method comprising

the step of concurrently or sequentially transmitting the presence signal in the plurality of inactive cells

5. The method according to one or more of the preceding claims, wherein the at least one activation condition includes at least one of energy reduction for the telecommunications infrastructure, load reduction for the active cell or reduction of electromagnetic radiation from the telecommunications infrastructure or from a particular set of cells in the infrastructure.

6. The method according to one or more of the preceding claims, comprising the step of transmitting a reporting identifier in at least one of the active cell and the inactive cell.

7. The method according to one or more of the preceding claims, wherein at least some of the plurality of terminals in the active cell are idle terminals when gathering information for the report.

8. The method according to claim 7, further comprising the step of temporarily decreasing a location area update period in at least one of the active cell and the inactive cell.

9. The method according to claim 7 or 8, wherein the reports are received via the active cell.

10. The method according to claim 7, further comprising the step of transmitting a paging message in the active cell instructing the idle terminals to obtain and/or report the information.

11. A computer program comprising software code portions configured, when executed on one or more processing units, to perform the method according to one more of the claims 1-10.

12. A wireless access telecommunications infrastructure comprising an active cell and at least one inactive cell,

the active cell containing a plurality of terminals, wherein the infrastructure comprises:

- a presence signal generator configured for transmitting a presence signal in the at least one inactive cell;
- a receiver configured for receiving reports from the plurality of terminals detecting the presence signal;
- a processor system configured for processing information contained in the reports received from the plurality of terminals to provide a processing result; and
- an activator configured for activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

13. The wireless access telecommunications infrastructure configured for performing the method according to one or more of the claims 1-10.

14. A signal transmitted in a cell of the wireless access telecommunication of claim 12 or 13, wherein the signal contains a reporting identifier indicating that the cell is an inactive cell.

15. A terminal configured for operating in the wireless access telecommunications infrastructure of claim 12 or 13 and for processing the signal according to claim 14 or operating in the method according to claim 10.

ABSTRACT

The invention relates to a method for activating at least one inactive cell in a wireless telecommunications infrastructure. The telecommunications infrastructure comprises an active cell containing a plurality of terminals. A presence signal is transmitted in the at least one inactive cell. The plurality of terminals in the active cell detect the presence signal(s) of the one or more inactive cells to gather information from the inactive cell. The information is reported to and received at the telecommunications infrastructure. The information received from the plurality of terminals is processed in a processing system of the telecommunications infrastructure to provide a processing result. The inactive cell is activated when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

+ FIG. 3

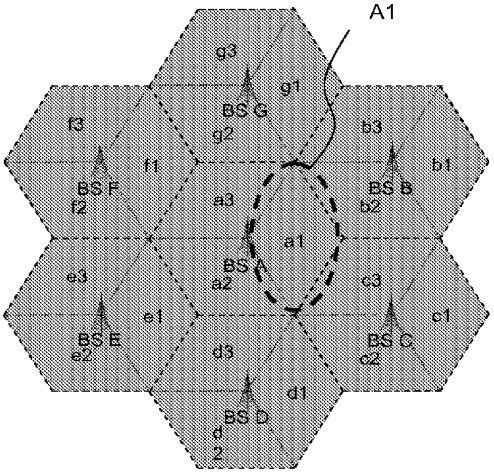

FIG. 1A

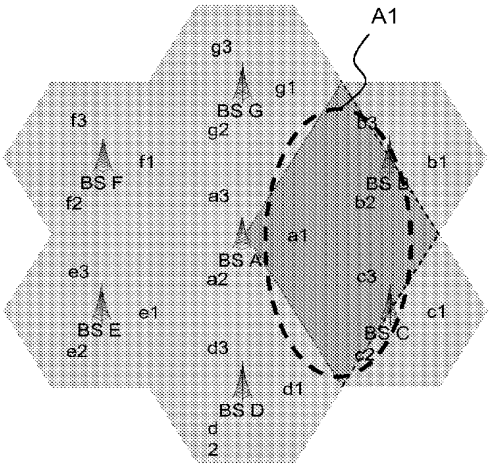

FIG. 1B

1/6

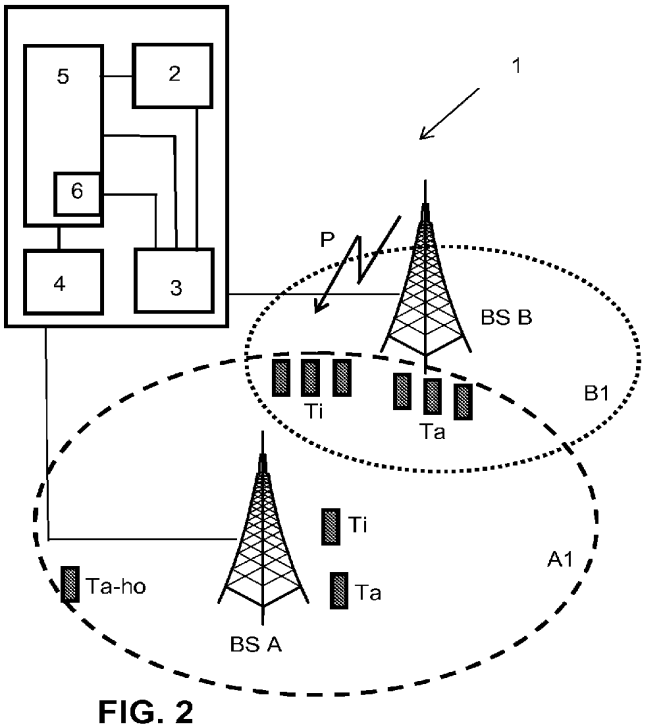
5
2
1
6
P
4
3
BS B
B1
Ti
Ta
Ti
A1
Ta-ho
Ta
BS A

FIG. 2

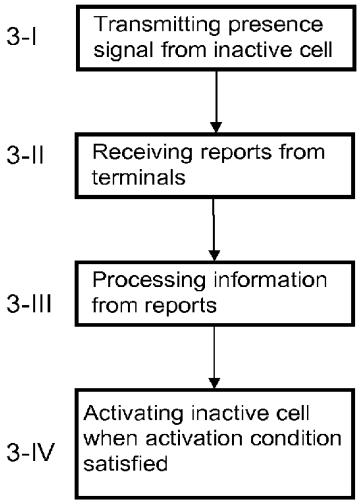
3-I
Transmitting presence signal from inactive cell
3-II
Receiving reports from terminals
3-III
Processing information from reports
3-IV
Activating inactive cell when activation condition satisfied

FIG. 3

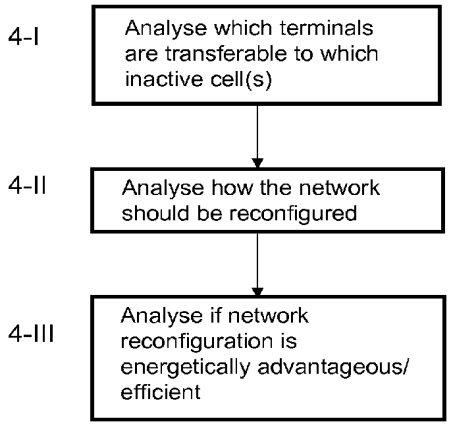
4-I
Analyse which terminals are transferable to which inactive cell(s)
4-II
Analyse how the network should be reconfigured
4-III
Analyse if network reconfiguration is energetically advantageous/ efficient

FIG. 4

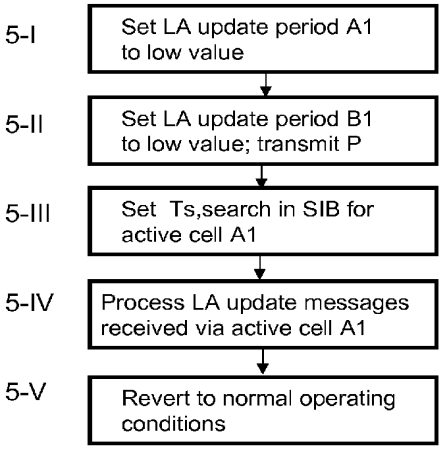
5-I
Set LA update period A1 to low value
5-II
Set LA update period B1 to low value; transmit P
5-III
Set Ts,search in SIB for active cell A1
5-IV
Process LA update messages received via active cell A1
5-V
Revert to normal operating conditions

FIG. 5

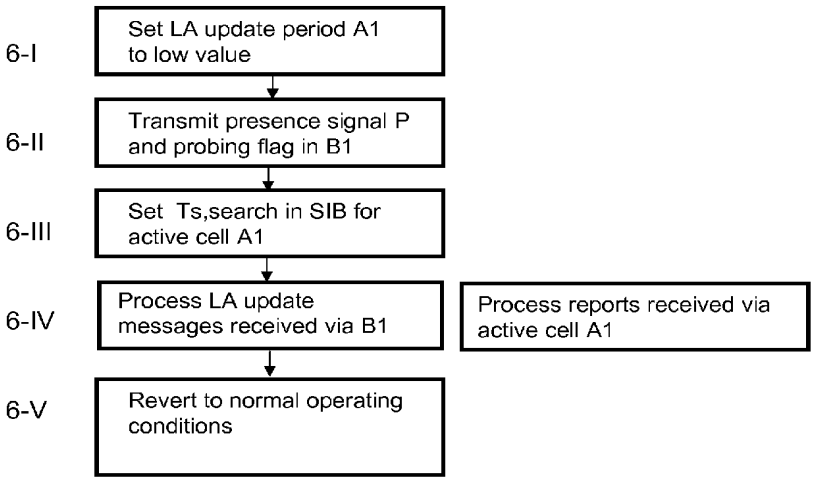
6-I
Set LA update period A1 to low value
6-II
Transmit presence signal P and probing flag in B1
6-III
Set Ts,search in SIB for active cell A1
6-IV
Process LA update messages received via B1
Process reports received via active cell A1
6-V
Revert to normal operating conditions

FIG. 6

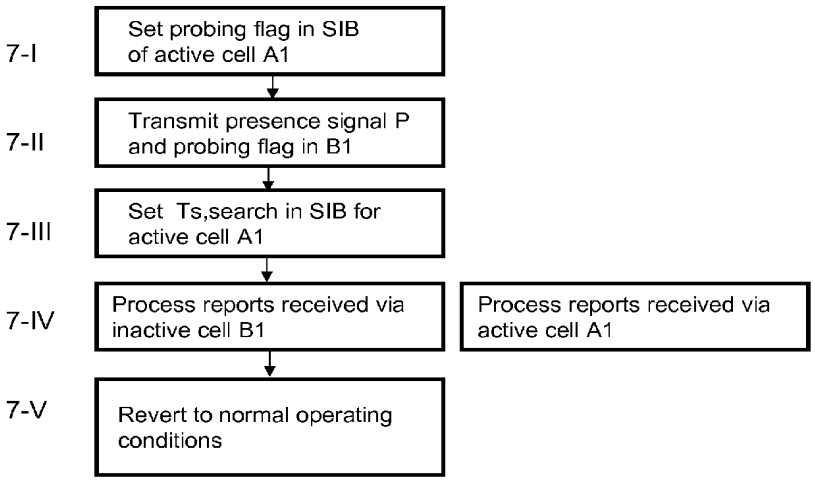
7-I
Set probing flag in SIB of active cell A1
7-II
Transmit presence signal P and probing flag in B1
7-III
Set Ts,search in SIB for active cell A1
7-IV
Process reports received via inactive cell B1
Process reports received via active cell A1
7-V
Revert to normal operating conditions

FIG. 7

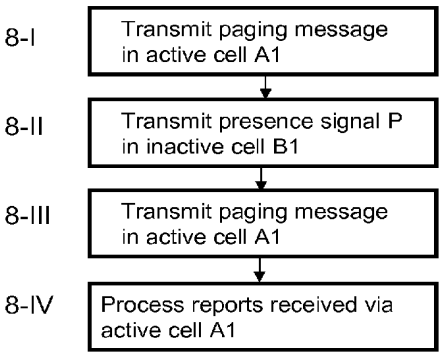

FIG. 8

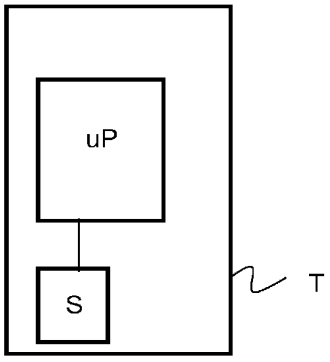

FIG. 9

ERICSSON EXHIBIT 1002, Page 406

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INTELLECTUAL PROPERTY
ORGANIZATION

DOCUMENT MADE AVAILABLE UNDER THE PATENT COOPERATION TREATY (PCT)

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International filing date:		**04 May 2011 (04.05.2011)**
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Document details:	Country/Office:	**EP**
	Number:	**10187119.2**
	Filing date:	**11 October 2010 (11.10.2010)**
Date of receipt at the International Bureau:		**06 June 2011 (06.06.2011)**

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a),(b) or (b-*bis*)

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The organization code and number of your priority application, to be used for filing abroad under the Paris Convention, is EP10196958.

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le President de l'Office européen des brevets
p.o.

R.C. van Dijk

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Method and telecommunications infrastructure for activating an inactive cell

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Method and telecommunications infrastructure for activating an inactive cell

FIELD OF THE INVENTION

The invention relates to the field of telecommunications infrastructures. More specifically, the invention relates to the field of activating inactive cells of a telecommunications infrastructure for purposes such as controlling energy consumption and electromagnetic radiation, particularly reducing energy consumption or electromagnetic radiation.

BACKGROUND OF THE INVENTION

The operation of wireless access networks for enabling wireless communication is highly energy consuming. In view of current environmental concerns, increased attention is paid recently to the energy consumption of telecommunications networks.

Various studies have been performed to reduce conventional energy consumption in wireless access networks, e.g. by exploring the option of using sustainable energy sources (Ericsson AB White Paper "Sustainable energy use in mobile communications, June 2007).

With the development of the 3GGP Long Term Evolution (LTE) network, energy saving for the network is also approached in the context of self organizing networks (SON). In a White Paper of NEC, dated February 2009, "NEC's proposals for next-generation radio network management", energy is considered as a significant part of the operation expenses of a cellular network. It is recognized that the main saving potential resides in using variations in load over time, that allows to switch off parts of the resources, for example during the night. When a complete base station is switched off, other base stations of the access network need to make up for the reduction in coverage area and capacity. This requires coordination between the nodes. A similar use case is described in 3GGP TR 36.902 v9.1.0 "Self-

configuring and self-optimizing network(SON) use cases and solutions".

Once base stations (or one or more cells thereof) have been deactivated, at some point in time these base stations (or cells) may have to be reactivated again. Thus, a decision is required when and/or which base stations or cells need to be activated.

A first solution would be to activate the base stations or cells at a predetermined time. As an example, it can be imagined that fewer base stations need to be active during night time and more base stations need to be active during the day.

Another solution would be to activate all inactive cells adjacent to (i.e. relevant for) a currently active cell when the currently active cell detects a certain traffic load exceeding a threshold or detects a rising traffic load.

There is a need in the art to improve these solutions by determining more accurately which base stations and/or cells should be activated.

SUMMARY OF THE INVENTION

A method for activating at least one inactive cell in a wireless telecommunications infrastructure is disclosed. The telecommunications infrastructure comprises an active cell containing a plurality of terminals. A presence signal is transmitted in the at least one inactive cell. The plurality of terminals in the active cell (which are not necessarily all terminals in the active cell) detect the presence signal(s) of the one or more inactive cells to gather information about the inactive cell. The information is reported to and received at the telecommunications infrastructure. The information received from the plurality of terminals is processed in a processing system of the telecommunications infrastructure to provide a processing result. It should be appreciated that the information contained in some reports from some terminals need not necessarily be processed. The inactive cell is activated when the processing result fulfils at least one activation condition such that at

least one of the plurality of terminals is within a coverage area of the activated cell.

Capabilities of terminals to gather information about a cell (e.g. to measure a signal transmitted by a cell) and to report such information are known in the art, for example to gather information about a neighbour cell in order to consider a handover to a neighbour cell. Examples for LTE include measuring and reporting Reference Signal Received Power (RSRP) and Reference Signal Received Quality (RSRQ). Also see 3GPP TS 37.320 "Radio measurement collection for Minimization of Drive Tests (MDT)". Examples for UMTS include measuring and reporting Received Signal Code Power (RSCP) and a quantity indicated as Ec/Io. For other technologies comparable quantities have been defined.

Processing information received from terminals may also include combining the received information with other information available to the infrastructure, such as the number of (failed) handover requests to an inactive cell, the number of (rejected) session requests from terminals trying to connect to an inactive cell, the positions of (some of) the terminals, the current load in an active cell, history or statistics of the history of the load in a cell, the location of a cell and the typical coverage area of a cell when active.

Receiving and processing information may continue e.g. until an activation condition has been fulfilled, or until a predetermined time has elapsed (e.g. since commencing to transmit a presence signal in an inactive cell) while an activation condition is not fulfilled, or until substantially no more additional information is received in relation to the transmission of a presence signal while an activation condition is not fulfilled. It should be appreciated that gathering adequate information about an inactive cell transmitting a presence signal may take some time, depending for example on how quickly a terminal may be informed about the measurements to be performed, on the type and duration of measurements to be performed (which may include performing signal strength and/or signal quality measurements on an inactive cell's presence signal, performing

handover evaluations, cell reselections and location area updates), on the way a terminal is able to perform the requested functions, on the complexity and number of reports a terminal may prepare, on the way the telecommunication infrastructure may receive the reports, on the type and number of reports and/or events to be received, on the fraction of the reports that include location information and on the accuracy of the location information, etc. The time period from commencing to transmit a presence signal in an inactive cell to the moment a decision is taken on whether or not to activate the inactive cell may be referred to as a 'probing period'.

Fulfilling an activation condition may be that the processing result indicates, for example, that the number of terminals which are estimated to be in the best server area of an inactive cell, when activated, is above a predetermined number of terminals or is above a predetermined fraction of the terminals currently served by one or more active cells, or that the load (expressed e.g. in the number of calls or in an aggregated bit rate or in another load measure) that is estimated to be absorbed by an inactive cell, when activated, is above a predetermined load measure.

A computer program containing software code portions (possibly distributed over several components in the telecommunications infrastructure) for performing the method when executed by a processing system is also disclosed.

A wireless access telecommunications infrastructure comprising an active cell and at least one inactive cell is also disclosed. The active cell can contain a plurality of terminals is also disclosed. The infrastructure comprises a presence signal generator configured for generating a presence signal to be transmitted in the at least one inactive cell. The infrastructure further comprises a receiver configured for receiving reports from the plurality of terminals detecting the presence signal and a processor system configured for processing information contained in the reports received from the plurality of terminals to provide a processing result. The processing system may be part of the telecommunications infrastructure or be

(partly) connected to the telecommunications infrastructure in which case the processing system is considered part of the telecommunications infrastructure. The infrastructure further comprises an activator configured for activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell. By using the (partly) existing capabilities of terminals to measure and report information received from neighbouring cells (typically applied for e.g. handover operations), the transmission of the presence signal in the currently inactive cell enables the telecommunications infrastructure to assess whether the terminals recognize this cell as an appropriate target, i.e. whether the terminals currently connected to or camping on the active cell are likely able to be connected to or camp on a currently inactive cell. The telecommunications infrastructure is configured to receive and process the information relating to the inactive cell(s) from the reports of various terminals within the active cell (possibly, but not necessarily, all terminals in the active cell). The reported information, possibly combined with other information available to the infrastructure, forms the basis to decide whether or not to actually activate the currently inactive cell (i.e. to change the network configuration of the telecommunications infrastructure) in order for the terminal to connect to or camp on the activated cell via a handover operation or cell reselection, respectively.

The information can be used by an energy evaluation algorithm for determining whether energy consumption of the telecommunications infrastructure can be reduced or used in an efficient manner, e.g. by efficiently controlling activation of cells in the telecommunications infrastructure if required.

The method and telecommunications infrastructure may, in addition or alternatively, also be applied for other purposes. As an example, similar considerations apply to the reduction of electromagnetic radiation produced by a base station. For example, for health reasons it is advisable to limit the amount and duration of electromagnetic radiation to a level

that is strictly necessary for the operation of the base station. When the level of electromagnetic radiation can be reduced or when a base station can be switched off, this may be well-appreciated by the population in the vicinity of the base station. Considerations may either apply to the complete telecommunications infrastructure or to a part of the infrastructure, e.g. for a plurality of cells. For example, heavily populated areas may be selected to have low electromagnetic radiation density, whereas in less densely populated areas, the electromagnetic radiation levels can be higher. In addition to health concerns, there may also be technical reasons to restrict the electromagnetic radiation, and therewith the possibility and level of interference experienced in adjacent areas.

It should be appreciated that the active cell and inactive cell may relate to any type of radio access technology (RAT) including, but not limited to GSM, UMTS, LTE, Wimax etc.

It should further be appreciated that the measurements for information on the inactive cell(s) of terminals in the active cell may relate to a single radio access technology (intra-RAT) or multiple different radio access technologies (inter-RAT). An example of inter-RAT includes a terminal in an active UMTS cell performing measurements on an inactive GSM cell.

The method and telecommunications infrastructure also allow taking account of the distribution of terminals in the active cell. For example, if the analysis reveals that a considerable number of terminals served by the active cell finds themselves near the edge of the active cell (i.e. the reported measurement information indicates a high signal level or signal quality for the presence signal of neighbouring inactive cells and much lower levels for the active cell for a considerable number of terminals), the total energy for the telecommunications infrastructure may be reduced by activating one or more inactive cells and hand over these terminals to these cells.

In the present application, an active cell is considered a cell enabling connection of a terminal to the base station responsible for the cell. In other words, the cell is fully operational.

An inactive cell is considered a cell that is not intended to carry any voice or data traffic but may transmit a presence signal during particular time intervals or continuously. A presence signal may comprise a beacon signal, such as BCCH in GSM network, CPICH in UMTS network or reference symbols in LTE in order to indicate the presence of the cell. In addition, the inactive cell may at least transmit some system information (e.g. cell identity, power level of its beacon signal, etc.), for example on a broadcast signal (BCH) containing system information blocks (MIB, SIB, etc.), depending on its level of functionality. A presence signal may also include a synchronization channel (SCH), commonly used in mobile communication systems such as GSM, UMTS and LTE, for cell search, for identifying a cell and for synchronization with a cell. An inactive cell may, during a probing period transmit a presence signal, for example reference symbols in LTE or CPICH in UMTS, synchronisation signal (SCH) and broadcast signal (BCH) containing system information blocks (MIB, SIB, etc) while not accepting any 'normal' traffic, such as voice or data connections.

The inactive cell can become an active cell by applying the method disclosed herein. The inactive cell may be an inactive cell because it does not accept handover for active terminals to the inactive cell or because it redirects connections to an active cell once a connection is requested from a terminal in the inactive cell. Such methods are known in the art and may for example be realised by settings a call admission control function (CAC) to block any handover request or any request for setting up a new session.

The main purpose of the inactive cells to transmit the presence signal is to allow the terminals in the active cell to perform measurements on these inactive cells and to report such measurements to the network. Terminals in the active cell can be distinguished between terminals in the active mode (active terminals) and terminals in the idle mode (idle terminals). A terminal with an active connection (e.g. a voice call or data being exchanged) is said to be in 'active mode' or 'connected mode'. When the terminal is in active mode (active terminal),

the network has detailed knowledge about the terminal and knows by which cell it is served. A terminal which is powered on but without an active connection is said to be in 'idle mode'. When the terminal is in idle mode (idle terminal), the network has limited knowledge about the mobile station and only knows in which paging or location area the terminal may be paged. In idle mode the terminal listens to e.g. a broadcast channel or a paging channel of a particular cell. It is said that the terminal 'camps on' that cell. Consequently, a decision as to activate an inactive cell (or which active cell(s) from a set of inactive cells) can thus be based on information gathered from terminals in different states, i.e. from active terminals (terminals which have an active connection with the network for conveying traffic) and possibly from idle terminals (terminals which do not have an active connection with the network).

As a first example, a decision to activate an inactive cell may be based on the information gathered only from active terminals, for example by one or more of the following:

1. Counting requests for handover from active terminals with the inactive cell as target/destination.

2. Receiving and processing reported measurements from active terminals, e.g. signal strength and/or quality of the presence signal transmitted in an inactive cell, location information (e.g. determined by GPS or by the mobile network), etc.

3. Counting requests for a new session from active terminals that attempted to set up a connection with the inactive cell (and were refused and/or redirected towards an active cell because the inactive cell does not accept 'normal' traffic).

4. Any other measurements by active terminals that would be useful in deciding whether or not to activate an inactive cell.

As a second example, a decision to activate an inactive cell may be based on the information gathered both from active terminals and from idle terminals. In addition to the possibilities listed above for active terminals, from the idle terminals one or more of the following could be used:

1. Counting events of cell reselection by an idle terminal from an active cell to an inactive cell. This may in particular be relevant to an inter-RAT case. For example, an idle terminal that was originally camped on an active cell reselects to an inactive cell and then camps on the inactive cell.

2. Counting events of a location area update (e.g. as a result of a cell reselection).

3. Receiving an processing measurements performed by idle terminals, e.g. about signal strength and/or quality of the presence signal transmitted in an inactive cell, location information (e.g. determined by GPS or by the mobile network), etc.

4. Any other measurements by idle terminals that would be useful in deciding whether or not to activate an inactive cell.

As a third example, a decision to activate an inactive cell may be based on the information gathered only from idle terminals. However, this is not preferred, because the information from currently active terminals is considered to be highly relevant and relatively easy to obtain.

As indicate above, an inactive cell is considered a cell that is not intended to carry any voice or data traffic but may transmit a presence signal. That leaves a whole spectrum of additional capabilities which may or may not be available in an inactive cell while transmitting a presence signal during a probing period. Two examples will be provided towards the ends of that spectrum; a first example of an inactive cell with close to full functionality and a second example of an inactive cell with close to minimum functionality. It may be noted that the functionality of an inactive cell also has some impact on the role the inactive cell may have in gathering information about the inactive cell.

A first example of an inactive cell is a cell which does not accept any ‘normal’ data or voice traffic from a terminal (realised, for example, by proper settings of the connection admission function, which blocks any handover towards the or session set-up to the inactive cell) but is otherwise close to fully functional. For example, the Tx and Rx chains may be fully

functional, the interfacing with the core network (in LTE the for example X2 or S1 interface, in UMTS for example the Iub interface with the RNC) may be activated, etc. Consequently, the inactive cell may be able to receive measurement reports from active and/or idle terminals, may be able to process or forward these reports, may be able to receive location area updates from idle terminals, etc. Also, requests for handover towards the inactive cell and requests for setting up a session to the inactive cell may be received and properly responded to, i.e. be refused or redirected towards an active cell. It is expected that with a close to full functionality during a probing period, a noticeable energy consumption is unavoidable but that still a major energy saving is achieved by not allowing 'normal' data or voice traffic.

A second example of an inactive cell is a cell which only performs close to the minimum of functions, i.e. the transmission of a presence signal. For example, only the downlink signalling (such as pilot channel/reference symbol, SCH, BCH, etc.) are active to indicate the presence and the identity of the inactive cell and to allow the terminals to perform measurements on the presence signal of the inactive cell. The inactive cell may be configured to not receive any signalling messages (e.g. related to handover, to session set-up, to location area updates, to measurement reports, etc.) during the probing interval. Communication with the core network may likewise be restricted to, for example, receiving management commands related to the transmission of the presence signal (including any associated information), to the activation of the inactive cell and to transmitting some status information. It is expected that with a close to minimum functionality during a probing period, a very high energy saving is achieved.

Between the ends of the spectrum a trade-off may be made between the energy consumption and the functionality provided by (and associated therewith the ease of information gathering) an inactive cell during its probing period.

The method for assessing whether activation of the inactive cell is possible or required can be performed during

subsequent time intervals (e.g. periodic time intervals), as defined in claim 2 in order to not bother the terminals (battery saving) and the network (reduction of network load) continuously. However, (semi-) continuous performance of the method when one or more cells are currently inactive may be an attractive alternative for rapid assessment of opportunities to change the configuration of the telecommunications infrastructure.

In an embodiment of the invention, defined in claim 3, the terminals may be provided with measurement and/or reporting parameters in order to control measurement and reporting operations by the terminals in the active cell. The parameters may e.g. be provided over a connection via the active cell to a terminal that is in the active mode or broadcasted in the active cells to terminals in the active or idle mode. The measurement parameters trigger terminals to perform measurements. The reporting parameters instruct terminals (when) to report measurements to the network.

In existing wireless access telecommunications networks, terminals usually already perform measurements in certain conditions and may report measurement results in certain other conditions. For example, active terminals in handover regions between adjacent cells usually already report measurement information from the adjacent cells to the network in order for the network to perform a handover decision for each individual terminal. The measurement parameters provided to the terminals as defined in claim 3 not only allow to obtain measurement information from active terminals in the handover region but also allow to obtain information about neighbour inactive cells from active terminals outside the handover region and from idle terminals within the active cell. These terminals may report that information to the telecommunications infrastructure.

As a first example, a reporting threshold usually applied in the terminal to prevent reporting measurements about neighbour signals with a signal level which is insufficient compared to the signal from the serving cell to be relevant for a possible handover may be adjusted temporarily to allow also reporting signal levels which would otherwise be considered

insufficient. As a second example, a signal level threshold usually applied in the idle terminals to prevent performing measurements on neighbour cells when the signal level from the serving cell is more than adequate, may be adjusted (e.g. increased) temporarily to allow measurements on neighbour cells. Providing the measurement and/or reporting parameters to the terminals in the active cell enables more terminals and enables terminals at more locations in the active cell (e.g. not only in what would normally be considered the handover region between two cells) to perform measurements and/or to provide reports to the network.

The telecommunications infrastructure may comprise several inactive cells that may concurrently or sequentially transmit the presence signal, enabling the terminals to measure signals from a plurality of cells concurrently or sequentially to allow the network to obtain a more complete picture of the possibilities for a network configuration change (claim 4). The inactive cells may be located in the active cells (e.g. micro cells), may be adjacent to the active cell or may be located further away from the active cell. The plurality of inactive cells may have an aggregated estimated coverage area that at least partially overlaps the coverage area of the active cell.

Concurrent transmission of a presence signal by several inactive cells may be time efficient and may provide a slightly different picture of the network situation. For example, in a situation with overlapping inactive cells, a sequential transmission of the presence signal could indicate that a particular user device would select more than one inactive cell if only a single of these inactive cells would be activated, whereas concurrent transmission of the presence signal would indicate which of these inactive cells the same user device would select if all these inactive cells would be activated. Sequential transmission of a presence signal may be work load efficient as it allows to refrain from completing the entire envisaged sequence, for example if the thus far collected information appears to be satisfactory. Sequential transmission of a presence signal may involve the sequential transmission in groups of inactive cells

to assess the best combination. The sequential variant may use history information to first transmit a presence signal in inactive cells that previously turned out successful candidates for activation.

In the embodiment of claim 6, a reporting identifier is transmitted in the inactive cell. The present application also discloses a signal transmitted in a cell of the infrastructure, wherein the signal comprises the reporting identifier.

Active terminals in the active cell may receive the reporting identifier and transmit the reporting identifier with the report in order to enable the telecommunications infrastructure to distinguish between reports from terminals related to normal handover (to an active cell) and reports from terminals reporting information about the inactive cells for assessing whether the inactive cell should be activated.

Idle terminals detecting the reporting identifier from the inactive cell may be configured to use this identifier to prevent cell reselection by the idle terminal to the inactive cell, to report the information about the inactive cell to the telecommunications infrastructure via the active cell before reselection to the inactive cell, or to report information about the inactive cell to the inactive cell when the inactive cell is configured to receive such reports.

The embodiment defined in claim 7 is advantageous for the reason that the number of idle terminals is normally much greater than the number of active terminals. Having a plurality of idle terminals reporting information on the presence signal(s) from the inactive cell(s) may greatly contribute to the complete picture of opportunities for reconfiguration of the telecommunications infrastructure and also may indicate possible traffic load in the near future. For the idle terminals to transmit reports to the telecommunications infrastructure, these terminals should temporarily become active.

Apart from the mechanism for idle terminals as described above in relation to claim 6, the embodiments of claims 8-10 provide several other mechanisms for participation of idle terminals in the method according to the invention. These em-

bodiments are described in further detail in the detailed description.

Briefly, the embodiment of claim 8 comprises temporarily decreasing a location area update period (or a similar period) in at least one of the active cell and the inactive cell. The embodiment is advantageous as it may require no or only few modifications to currently existing networks.

The embodiment of claim 9 comprises the idle terminals to report measurement information to the telecommunications infrastructure via the active cell, whereas these terminals would otherwise reselect to the inactive cell and attempt reporting to the inactive cell. This embodiment allows the inactive cells to maintain a status wherein these cells are not able or are configured not to be able to receive reports.

The embodiment of claim 10 comprises transmitting a paging message in the active cell instructing the idle terminals to obtain and/or report the information. The idle terminals listen to broadcast and paging channels and can be triggered to detect information from inactive cells using these channels. Using such paging message, less need exists to temporarily reconfigure the system information of the active cell different from the normal operation. This is particularly true if the paging messages carry configuration parameters for the idle terminals, such as the measurement and/or reporting parameters defined in claim 3.

The embodiments of claims 6 and 10 require modifications to the processing capabilities of currently existing wireless terminals. The present application discloses a wireless terminal for use in these embodiments.

Hereinafter, embodiments of the invention will be described in further detail. It should be appreciated, however, that these embodiments may not be construed as limiting the scope of protection for the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIGS. 1A and 1B are schematic illustrations of base stations in a wireless access telecommunications infrastructure providing active cells and inactive cells;

FIG. 2 is a schematic illustration of a telecommunications infrastructure comprising a base station defining an active cell containing a plurality of terminals and a base station providing an inactive cell transmitting a presence signal;

FIG. 3 is a flow chart illustrating various steps of a method according to an embodiment of the invention;

FIG. 4 is a flow chart illustrating the information processing step in further detail;

FIGS. 5-8 are flow chart illustrating steps of a method for participation of idle terminals and

FIG. 9 is a schematic illustration of a wireless terminal configured for being operable in the telecommunication infrastructure of FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1A is a schematic illustration of base stations BS A – BS G in a wireless access telecommunications infrastructure providing a plurality of active cells. Each base station location comprises three sectors, thus covering an area around the base station location. For example, cell A1 of base station location BS A serves its best server area marked ‘a1’. Similarly, cell A2 and A3 of the same location serve their best server area marked ‘a2’ and ‘a3’ respectively. A same set-up is shown for the other base station locations BS B to BS G. In FIG. 1A, the regular pattern of base stations and sectors leads to the commonly known hexagonal pattern of coverage areas.

FIG. 1B shows the same areas in a light grey colour. For example for energy saving reasons, some cells at base station locations B and C have been switched off and cell A1, together with some other cells (not shown) now provides service to some of BS B and BS C’s best server areas. In FIG. 1B, a darker gray shading illustrates that cell A1 provides service not only in its ‘own’ or ‘native’ area a1, but also in areas b2 and c3 and in part of the areas b3 and c2. Other cells may simi-

larly have been switched off and service in their ('native') areas may be provided by one or more of the surrounding cells.

FIG. 2 is a schematic illustration of a wireless access telecommunications infrastructure 1 comprising a base station BS A defining an active cell A1 containing a plurality of active terminals Ta and idle terminals Ti. Base station BS B provides an inactive cell B1 wherein it transmits a presence signal P.

Telecommunications infrastructure 1 comprises a presence signal generator 2 for generating the presence signal P via interface 3. The telecommunications infrastructure 1 further comprises a receiver 4 configured for receiving reports from the plurality of terminals Ta, Ti detecting the presence signal P. A processor system 5 is configured for processing information contained in the reports received from the plurality of terminals Ta, Ti to provide a processing result. The processor system 5 has an activation module 6 configured for activating the inactive cell of BS B when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals Ta, Ti is within a coverage area of the activated cell B1 of base station BS B.

Various events may trigger the telecommunications system 1 to operate the method as illustrated in the flow chart of FIG. 3. The method may be performed periodically or continuously, wherein generator 2 periodically or continuously generates the presence signal P in inactive cell B1. In at least some situations, it is advantageous to transmit the presence signal P concurrently by several related cells (rather than transmitting the presence signal P for separate cells, e.g. one-by-one). For example, in FIG. 1B, it may be advantageous to perform the method and evaluation concurrently for cells B3, B2, C3 and C2. A same or similar advantage may apply to cells which otherwise provide mutual coverage or are in close proximity of each other. Alternatively or in addition, the transmission of the presence signal P may be initiated by a predetermined condition in an active cell A1 verified by processing system 5, e.g. a traffic load exceeding a threshold or a traffic load showing a substantial increase.

The method as illustrated in the flow chart of FIG. 3 may be performed as follows. In step 3-I, a presence signal P is generated by generator 2 and transmitted in the at least one inactive cell of base station BS B. The plurality of terminals Ta, Ti in the active cell A1 (which are not necessarily all terminals in the active cell) detect and measure the presence signal P of the inactive cell B1 and gather information about the inactive cell (e.g. signal level/quality of presence signal P and cell identity of inactive cell B1). The information is reported to and received at the telecommunications network via the active cell A1 and receiver 4 (step 3-II). Alternatively, some of the information, in particular from idle terminals Ti, may be also reported via inactive cells, presuming these are configured for at least receiving such reports. The information received from the plurality of terminals Ta, Ti is processed in processing system 5 to provide a processing result (step 3-III). It should be appreciated that the information contained in some reports from some terminals need not be processed by processing system 5 and that processing system 5 may use additional information not received from the terminals (e.g. information typically available from a management system such as the location and configuration of the base stations etc.). The inactive cell B1 is activated in step 3-IV when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals Ta, Ti is within a coverage area of the activated cell B1.

FIG. 4 shows a flow chart exemplifying some steps of processing step 3-III in further detail. The telecommunications infrastructure 1 allows to take account of the distribution of terminals Ta and Ti in the active cell A1. The information obtained from the terminals Ta (such as measured signal level/quality or path loss) can be applied for energy reduction purposes. For example, if the analysis (e.g. based on the reported signal level measurements) reveals that a considerable number of active terminals Ta served by the active cell A1 finds themselves near the edge of the active cell A1 as shown in FIG. 2 and is transferable to inactive cell B1 (step 4-I), a recon-

figuration of the network can be analysed (step 4-II) wherein the inactive cell B1 is activated (step 4-II). The activation condition wherein the total energy for the telecommunications infrastructure 1 can be reduced (step 4-III) may be fulfilled since the power reduction estimated to be obtained by transferring these terminals away from active cell A1 may be more than the power estimated to be required for an activated cell B1 and for serving these terminals by cell B1.

The analysis as depicted in FIG. 4 may also be used for increasing the energy consumption of the telecommunications network in an efficient manner. As an example, if the load in active cell A1 increases, at some point in time additional cells need to be activated. Reports from the active terminals Ta may indicate (e.g. from the signal levels / signal quality reported about the presence signal P of cell B1) that cell B1 is a suitable candidate for activation.

As an alternative or in addition, triggered reports from idle terminals Ti may be considered in the decision which cell is most suitably reactivated to alleviate the effects of the local traffic overload. Note that the number of idle terminals in a cell is usually much larger than the number of active terminals. Reports from such idle terminal typically indicate the best cell as selected by each triggered idle terminal, choosing from both active and inactive cells that transmit a presence signal P. Counting for each inactive cell transmitting presence signal P how many idle terminals Ti (optionally: how many idle terminals that currently camp on the overloaded active cell) would prefer that inactive cell, provides an indication of the near-future traffic load that can be absorbed by the inactive cell when fully reactivated, thus relaxing the currently overloaded active cell from that (potential) ‘burden’. Instead or along with the information on the active terminals Ta, the information on the idle terminals Ti can be considered in the decision process regarding which inactive cell to activate.

Several methods of triggering active user terminals Ta and idle terminals Ti to obtain information on the inactive

cell(s) and to report this information will now be discussed in further detail.

Generally, the terminals may be provided with measurement and/or reporting parameters in order to control measurement and reporting operations by the terminals in the active cell A1. The parameters may e.g. be provided over a connection via the active cell to an active terminal Ta or broadcasted in the active cell A1 to active and idle terminals Ta, Ti using e.g. system information blocks SIB.

An active terminal Ta receives instructions from the network about which measurements to perform and which events to report to the network (e.g. the event that a neighbour inactive cell B1 is detected with a signal strength/quality that is better by x dB than that of the currently serving active cell A1). When a measurement leads to one of the specified events, the terminal Ta reports the relevant information (e.g. an identification of the detected neighbour inactive cell B1, its measured present signal level/quality and the measured signal level/quality of the active cell A1) over the existing connection to the telecommunications infrastructure 1. Either in response to a report from a terminal Ta or autonomously, the telecommunications infrastructure 1 may instruct the terminal Ta to perform additional measurements of a same or different kind and to report the results.

Base station BS B may transmit a reporting identifier, hereinafter also referred to as ‘probing flag’, in the inactive cell B1. Active terminals Ta in the active cell A1 may receive the reporting identifier and transmit the reporting identifier with the report containing information regarding inactive cell B1. The active terminal Ta is thus configured to recognize the reporting identifier and to include this reporting identifier in the report containing the information on the inactive cell B1. This facilitates the processing system 5 of telecommunications infrastructure 1 to more easily distinguish between terminals Ta-ho (see FIG. 2) reporting in the context of a normal handover to another active cell (not shown in FIG. 2) and terminals Ta reporting information from the inactive cell B for assessing

whether the inactive cell should be activated. An alternative for enabling the telecommunications infrastructure 1 to distinguish between reports relating to normal handovers and reports to be analyzed towards a decision whether to activate an inactive cell is to inform the base station BS A (or at least the associated entity normally handling the handover-related reports) of the identity of the inactive cells transmitting presence signals, such that reports related to an identity of an inactive cell can be excluded from being processed towards a handover decision and can be forwarded to processing system 5.

In order for idle terminals in active cell A1 to be triggered to obtain information about inactive neighbour cell B1, various parameters may be broadcasted in the active cell A1 in the system information block SIB for cell reselection. One example of such a parameter is an absolute signal level threshold Ts,search. This threshold is used by idle terminals as a reference for the received signal level Srxlev, measured by the terminals, from the active cell A1 and to decide if neighbour measurements for cell reselection are needed. Different values might be assigned to Ts,search for the measurement of intra-frequency, inter-frequency and inter-RAT neighbours. If Srxlev < Ts,search, the terminal will search for corresponding (intra-frequency, inter-frequency or inter-RAT) neighbour cells and measure the received signal level Nrxlev and/or Nqual. Nrxlev is the received signal level of the presence signal from a neighbour cell, e.g. from the inactive cell B1. Nqual is the received signal quality from a neighbour cell, e.g. from inactive cell B1 (e.g. E_c/I_0 of the CPICH for UMTS cells or RSRQ of the reference symbols for LTE cells). Hysteresis parameter Qhyst for the active cell A1 and offset parameters Qoffset,n to be applied to each neighbour *n* specifically, can also be broadcasted in the active cell A1.

Next, exemplary methods will be discussed for instructing idle terminals Ti to perform measurements on inactive cells and to report this information to the telecommunications infrastructure 1.

In a first method, illustrated in the flow chart of FIG. 5, a location area update period (or a similar period) is decreased in the active cell A1 and the inactive cell B1. The embodiment is advantageous as it requires no modifications to currently existing networks.

In the active cell A1, in the system information (SIB) to be broadcast on the broadcast channel of the active cell A1, a relatively short value (e.g. 30 s, 1 min) is set for the periodic location area (LA) update (instead of a nominal value, e.g. 30 min, 1 hour, infinite). This is illustrated in step 5-I. A paging message may be issued in the cell A1 indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1.

As a consequence, an idle terminal Ti camping on the active cell A1 reads the modified SIB and starts providing frequent (e.g. every 30 s, 1 min) periodic LA updates. An LA Update message also includes information about the identity of the terminal. The telecommunications infrastructure 1 (more particularly processing system 5) receives the LA Update messages and may derive (e.g. every 30 s, 1 min) how many and which terminals Ti are currently camping on the active cell A1. This provides information about the initial situation regarding idle terminals in the active cell.

In step 5-II, the inactive cell(s) B1 set a periodic LA update value to a similarly short (e.g. 30 s, 1 min) value as used for the active cell A1. The presence signal P is transmitted in the inactive cell B1.

In the active cell A1, in the system information (SIB) to be broadcast on the broadcast channel of the cell, the absolute signal level threshold parameter Ts,search is set higher than nominal (e.g. nominal value +[5,10] dBm), step 5-III. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells B1. In the cell, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselec-

tion evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal Ti for which the received signal level of the active cell A1 is below the adjusted (increased) threshold Ts,search measures the neighbour cells, for example including inactive neighbour B1. For some RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active) neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell. The ranking mechanism may be dependent on the radio access technologies of the involved cells and possibly also on other conditions like environment characteristics. In the existing art it is for instance known that cell reselection in a network consisting of cells with different radio access technologies may be organised in a 2-step manner: For instance in a network consisting of both UMTS (UTRAN) and GSM (GERAN) cells, first a ranking based on received signal level (Srxlev for the serving cell and Nrxlev for the neighbour cells) may be performed, taking account of corresponding Qhyst and Qoffset,n (noted as Qhyst(1) and Qoffset,n(1)). If the highest ranked cell is a GSM cell, the terminal will reselect to this cell. However, for the ranking of the UMTS cells, received signal quality (e.g. E_c/I_0) is a better indicator of the suitability of a cell for cell reselection. Therefore, if a UMTS cell is the highest ranked in the first step, a second step follows, in which the UMTS cells are ranked based on received signal quality, still taking Qhyst and Qoffset,n (noted as Qhyst(2) and Qoffset,n(2)) into account. The terminal then reselects to the highest ranked UMTS cell in this second ranking.

Similarly, for different combinations of RATs different ranking methods may be devised.

It is also known from the existing art that differences in certain geographical environments may be used to select a ranking mechanism form a set of implemented ranking mechanisms.

The remainder of this text is based on applying the example of cell-ranking based on received signal level. It should however be understood that also other cell ranking mechanisms can be applied.

An idle terminal Ti persisting to camping on the active cell A1 continues providing frequent LA Updates messages to the active cell A1. An idle terminal Ti which has reselected to an inactive cell B1 (which is assumed to be configured for frequent LA Updates as indicated above) will provide its frequent LA Update messages to the relevant inactive cell B1. An idle terminal Ti which has reselected another active cell will adhere to the LA Update regime as broadcast by that cell (which may be a nominal value, e.g. 30 min, 1 hour, etc.)

After a transitional period (whose length may depend on the duration of the cell reselection procedure and the LA Update period), the processing system 5 may derive in step 5-IV from the received LA Update messages how many and which idle terminals remain camped on the active cell, how many and which idle terminals have reselected an inactive cell (and which cell) and how many and, possibly, which idle terminals have reselected from the active cell to other cells. This analysis provides an estimate about the situation regarding idle terminals Ti when each of the inactive cells B1 would be activated.

The information obtained from step 5-IV may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 5-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions. A paging message may be issued indicating modified system information. This pag-

ing message is also received by idle terminals still camping on the active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision obtained from the processing of step 5-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions. In these cells, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on any of the cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 5-V in FIG. 5 for both the active cell A1 and the activated cell B1.

Still further, after the decision obtained from the processing of step 5-IV, the inactive cells that are decided to be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped on such a cell will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read modified system information is RAT dependent.

In a second method, illustrated in the flow chart of FIG. 6, a location area update period (or a similar period) is decreased in the active cell A1 and a reporting identifier, also referred to here below as probing flag, is broadcast in the inactive cell B1 during a time interval.

The first step, indicated by 6-I, is equivalent to step 5-I in FIG. 5.

Different from the first method, the LA update period is not changed in the inactive cells B1. A reporting identifier is transmitted in the inactive cells B1 (step 6-II). The presence signal P, possibly including the probing flag, is transmitted in the inactive cells B1.

In the active cell A1, the absolute signal level threshold parameter Ts,search is set higher than nominal (e.g. nominal value +[5,10] dBm) in step 6-III and is broadcasted in the system information (SIB) on the broadcast channel of the cell. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells. A paging message may be issued indicating modified system information. This paging message is also received by idle terminals Ti camping on the cell. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselection evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal Ti for which the absolute received signal level of the active cell A1 is below the adjusted threshold Ts,search measures the neighbours. For some RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active) neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell.

An idle terminal Ti persisting to camping on the active cell A1 continues providing frequent LA Updates messages to the active cell A1. An idle terminal Ti which reselects to an inactive cell B1 (the terminal Ti may detect this from the probing flag in the inactive cell’s broadcast channel) is configured to, shortly after performing the reselection, send a LA Update message to the selected inactive cell B1. This first LA Update message is sent, regardless the setting of the LA Update period in the inactive cell B1. An idle terminal reporting a cell reselection to an inactive neighbour cell may be further configured to also report the presence of the probing flag in its LA Update

message. This could ease bookkeeping at the processing system 5 regarding the neighbour state (inactive or active).

Different from the first method, the inactive cells B1 are configured with a nominal period for LA Updates. Consequently an idle terminal camping on an inactive cell provides (subsequent to the first LA Update message sent shortly after camping on a cell with its probing flag set) only nominal LA Update messages (e.g. 30 min, 1 hour, etc.) to the cell. An idle terminal Ti which has reselected another active cell will adhere to the LA Update regime as broadcast by that cell (which may be a nominal value, e.g. 30 min, 1 hour, etc.).

After of transitional period (whose length may depend on the duration of the cell reselection procedure and the selected LA Update period in the cell A1), the telecommunications infrastructure 1 (more specifically, the processing system 5) may derive from the received LA Update messages how many and which idle terminals remain camped on the active cell A1, how many and which idle terminals Ti have reselected an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals have reselected from the active cell A1 to other cells. This provides an estimate about the situation regarding idle terminals when each of the inactive cells B1 will be activated (step 6-IV).

It should be noted that in the second method, the LA area update messages used to obtain the processing result are reported to the inactive cell B1 (and then via interface 3 to processing system 5, see FIG. 2).

In order to decrease the burden on the inactive cell B1, a first alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, does not perform cell reselection to that cell as long as it has its probing flag set; it sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on (see the box beside 6-IV in FIG. 6). Different from the first method illustrated in FIG. 5, and

different from the second method's basis described above, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, an inactive cell in this first alternative needs not to support reception of LA Update messages as described above. Also different from the first method illustrated in FIG. 5, an idle terminal Ti in this first alternative of the second method does not reselect to an inactive cell (comparable to active terminals Ta not being handed over to inactive cell B1).

A second alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, first sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on and only subsequently performs cell reselection to the best cell (see the box beside 6-IV in FIG. 6). Different from the first method illustrated in FIG. 5, and different from the second method's basis described above, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, again, an inactive cell needs not to support reception of LA Update messages.

Different from the first method, the inactive cells are configured with a nominal period for LA Updates. In this case, to prevent that LA Updates are sent to the inactive cell, the inactive cell may be configured with an infinite LA Update period during the period(s) wherein the presence signal P is transmitted in the inactive cell.

The information obtained from step 6-IV (and possibly step 6-I) may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 6-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions. A paging message

may be issued indicating modified system information. This paging message is also received by idle terminals still camping on the original active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision in step 6-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions including removal of the probing flag. This system information modification may, but not necessarily needs be announced in the activated cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 6-V, including a reset to the nominal LA update value for cell A1 and to remove the probing flag in activated cell(s) B1 in FIG. 6.

Still further, after the decision obtained from the processing of step 6-IV, the inactive cells that are decided to be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped on such a cell will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read system information is RAT dependent.

In a third method, illustrated in the flow chart of FIG. 7, the reporting identifier, also referred to as probing flag, is broadcasted in both the active cell A1 and the inactive cell B1. This third method does not rely on frequent periodic LA updates.

In step 7-I, the system information (SIB) to be broadcasted on the broadcast channel of the active cell A1 comprises a probing flag. In the active cell, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1.

An idle terminal Ti, detecting the probing flag, is configured (see FIG. 9) to report information about its identity (e.g. IMSI) and best cell (in this case, likely the active cell A1) to the cell it camps on. The information about the cell identity is not necessarily included in the report but may be added by the cell via which the report is sent. The report is sent once, on first detection of the probing flag being set. It is an option that an idle terminal Ti which has reselected another active cell will not send a report, which would prevent unnecessary reports to be received in other active cells. The telecommunications infrastructure (more precisely the processing system 5) receives the reports and may derive how many and which terminals Ti are currently camping on the active cell. This provides the information about the situation regarding idle terminals before the probing period starts.

Then, in step 7-II, a probing flag is also transmitted in the inactive cell(s) B1 and the presence signal P is transmitted as well.

In the active cell A1, the absolute signal level threshold Ts,search parameter is set higher than nominal (e.g. nominal value +[5,10] dBm) and in step 7-III is broadcast in the system information (SIB) on the broadcast channel of the cell. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells. A paging message may be issued indicating modified system information. This paging message is also received by idle terminals Ti camping on the cell. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselection evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal for which the absolute received signal level of the active cell A1 is below the adjusted threshold Ts,search measures the neighbours. For some RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active) neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell.

An idle terminal persisting to camping on the active cell A1 sends a report as described above for step 7-I regarding the active cell A1 to the active cell A1. An idle terminal Ti which reselects to an inactive cell (the terminal may detect this from the probing flag in the inactive cell's broadcast channel) is configured to, shortly after performing the reselection, send a report as described for step 7-I to the selected inactive cell (see FIG. 9). The report is sent once, on first detection of the probing flag being set in the cell it is camped on and to the cell it is camped on. It is an option that an idle terminal which has reselected another active cell will not send a report, which would prevent unnecessary reports to be received in other active cells. An idle terminal reporting a cell reselection to an inactive neighbour cell may be further configured to also report the presence of the probing flag in its report. This could ease bookkeeping at the processing system 5 regarding the neighbour state (probing or nominal).

After a transitional period (whose length may depend on the duration of the cell reselection procedure and time to send the associated reports), the telecommunications infrastructure 1 (more precisely, the processing system 5) may derive from the received reports how many and which idle terminals remain camped on the active cell A1, how many and which idle terminals have reselected an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals have reselected from the active cell to other cells. This provides an estimate about the situation regarding idle terminals when each of the inactive cells B1 will be activated.

Again, in order to decrease the burden on the inactive cell B1, a first alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, does not perform cell reselection to that cell as long as it has its probing flag set, yet may remain camping on such a cell; it sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on (see the box beside 7-IV in FIG. 7). Comparable to the second method's first alternative, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, an inactive cell in this first alternative needs not to support reception of reports as described above.

A second alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, first sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on and only subsequently performs cell reselection to the best cell (see the box beside 7-IV in FIG. 7). Comparable to the second method's second alternative, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, again, an inactive cell B1 needs not to support reception of reports as described above.

The information obtained from step 7-IV (and possibly step 7-I) may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 7-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions (which also includes removal of the probing flag). A paging message may be issued indicating modified system information. This paging mes-

sage is also received by idle terminals still camping on the original active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision in step 7-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions including removal of the probing flag. This system information modification may, but not necessarily needs be announced in the activated cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 7-V including a removal of the probing flags in active cell A1 and activated cell(s) B1.

Still further, after the decision obtained from the processing of step 7-IV, the inactive cells that are decided to be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped on such a cell will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read system information is RAT dependent.

Finally, in a fourth method, illustrated in the flow chart of FIG. 8, a measurement-and-report paging message, hereinafter denoted as paging message, is transmitted in the active cell A1 instructing the idle terminals Ti to obtain and report information on the inactive cells B1. The idle terminals Ti listen to broadcast and paging channels and can be triggered, using these channel(s), to obtain information on the inactive cells B1. The method may be combined with probing flags transmitted in the inactive cells.

In a first optional step 8-I, a paging message is transmitted in the active cell A1. The paging message may optionally comprise configuration parameters (see below), which

configuration parameters are to be applied by the idle terminal Ti.

In response to step 8-I, an idle terminal receiving the paging message is configured (see FIG. 9) to perform measurements on the serving cell (in this case the active cell A1) and on its neighbour cells, regardless the criterion settings for initiating a search (such as parameter Ts,search), and to subsequently send a report, by default to the cell that issued the paging message (in this case the active cell A1). After sending the report, a cell reselection may be performed. The idle terminal can be configured to not performing cell reselection as long as the highest-ranked cell has the probing flag set (comparable to the first alternative of the second or third method).

As indicated above, the paging message may optionally comprise configuration parameters. Examples are parameters that further specify the measurements to be made (which terminals should measure, which cell(s) to be measured, which RAT to be measured, which characteristics, etc.), parameters that further specify the subsequent reselection (such as offset or hysteresis parameters) and parameters that further specify the report to be provided (whether or not to provide a report, how many of the best cells to be reported, which quantities – e.g. signal level/quality, path loss estimates – to be reported, destination of the report, etc.). The paging parameters may alternatively or in addition, include a reference where the (further) parameters may be obtained, e.g. a reference (link) to a broadcast channel or the like, for example when the set of parameters is impractically large to be sent in the paging message itself.

A terminal receiving configuration parameter values in (or associated with) the paging message applies the received values when performing the measurements, the cell reselection procedure and the reporting as commanded by the paging message. It may be that in case of a conflict with an existing parameter having been assigned a value, the value received in the paging message is only applied for the measurements etc. related to the present method. Other procedures continue to apply the already

assigned value and are not affected by the value in the paging message.

The reported information includes at least an indication about the terminal identity (e.g. IMSI) and about the identity of the best cell. The report is sent once, on detection of the paging message, and by default (unless instructed otherwise) to the cell that issued the paging message, regardless the cell reselection that may be the result of the search.

The telecommunications infrastructure 1 (more precisely, the processing system 5) receives the reports and may derive how many and which terminals were camping on the active cell A1 and received the paging message and also may derive how many and which terminals are likely to remain camping on the active cell A1 after the paging message. This provides the information about the situation regarding idle terminals before the probing period starts.

Step 8-I is an optional step that may e.g. be omitted if the processing system 5 has no particular interest in obtaining information about the situation regarding idle terminals Ti in the active cell A1 before the start of transmitting the presence signal P in the inactive cell(s) B1.

Step 8-II involves the transmission of the presence signal P in the inactive cell(s). A probing flag may also be transmitted. Optionally, one or more of the inactive cells may be configured with system information parameters different from the normal operating conditions, e.g. values set specifically for the method.

Optionally, as described for previous methods illustrated in FIGS. 5-7, the active cell A1 may be configured with system information parameters different from the normal operating conditions, e.g. values set specifically for the probing phase. It is, however, envisaged that the possibility to specify configuration parameters in (or associated with) the paging message, has advantages over making temporary modifications to system information parameters.

In step 8-III, again a paging message is transmitted in the active cell A1. The paging message may optionally comprise

configuration parameters as described above. The values of these parameters may be different from those in the paging message optionally transmitted in step 8-I in active cell A1.

In order to decrease the load of reports, the paging message may also instruct only a fraction f of the idle terminals Ti in the active cell A1 to perform measurements and to provide a report. Mechanisms, such a paging groups, can be used to address or to instruct a particular fraction f (subset) of the idle terminals Ti. A fraction f of the idle terminals may also be established by configuring the idle terminal Ti to, randomly or deterministically determined, only provide the requested reports for a fraction f of the requests.

In response to step 8-III, an idle terminal receiving a paging message is configured to perform measurements on the serving cell (in this case the active cell A1) and on its neighbour cells, regardless the criterion settings for initiating a search, and to subsequently send a report (in this case to the default which is the cell that issued the paging message, i.e. active cell A1). The report is sent once, on detection of the paging message. After sending the report a cell reselection may be performed. The idle terminal can be configured to not performing cell reselection as long as the highest-ranked cell has the probing flag set.

The report includes at least an indication about the identity of the best cell and preferably an indication about the terminal identity (e.g. IMSI). The report may additionally include the status of the probing flag, if any, of the reported best cell.

The telecommunications infrastructure 1 (or more precisely, the processing system 5) receives the reports and may derive from the received reports how many and which idle terminals are likely to remain camped on the active cell, how many and which idle terminals are likely to reselect to an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals are likely to reselect to another cell (and which other cell). This provides an estimate about the situation re-

garding idle terminals when each of the inactive cells will be activated (step 8-IV).

The information obtained from step 8-IV (and possibly step 8-I, when performed) may be taken into account in the evaluation by the telecommunications infrastructure 1 (more precisely processing system 5) about which of the inactive cells to activate and which not.

If the system information of the active cell A1 has been set differently for the execution of the method than during normal operating conditions, then the system information for the active cell may be reverted back to normal operating conditions (not shown in FIG. 8).

If the inactive cell B1 is activated the following applies. If a probing flag was set, the probing flag may be removed. This system information change need not be announced by a paging message in the relevant cell(s). If the system information of the inactive cell has been set differently for the probing phase than during normal operating conditions, then the system information for the cell may be reverted back to normal operating conditions. If a probing flag was not set, an idle terminal camped there, will remain camped there.

If the inactive cell B1 is decided to not be activated, it may be switched off. If a probing flag was not set in the cell, an idle terminal camped there will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells, possibly reselecting another neighbour cell).

A paging message may be transmitted again after activating inactive cells wherein a probing flag was transmitted. In this case a primary objective is to actually let an idle terminal camped on the active cell A1 perform a reselection to one of the activated neighbour cells B1, when such reselection is still applicable. The processing system 5 may choose to either ignore the reports or to process the reports to assess the final configuration or to have it confirmed. If the system has no interest in assessing / confirming the final configuration, this

paging message may advantageously specify a configuration parameter indicating that no reports are to be sent.

It should be appreciated that 3GPP already specified functions for information gathering by a terminal such as described in 3GPP TS 37.320 "Radio Measurement collection for Minimization of Drive Tests (MDT)", which allows to configuring active terminals and/or idle terminals to perform measurements and to report the result to the network. With the described approaches, the responsiveness of the MDT measurements may be greatly improved and be made better suited to also gather information for the purpose of deciding which inactive cell(s) to activate.

In some of the methods and alternatives for triggering idle terminals Ti as described above, it may occur that an idle terminal Ti which camps on an inactive cell B1 initiates a session (e.g. initiates a voice or a data call). There are various ways to handle this situation.

When the inactive cell, despite its 'inactive' status, is to a sufficiently large extent operational, it may choose to accept the request and to support the call in the normal way, at least temporarily. Subsequently, the inactive cell may attempt to handover the call to an active cell; alternatively it may continue serving the call until a decision has been taken about the activation (or not) of that cell. If activated, it may continue to serve the call as an active cell; if not activated, it may handover the call to an active cell before the inactive cell is switched off.

When the inactive cell has insufficient capabilities to accept and/or support a call, or when it is otherwise undesirable to do so, the inactive cell may deny the call request. Various wireless access technologies provide a mechanism to elegantly and quickly refer a refused caller to an alternative, e.g. 'directed retry'. In that case, the inactive cell only needs to support the corresponding signalling.

Finally, note that by using a probing flag in an inactive cell and by using an idle terminal configured to not actually reselect to or camp on a cell which has its probing

flag set (also see the first alternative of the second and third method and see the fourth method), it can be prevented that idle terminals actually camp on an inactive cell.

In each of the above methods, the process of counting how many idle terminals will perform cell reselection may use a hysteresis Qhyst in the terminal for the measurement result.

Similarly, a neighbour-specific offset Qoffset,n can be applied to (e.g. added to) the measurement result in the terminal. By means of these cell-specific offsets a cell may be either be promoted or demoted in the ranking of cells for cell reselection.

In the above-described methods, conditions for cell reselection have been frequently addressed. In addition to these conditions, there may be various other conditions that determine whether a cell is suitable to be camped on by the idle terminal. It is assumed that all inactive neighbours are classified as a 'suitable cell', e.g. their Nrxlev and Nqual are sufficiently high to consider them for camping. It is also assumed that suitable averaging is applied to the measurements. Additionally, it is assumed that a (minimum) period is taken into account for which a highest-ranked cell has to be different from the current (active) cell before actually performing a cell reselection. This minimum period (timer) may also broadcasted via the broadcast channel of the cell in the same SIB.

For the measurement of inter-frequency or inter-RAT neighbour cells, active terminals Ta need some (measurement) time gaps to carry out the measurement. This might be managed by using the idle period provided by discontinuous reception (DRX) or radio resource scheduling. One example is the so called "compressed mode" in UMTS networks, where the data rate (and also transmit power) is temporarily doubled, so the data can be sent twice as fast and the resulting time gap could be used for inter-frequency of inter-RAT measurement.

Whereas the disclosed method and telecommunications infrastructure use existing measurement and reporting capabilities of wireless terminals, in at least some of the above-described embodiments the capabilities of wireless terminals should be

adapted to participate in these embodiments. Examples have been indicated above and include the recognition, processing and actions performed for cell reselection, in response to the reporting identifier (probing flag) and/or the measurement-and-reporting paging message of the above-described fourth method. Most of these enhanced capabilities will be obtained by software modifications in the wireless terminals. Therefore, FIG. 9 is a highly schematic illustration of a wireless terminal T comprising storage S and processor uP configured for storing and operating the modified software. For a base station BS A, BS B similar considerations apply.

Other network elements and signalling may also be affected, depending on how and where the modules 2~6 (as shown in Fig. 2) are deployed. One option is that the modules are deployed in a centralized fashion in the operation and management centre (OMC), the main impact may then be to the signalling messages that are carried between the OMC and base stations BS A and BS B.

Another option is that the modules are deployed in a distributed fashion in the radio network, e.g. in RNC (Radio Network Controller) of UMTS or eNodeB (LTE term for base station) of LTE. Then, additional signalling between these network nodes is required. For example, if BS A is an UMTS base station and BS B is an LTE base station, additional signalling between RNC and eNodeB is required for the purpose of this invention.

CLAIMS

1. A method for activating at least one inactive cell in a wireless telecommunications infrastructure, the telecommunications infrastructure comprising an active cell containing a plurality of terminals, the method comprising the steps of:

- transmitting a presence signal in the at least one inactive cell;
- receiving reports from the plurality of terminals detecting the presence signal;
- processing information contained in the reports received from the plurality of terminals in a processing system of the telecommunications infrastructure to provide a processing result; and
- activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

2. The method according to claim 1, further comprising the steps of:

- terminating transmission of the presence signal in the at least one inactive cell when the processed information does not fulfil the at least one activation condition
- transmitting the presence signal in the at least one inactive cell again at a later time.

3. The method according to claim 1 or 2, further comprising the step of providing the terminals in the active cell with measurement parameters and/or reporting parameters to obtain the information regarding the presence signal from the inactive cell.

4. The method according to one or more of the preceding claims, wherein the telecommunications infrastructure contains a plurality of inactive cells, the method comprising

the step of concurrently or sequentially transmitting the presence signal in the plurality of inactive cells

5. The method according to one or more of the preceding claims, wherein the at least one activation condition includes at least one of energy reduction for the telecommunications infrastructure, load reduction for the active cell or reduction of electromagnetic radiation from the telecommunications infrastructure or from a particular set of cells in the infrastructure.

6. The method according to one or more of the preceding claims, comprising the step of transmitting a reporting identifier in at least one of the active cell and the inactive cell.

7. The method according to one or more of the preceding claims, wherein at least some of the plurality of terminals in the active cell are idle terminals when gathering information for the report.

8. The method according to claim 7, further comprising the step of temporarily decreasing a location area update period in at least one of the active cell and the inactive cell.

9. The method according to claim 7 or 8, wherein the reports are received via the active cell.

10. The method according to claim 7, further comprising the step of transmitting a paging message in the active cell instructing the idle terminals to obtain and/or report the information.

11. A computer program comprising software code portions configured, when executed on one or more processing units, to perform the method according to one more of the claims 1-10.

12. A wireless access telecommunications infrastructure comprising an active cell and at least one inactive cell,

the active cell containing a plurality of terminals, wherein the infrastructure comprises:

- a presence signal generator configured for transmitting a presence signal in the at least one inactive cell;
- a receiver configured for receiving reports from the plurality of terminals detecting the presence signal;
- a processor system configured for processing information contained in the reports received from the plurality of terminals to provide a processing result; and
- an activator configured for activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

13. The wireless access telecommunications infrastructure configured for performing the method according to one or more of the claims 1-10.

14. A signal transmitted in a cell of the wireless access telecommunication of claim 12 or 13, wherein the signal contains a reporting identifier indicating that the cell is an inactive cell.

15. A terminal configured for operating in the wireless access telecommunications infrastructure of claim 12 or 13 and for processing the signal according to claim 14 or operating in the method according to claim 10.

ABSTRACT

The invention relates to a method for activating at least one inactive cell in a wireless telecommunications infrastructure. The telecommunications infrastructure comprises an active cell containing a plurality of terminals. A presence signal is transmitted in the at least one inactive cell. The plurality of terminals in the active cell detect the presence signal(s) of the one or more inactive cells to gather information from the inactive cell. The information is reported to and received at the telecommunications infrastructure. The information received from the plurality of terminals is processed in a processing system of the telecommunications infrastructure to provide a processing result. The inactive cell is activated when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

+ FIG. 3

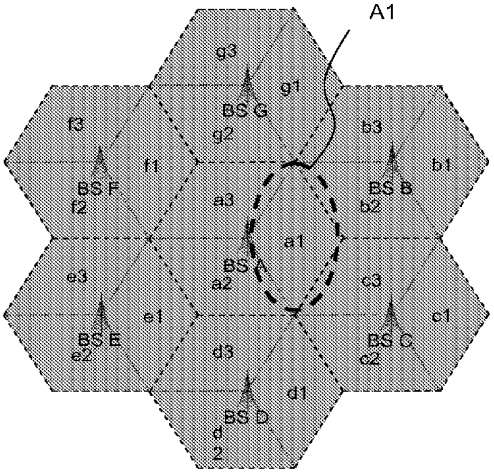

FIG. 1A

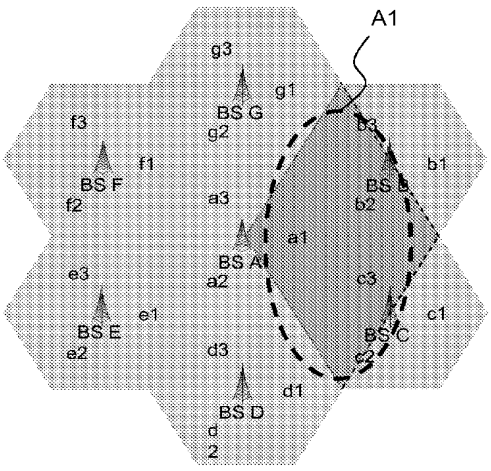

FIG. 1B

1/6

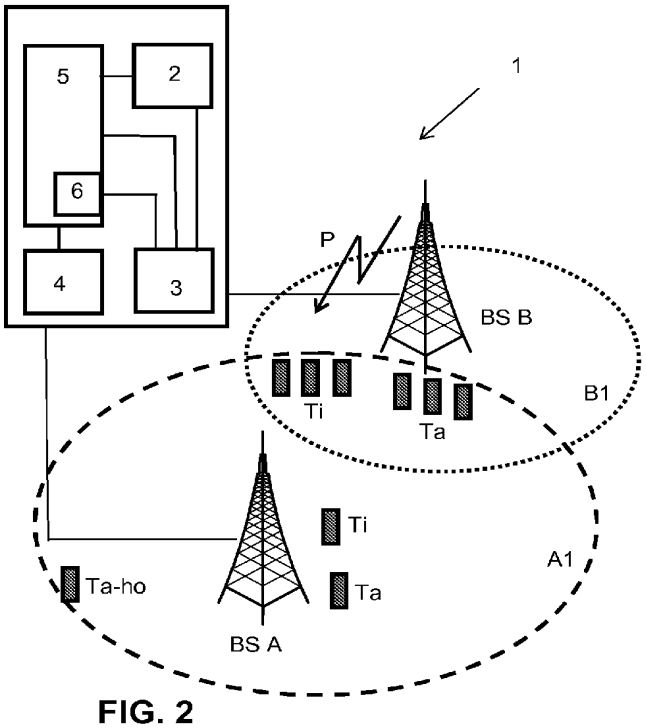
5
2
6
4
3
1
P
BS B
B1
Ti
Ta
Ti
Ta
A1
Ta-ho
BS A

FIG. 2

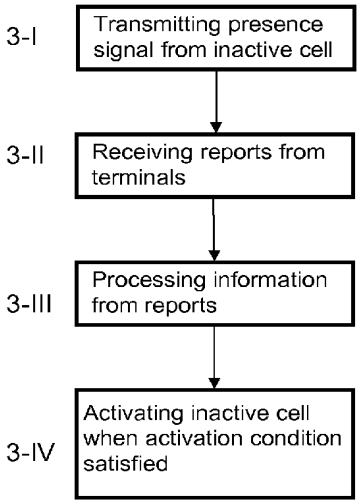
3-I
Transmitting presence signal from inactive cell
3-II
Receiving reports from terminals
3-III
Processing information from reports
3-IV
Activating inactive cell when activation condition satisfied

FIG. 3

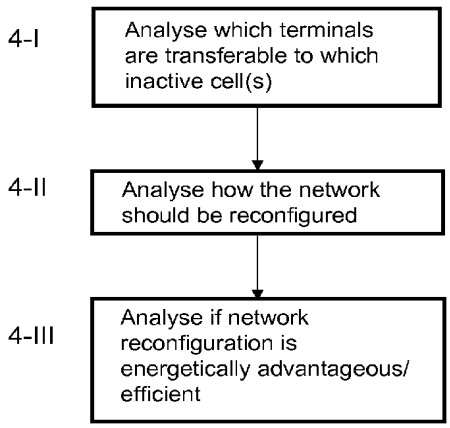
4-I
Analyse which terminals are transferable to which inactive cell(s)
4-II
Analyse how the network should be reconfigured
4-III
Analyse if network reconfiguration is energetically advantageous/ efficient

FIG. 4

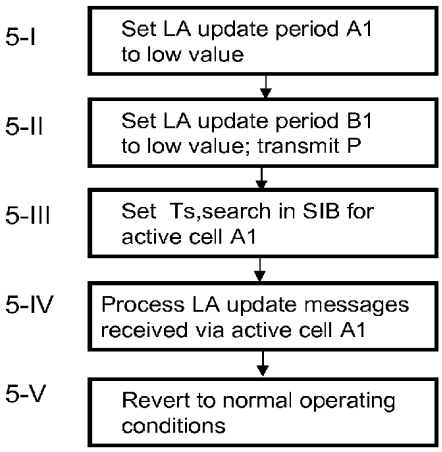
5-I
Set LA update period A1 to low value
5-II
Set LA update period B1 to low value; transmit P
5-III
Set Ts,search in SIB for active cell A1
5-IV
Process LA update messages received via active cell A1
5-V
Revert to normal operating conditions

FIG. 5

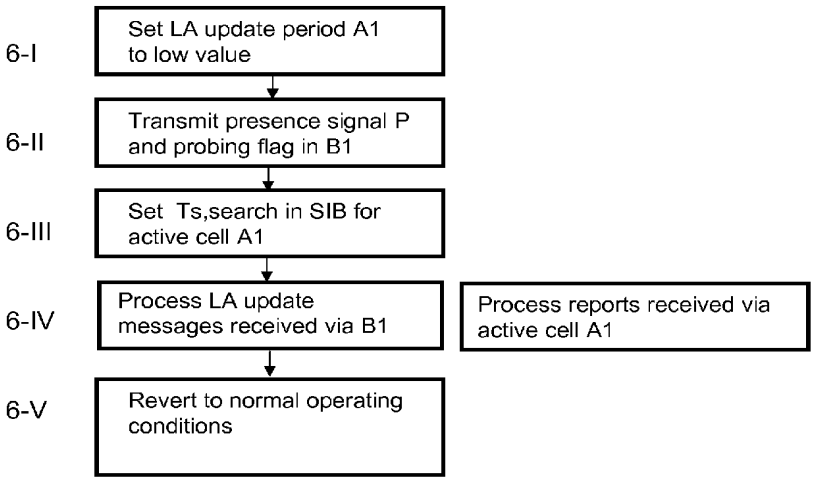
6-I
Set LA update period A1 to low value
6-II
Transmit presence signal P and probing flag in B1
6-III
Set Ts,search in SIB for active cell A1
6-IV
Process LA update messages received via B1
Process reports received via active cell A1
6-V
Revert to normal operating conditions

FIG. 6

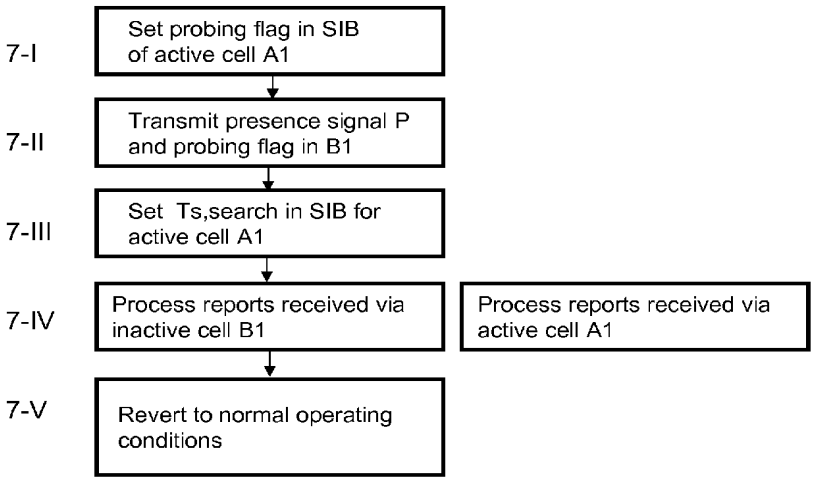
7-I
Set probing flag in SIB of active cell A1
7-II
Transmit presence signal P and probing flag in B1
7-III
Set Ts,search in SIB for active cell A1
7-IV
Process reports received via inactive cell B1
Process reports received via active cell A1
7-V
Revert to normal operating conditions

FIG. 7

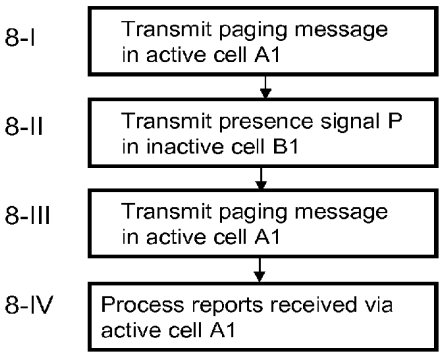
8-I
Transmit paging message in active cell A1
8-II
Transmit presence signal P in inactive cell B1
8-III
Transmit paging message in active cell A1
8-IV
Process reports received via active cell A1

FIG. 8

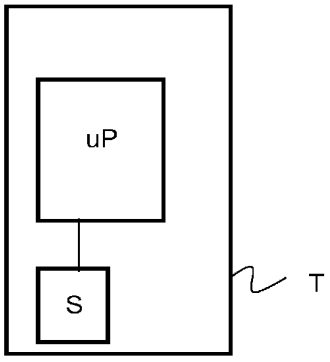
uP
S
T

FIG. 9

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WORLD
INTELLECTUAL PROPERTY
ORGANIZATION

DOCUMENT MADE AVAILABLE UNDER THE PATENT COOPERATION TREATY (PCT)

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[Continued on next page]

(54) Title: METHOD AND TELECOMMUNICATIONS INFRASTRUCTURE FOR ACTIVATING AN INACTIVE CELL

(57) Abstract: The invention relates to a method for activating at least one inactive cell in a wireless telecommunications infrastructure. The telecommunications infrastructure comprises an active cell containing a plurality of terminals. A presence signal is transmitted in the at least one inactive cell. The plurality of terminals in the active cell detect the presence signal (s) of the one or more inactive cells to gather information from the inactive cell. The information is reported to and received at the telecommunications infrastructure. The information received from the plurality of terminals is processed in a processing system of the telecommunications infrastructure to provide a processing result. The inactive cell is activated when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

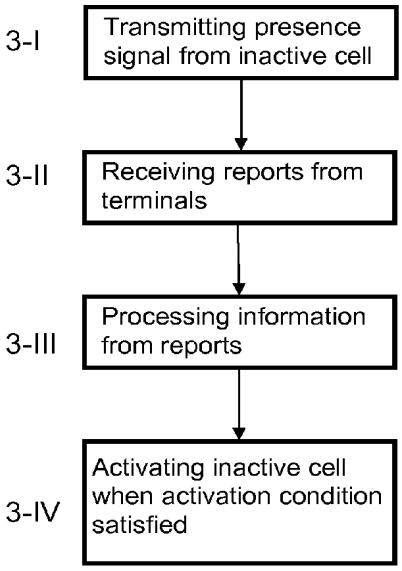

FIG. 3

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Published:

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

Method and telecommunications infrastructure for activating an inactive cell

FIELD OF THE INVENTION

The invention relates to the field of telecommunications infrastructures. More specifically, the invention relates to the field of activating inactive cells of a telecommunications infrastructure for purposes such as controlling energy consumption and electromagnetic radiation, particularly reducing energy consumption or electromagnetic radiation.

BACKGROUND OF THE INVENTION

The operation of wireless access networks for enabling wireless communication is highly energy consuming. In view of current environmental concerns, increased attention is paid recently to the energy consumption of telecommunications networks.

Various studies have been performed to reduce conventional energy consumption in wireless access networks, e.g. by exploring the option of using sustainable energy sources (Ericsson AB White Paper "Sustainable energy use in mobile communications, June 2007).

With the development of the 3GGP Long Term Evolution (LTE) network, energy saving for the network is also approached in the context of self organizing networks (SON). In a White Paper of NEC, dated February 2009, "NEC's proposals for next-generation radio network management", energy is considered as a significant part of the operation expenses of a cellular network. It is recognized that the main saving potential resides in using variations in load over time, that allows to switch off parts of the resources, for example during the night. When a complete base station is switched off, other base stations of the access network need to make up for the reduction in coverage area and capacity. This requires coordination between the nodes. A similar use case is described in 3GGP TR 36.902 v9.1.0 "Self-

configuring and self-optimizing network(SON) use cases and solutions".

Once base stations (or one or more cells thereof) have been deactivated, at some point in time these base stations (or cells) may have to be reactivated again. Thus, a decision is required when and/or which base stations or cells need to be activated.

A first solution would be to activate the base stations or cells at a predetermined time. As an example, it can be imagined that fewer base stations need to be active during night time and more base stations need to be active during the day.

Another solution would be to activate all inactive cells adjacent to (i.e. relevant for) a currently active cell when the currently active cell detects a certain traffic load exceeding a threshold or detects a rising traffic load.

There is a need in the art to improve these solutions by determining more accurately which base stations and/or cells should be activated.

SUMMARY OF THE INVENTION

A method for activating at least one inactive cell in a wireless telecommunications infrastructure is disclosed. The telecommunications infrastructure comprises an active cell containing a plurality of terminals. A presence signal is transmitted in the at least one inactive cell. The plurality of terminals in the active cell (which are not necessarily all terminals in the active cell) detect the presence signal(s) of the one or more inactive cells to gather information about the inactive cell. The information is reported to and received at the telecommunications infrastructure. The information received from the plurality of terminals is processed in a processing system of the telecommunications infrastructure to provide a processing result. It should be appreciated that the information contained in some reports from some terminals need not necessarily be processed. The inactive cell is activated when the processing result fulfils at least one activation condition such that at

least one of the plurality of terminals is within a coverage area of the activated cell.

Capabilities of terminals to gather information about a cell (e.g. to measure a signal transmitted by a cell) and to report such information are known in the art, for example to gather information about a neighbour cell in order to consider a handover to a neighbour cell. Examples for LTE include measuring and reporting Reference Signal Received Power (RSRP) and Reference Signal Received Quality (RSRQ). Also see 3GPP TS 37.320 "Radio measurement collection for Minimization of Drive Tests (MDT)". Examples for UMTS include measuring and reporting Received Signal Code Power (RSCP) and a quantity indicated as Ec/Io. For other technologies comparable quantities have been defined.

Processing information received from terminals may also include combining the received information with other information available to the infrastructure, such as the number of (failed) handover requests to an inactive cell, the number of (rejected) session requests from terminals trying to connect to an inactive cell, the positions of (some of) the terminals, the current load in an active cell, history or statistics of the history of the load in a cell, the location of a cell and the typical coverage area of a cell when active.

Receiving and processing information may continue e.g. until an activation condition has been fulfilled, or until a predetermined time has elapsed (e.g. since commencing to transmit a presence signal in an inactive cell) while an activation condition is not fulfilled, or until substantially no more additional information is received in relation to the transmission of a presence signal while an activation condition is not fulfilled. It should be appreciated that gathering adequate information about an inactive cell transmitting a presence signal may take some time, depending for example on how quickly a terminal may be informed about the measurements to be performed, on the type and duration of measurements to be performed (which may include performing signal strength and/or signal quality measurements on an inactive cell's presence signal, performing

handover evaluations, cell reselections and location area updates), on the way a terminal is able to perform the requested functions, on the complexity and number of reports a terminal may prepare, on the way the telecommunication infrastructure may receive the reports, on the type and number of reports and/or events to be received, on the fraction of the reports that include location information and on the accuracy of the location information, etc. The time period from commencing to transmit a presence signal in an inactive cell to the moment a decision is taken on whether or not to activate the inactive cell may be referred to as a 'probing period'.

Fulfilling an activation condition may be that the processing result indicates, for example, that the number of terminals which are estimated to be in the best server area of an inactive cell, when activated, is above a predetermined number of terminals or is above a predetermined fraction of the terminals currently served by one or more active cells, or that the load (expressed e.g. in the number of calls or in an aggregated bit rate or in another load measure) that is estimated to be absorbed by an inactive cell, when activated, is above a predetermined load measure.

A computer program containing software code portions (possibly distributed over several components in the telecommunications infrastructure) for performing the method when executed by a processing system is also disclosed.

A wireless access telecommunications infrastructure comprising an active cell and at least one inactive cell is also disclosed. The active cell can contain a plurality of terminals is also disclosed. The infrastructure comprises a presence signal generator configured for generating a presence signal to be transmitted in the at least one inactive cell. The infrastructure further comprises a receiver configured for receiving reports from the plurality of terminals detecting the presence signal and a processor system configured for processing information contained in the reports received from the plurality of terminals to provide a processing result. The processing system may be part of the telecommunications infrastructure or be

(partly) connected to the telecommunications infrastructure in which case the processing system is considered part of the telecommunications infrastructure. The infrastructure further comprises an activator configured for activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell. By using the (partly) existing capabilities of terminals to measure and report information received from neighbouring cells (typically applied for e.g. handover operations), the transmission of the presence signal in the currently inactive cell enables the telecommunications infrastructure to assess whether the terminals recognize this cell as an appropriate target, i.e. whether the terminals currently connected to or camping on the active cell are likely able to be connected to or camp on a currently inactive cell. The telecommunications infrastructure is configured to receive and process the information relating to the inactive cell(s) from the reports of various terminals within the active cell (possibly, but not necessarily, all terminals in the active cell). The reported information, possibly combined with other information available to the infrastructure, forms the basis to decide whether or not to actually activate the currently inactive cell (i.e. to change the network configuration of the telecommunications infrastructure) in order for the terminal to connect to or camp on the activated cell via a handover operation or cell reselection, respectively.

The information can be used by an energy evaluation algorithm for determining whether energy consumption of the telecommunications infrastructure can be reduced or used in an efficient manner, e.g. by efficiently controlling activation of cells in the telecommunications infrastructure if required.

The method and telecommunications infrastructure may, in addition or alternatively, also be applied for other purposes. As an example, similar considerations apply to the reduction of electromagnetic radiation produced by a base station. For example, for health reasons it is advisable to limit the amount and duration of electromagnetic radiation to a level

that is strictly necessary for the operation of the base station. When the level of electromagnetic radiation can be reduced or when a base station can be switched off, this may be well-appreciated by the population in the vicinity of the base station. Considerations may either apply to the complete telecommunications infrastructure or to a part of the infrastructure, e.g. for a plurality of cells. For example, heavily populated areas may be selected to have low electromagnetic radiation density, whereas in less densely populated areas, the electromagnetic radiation levels can be higher. In addition to health concerns, there may also be technical reasons to restrict the electromagnetic radiation, and therewith the possibility and level of interference experienced in adjacent areas.

It should be appreciated that the active cell and inactive cell may relate to any type of radio access technology (RAT) including, but not limited to GSM, UMTS, LTE, Wimax etc.

It should further be appreciated that the measurements for information on the inactive cell(s) of terminals in the active cell may relate to a single radio access technology (intra-RAT) or multiple different radio access technologies (inter-RAT). An example of inter-RAT includes a terminal in an active UMTS cell performing measurements on an inactive GSM cell.

The method and telecommunications infrastructure also allow taking account of the distribution of terminals in the active cell. For example, if the analysis reveals that a considerable number of terminals served by the active cell finds themselves near the edge of the active cell (i.e. the reported measurement information indicates a high signal level or signal quality for the presence signal of neighbouring inactive cells and much lower levels for the active cell for a considerable number of terminals), the total energy for the telecommunications infrastructure may be reduced by activating one or more inactive cells and hand over these terminals to these cells.

In the present application, an active cell is considered a cell enabling connection of a terminal to the base station responsible for the cell. In other words, the cell is fully operational.

An inactive cell is considered a cell that is not intended to carry any voice or data traffic but may transmit a presence signal during particular time intervals or continuously. A presence signal may comprise a beacon signal, such as BCCH in GSM network, CPICH in UMTS network or reference symbols in LTE in order to indicate the presence of the cell. In addition, the inactive cell may at least transmit some system information (e.g. cell identity, power level of its beacon signal, etc.), for example on a broadcast signal (BCH) containing system information blocks (MIB, SIB, etc.), depending on its level of functionality. A presence signal may also include a synchronization channel (SCH), commonly used in mobile communication systems such as GSM, UMTS and LTE, for cell search, for identifying a cell and for synchronization with a cell. An inactive cell may, during a probing period transmit a presence signal, for example reference symbols in LTE or CPICH in UMTS, synchronisation signal (SCH) and broadcast signal (BCH) containing system information blocks (MIB, SIB, etc) while not accepting any 'normal' traffic, such as voice or data connections.

The inactive cell can become an active cell by applying the method disclosed herein. The inactive cell may be an inactive cell because it does not accept handover for active terminals to the inactive cell or because it redirects connections to an active cell once a connection is requested from a terminal in the inactive cell. Such methods are known in the art and may for example be realised by settings a call admission control function (CAC) to block any handover request or any request for setting up a new session.

The main purpose of the inactive cells to transmit the presence signal is to allow the terminals in the active cell to perform measurements on these inactive cells and to report such measurements to the network. Terminals in the active cell can be distinguished between terminals in the active mode (active terminals) and terminals in the idle mode (idle terminals). A terminal with an active connection (e.g. a voice call or data being exchanged) is said to be in 'active mode' or 'connected mode'. When the terminal is in active mode (active terminal),

the network has detailed knowledge about the terminal and knows by which cell it is served. A terminal which is powered on but without an active connection is said to be in 'idle mode'. When the terminal is in idle mode (idle terminal), the network has limited knowledge about the mobile station and only knows in which paging or location area the terminal may be paged. In idle mode the terminal listens to e.g. a broadcast channel or a paging channel of a particular cell. It is said that the terminal 'camps on' that cell. Consequently, a decision as to activate an inactive cell (or which active cell(s) from a set of inactive cells) can thus be based on information gathered from terminals in different states, i.e. from active terminals (terminals which have an active connection with the network for conveying traffic) and possibly from idle terminals (terminals which do not have an active connection with the network).

As a first example, a decision to activate an inactive cell may be based on the information gathered only from active terminals, for example by one or more of the following:

1. Counting requests for handover from active terminals with the inactive cell as target/destination.

2. Receiving and processing reported measurements from active terminals, e.g. signal strength and/or quality of the presence signal transmitted in an inactive cell, location information (e.g. determined by GPS or by the mobile network), etc.

3. Counting requests for a new session from active terminals that attempted to set up a connection with the inactive cell (and were refused and/or redirected towards an active cell because the inactive cell does not accept 'normal' traffic).

4. Any other measurements by active terminals that would be useful in deciding whether or not to activate an inactive cell.

As a second example, a decision to activate an inactive cell may be based on the information gathered both from active terminals and from idle terminals. In addition to the possibilities listed above for active terminals, from the idle terminals one or more of the following could be used:

1. Counting events of cell reselection by an idle terminal from an active cell to an inactive cell. This may in particular be relevant to an inter-RAT case. For example, an idle terminal that was originally camped on an active cell reselects to an inactive cell and then camps on the inactive cell.

2. Counting events of a location area update (e.g. as a result of a cell reselection).

3. Receiving an processing measurements performed by idle terminals, e.g. about signal strength and/or quality of the presence signal transmitted in an inactive cell, location information (e.g. determined by GPS or by the mobile network), etc.

4. Any other measurements by idle terminals that would be useful in deciding whether or not to activate an inactive cell.

As a third example, a decision to activate an inactive cell may be based on the information gathered only from idle terminals. However, this is not preferred, because the information from currently active terminals is considered to be highly relevant and relatively easy to obtain.

As indicate above, an inactive cell is considered a cell that is not intended to carry any voice or data traffic but may transmit a presence signal. That leaves a whole spectrum of additional capabilities which may or may not be available in an inactive cell while transmitting a presence signal during a probing period. Two examples will be provided towards the ends of that spectrum; a first example of an inactive cell with close to full functionality and a second example of an inactive cell with close to minimum functionality. It may be noted that the functionality of an inactive cell also has some impact on the role the inactive cell may have in gathering information about the inactive cell.

A first example of an inactive cell is a cell which does not accept any ‘normal’ data or voice traffic from a terminal (realised, for example, by proper settings of the connection admission function, which blocks any handover towards the or session set-up to the inactive cell) but is otherwise close to fully functional. For example, the Tx and Rx chains may be fully

functional, the interfacing with the core network (in LTE the for example X2 or S1 interface, in UMTS for example the Iub interface with the RNC) may be activated, etc. Consequently, the inactive cell may be able to receive measurement reports from active and/or idle terminals, may be able to process or forward these reports, may be able to receive location area updates from idle terminals, etc. Also, requests for handover towards the inactive cell and requests for setting up a session to the inactive cell may be received and properly responded to, i.e. be refused or redirected towards an active cell. It is expected that with a close to full functionality during a probing period, a noticeable energy consumption is unavoidable but that still a major energy saving is achieved by not allowing 'normal' data or voice traffic.

A second example of an inactive cell is a cell which only performs close to the minimum of functions, i.e. the transmission of a presence signal. For example, only the downlink signalling (such as pilot channel/reference symbol, SCH, BCH, etc.) are active to indicate the presence and the identity of the inactive cell and to allow the terminals to perform measurements on the presence signal of the inactive cell. The inactive cell may be configured to not receive any signalling messages (e.g. related to handover, to session set-up, to location area updates, to measurement reports, etc.) during the probing interval. Communication with the core network may likewise be restricted to, for example, receiving management commands related to the transmission of the presence signal (including any associated information), to the activation of the inactive cell and to transmitting some status information. It is expected that with a close to minimum functionality during a probing period, a very high energy saving is achieved.

Between the ends of the spectrum a trade-off may be made between the energy consumption and the functionality provided by (and associated therewith the ease of information gathering) an inactive cell during its probing period.

The method for assessing whether activation of the inactive cell is possible or required can be performed during

subsequent time intervals (e.g. periodic time intervals), as defined in claim 2 in order to not bother the terminals (battery saving) and the network (reduction of network load) continuously. However, (semi-) continuous performance of the method when one or more cells are currently inactive may be an attractive alternative for rapid assessment of opportunities to change the configuration of the telecommunications infrastructure.

In an embodiment of the invention, defined in claim 3, the terminals may be provided with measurement and/or reporting parameters in order to control measurement and reporting operations by the terminals in the active cell. The parameters may e.g. be provided over a connection via the active cell to a terminal that is in the active mode or broadcasted in the active cells to terminals in the active or idle mode. The measurement parameters trigger terminals to perform measurements. The reporting parameters instruct terminals (when) to report measurements to the network.

In existing wireless access telecommunications networks, terminals usually already perform measurements in certain conditions and may report measurement results in certain other conditions. For example, active terminals in handover regions between adjacent cells usually already report measurement information from the adjacent cells to the network in order for the network to perform a handover decision for each individual terminal. The measurement parameters provided to the terminals as defined in claim 3 not only allow to obtain measurement information from active terminals in the handover region but also allow to obtain information about neighbour inactive cells from active terminals outside the handover region and from idle terminals within the active cell. These terminals may report that information to the telecommunications infrastructure.

As a first example, a reporting threshold usually applied in the terminal to prevent reporting measurements about neighbour signals with a signal level which is insufficient compared to the signal from the serving cell to be relevant for a possible handover may be adjusted temporarily to allow also reporting signal levels which would otherwise be considered

insufficient. As a second example, a signal level threshold usually applied in the idle terminals to prevent performing measurements on neighbour cells when the signal level from the serving cell is more than adequate, may be adjusted (e.g. increased) temporarily to allow measurements on neighbour cells. Providing the measurement and/or reporting parameters to the terminals in the active cell enables more terminals and enables terminals at more locations in the active cell (e.g. not only in what would normally be considered the handover region between two cells) to perform measurements and/or to provide reports to the network.

The telecommunications infrastructure may comprise several inactive cells that may concurrently or sequentially transmit the presence signal, enabling the terminals to measure signals from a plurality of cells concurrently or sequentially to allow the network to obtain a more complete picture of the possibilities for a network configuration change (claim 4). The inactive cells may be located in the active cells (e.g. micro cells), may be adjacent to the active cell or may be located further away from the active cell. The plurality of inactive cells may have an aggregated estimated coverage area that at least partially overlaps the coverage area of the active cell.

Concurrent transmission of a presence signal by several inactive cells may be time efficient and may provide a slightly different picture of the network situation. For example, in a situation with overlapping inactive cells, a sequential transmission of the presence signal could indicate that a particular user device would select more than one inactive cell if only a single of these inactive cells would be activated, whereas concurrent transmission of the presence signal would indicate which of these inactive cells the same user device would select if all these inactive cells would be activated. Sequential transmission of a presence signal may be work load efficient as it allows to refrain from completing the entire envisaged sequence, for example if the thus far collected information appears to be satisfactory. Sequential transmission of a presence signal may involve the sequential transmission in groups of inactive cells

to assess the best combination. The sequential variant may use history information to first transmit a presence signal in inactive cells that previously turned out successful candidates for activation.

In the embodiment of claim 6, a reporting identifier is transmitted in the inactive cell. The present application also discloses a signal transmitted in a cell of the infrastructure, wherein the signal comprises the reporting identifier.

Active terminals in the active cell may receive the reporting identifier and transmit the reporting identifier with the report in order to enable the telecommunications infrastructure to distinguish between reports from terminals related to normal handover (to an active cell) and reports from terminals reporting information about the inactive cells for assessing whether the inactive cell should be activated.

Idle terminals detecting the reporting identifier from the inactive cell may be configured to use this identifier to prevent cell reselection by the idle terminal to the inactive cell, to report the information about the inactive cell to the telecommunications infrastructure via the active cell before reselection to the inactive cell, or to report information about the inactive cell to the inactive cell when the inactive cell is configured to receive such reports.

The embodiment defined in claim 7 is advantageous for the reason that the number of idle terminals is normally much greater than the number of active terminals. Having a plurality of idle terminals reporting information on the presence signal(s) from the inactive cell(s) may greatly contribute to the complete picture of opportunities for reconfiguration of the telecommunications infrastructure and also may indicate possible traffic load in the near future. For the idle terminals to transmit reports to the telecommunications infrastructure, these terminals should temporarily become active.

Apart from the mechanism for idle terminals as described above in relation to claim 6, the embodiments of claims 8-10 provide several other mechanisms for participation of idle terminals in the method according to the invention. These em-

bodiments are described in further detail in the detailed description.

Briefly, the embodiment of claim 8 comprises temporarily decreasing a location area update period (or a similar period) in at least one of the active cell and the inactive cell. The embodiment is advantageous as it may require no or only few modifications to currently existing networks.

The embodiment of claim 9 comprises the idle terminals to report measurement information to the telecommunications infrastructure via the active cell, whereas these terminals would otherwise reselect to the inactive cell and attempt reporting to the inactive cell. This embodiment allows the inactive cells to maintain a status wherein these cells are not able or are configured not to be able to receive reports.

The embodiment of claim 10 comprises transmitting a paging message in the active cell instructing the idle terminals to obtain and/or report the information. The idle terminals listen to broadcast and paging channels and can be triggered to detect information from inactive cells using these channels. Using such paging message, less need exists to temporarily reconfigure the system information of the active cell different from the normal operation. This is particularly true if the paging messages carry configuration parameters for the idle terminals, such as the measurement and/or reporting parameters defined in claim 3.

The embodiments of claims 6 and 10 require modifications to the processing capabilities of currently existing wireless terminals. The present application discloses a wireless terminal for use in these embodiments.

Hereinafter, embodiments of the invention will be described in further detail. It should be appreciated, however, that these embodiments may not be construed as limiting the scope of protection for the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIGS. 1A and 1B are schematic illustrations of base stations in a wireless access telecommunications infrastructure providing active cells and inactive cells;

FIG. 2 is a schematic illustration of a telecommunications infrastructure comprising a base station defining an active cell containing a plurality of terminals and a base station providing an inactive cell transmitting a presence signal;

FIG. 3 is a flow chart illustrating various steps of a method according to an embodiment of the invention;

FIG. 4 is a flow chart illustrating the information processing step in further detail;

FIGS. 5-8 are flow chart illustrating steps of a method for participation of idle terminals and

FIG. 9 is a schematic illustration of a wireless terminal configured for being operable in the telecommunication infrastructure of FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1A is a schematic illustration of base stations BS A – BS G in a wireless access telecommunications infrastructure providing a plurality of active cells. Each base station location comprises three sectors, thus covering an area around the base station location. For example, cell A1 of base station location BS A serves its best server area marked ‘a1’. Similarly, cell A2 and A3 of the same location serve their best server area marked ‘a2’ and ‘a3’ respectively. A same set-up is shown for the other base station locations BS B to BS G. In FIG. 1A, the regular pattern of base stations and sectors leads to the commonly known hexagonal pattern of coverage areas.

FIG. 1B shows the same areas in a light grey colour. For example for energy saving reasons, some cells at base station locations B and C have been switched off and cell A1, together with some other cells (not shown) now provides service to some of BS B and BS C’s best server areas. In FIG. 1B, a darker gray shading illustrates that cell A1 provides service not only in its ‘own’ or ‘native’ area a1, but also in areas b2 and c3 and in part of the areas b3 and c2. Other cells may simi-

larly have been switched off and service in their ('native') areas may be provided by one or more of the surrounding cells.

FIG. 2 is a schematic illustration of a wireless access telecommunications infrastructure 1 comprising a base station BS A defining an active cell A1 containing a plurality of active terminals Ta and idle terminals Ti. Base station BS B provides an inactive cell B1 wherein it transmits a presence signal P.

Telecommunications infrastructure 1 comprises a presence signal generator 2 for generating the presence signal P via interface 3. The telecommunications infrastructure 1 further comprises a receiver 4 configured for receiving reports from the plurality of terminals Ta, Ti detecting the presence signal P. A processor system 5 is configured for processing information contained in the reports received from the plurality of terminals Ta, Ti to provide a processing result. The processor system 5 has an activation module 6 configured for activating the inactive cell of BS B when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals Ta, Ti is within a coverage area of the activated cell B1 of base station BS B.

Various events may trigger the telecommunications system 1 to operate the method as illustrated in the flow chart of FIG. 3. The method may be performed periodically or continuously, wherein generator 2 periodically or continuously generates the presence signal P in inactive cell B1. In at least some situations, it is advantageous to transmit the presence signal P concurrently by several related cells (rather than transmitting the presence signal P for separate cells, e.g. one-by-one). For example, in FIG. 1B, it may be advantageous to perform the method and evaluation concurrently for cells B3, B2, C3 and C2. A same or similar advantage may apply to cells which otherwise provide mutual coverage or are in close proximity of each other. Alternatively or in addition, the transmission of the presence signal P may be initiated by a predetermined condition in an active cell A1 verified by processing system 5, e.g. a traffic load exceeding a threshold or a traffic load showing a substantial increase.

The method as illustrated in the flow chart of FIG. 3 may be performed as follows. In step 3-I, a presence signal P is generated by generator 2 and transmitted in the at least one inactive cell of base station BS B. The plurality of terminals Ta, Ti in the active cell A1 (which are not necessarily all terminals in the active cell) detect and measure the presence signal P of the inactive cell B1 and gather information about the inactive cell (e.g. signal level/quality of presence signal P and cell identity of inactive cell B1). The information is reported to and received at the telecommunications network via the active cell A1 and receiver 4 (step 3-II). Alternatively, some of the information, in particular from idle terminals Ti, may be also reported via inactive cells, presuming these are configured for at least receiving such reports. The information received from the plurality of terminals Ta, Ti is processed in processing system 5 to provide a processing result (step 3-III). It should be appreciated that the information contained in some reports from some terminals need not be processed by processing system 5 and that processing system 5 may use additional information not received from the terminals (e.g. information typically available from a management system such as the location and configuration of the base stations etc.). The inactive cell B1 is activated in step 3-IV when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals Ta, Ti is within a coverage area of the activated cell B1.

FIG. 4 shows a flow chart exemplifying some steps of processing step 3-III in further detail. The telecommunications infrastructure 1 allows to take account of the distribution of terminals Ta and Ti in the active cell A1. The information obtained from the terminals Ta (such as measured signal level/quality or path loss) can be applied for energy reduction purposes. For example, if the analysis (e.g. based on the reported signal level measurements) reveals that a considerable number of active terminals Ta served by the active cell A1 finds themselves near the edge of the active cell A1 as shown in FIG. 2 and is transferable to inactive cell B1 (step 4-I), a recon-

figuration of the network can be analysed (step 4-II) wherein the inactive cell B1 is activated (step 4-II). The activation condition wherein the total energy for the telecommunications infrastructure 1 can be reduced (step 4-III) may be fulfilled since the power reduction estimated to be obtained by transferring these terminals away from active cell A1 may be more than the power estimated to be required for an activated cell B1 and for serving these terminals by cell B1.

The analysis as depicted in FIG. 4 may also be used for increasing the energy consumption of the telecommunications network in an efficient manner. As an example, if the load in active cell A1 increases, at some point in time additional cells need to be activated. Reports from the active terminals Ta may indicate (e.g. from the signal levels / signal quality reported about the presence signal P of cell B1) that cell B1 is a suitable candidate for activation.

As an alternative or in addition, triggered reports from idle terminals Ti may be considered in the decision which cell is most suitably reactivated to alleviate the effects of the local traffic overload. Note that the number of idle terminals in a cell is usually much larger than the number of active terminals. Reports from such idle terminal typically indicate the best cell as selected by each triggered idle terminal, choosing from both active and inactive cells that transmit a presence signal P. Counting for each inactive cell transmitting presence signal P how many idle terminals Ti (optionally: how many idle terminals that currently camp on the overloaded active cell) would prefer that inactive cell, provides an indication of the near-future traffic load that can be absorbed by the inactive cell when fully reactivated, thus relaxing the currently overloaded active cell from that (potential) ‘burden’. Instead or along with the information on the active terminals Ta, the information on the idle terminals Ti can be considered in the decision process regarding which inactive cell to activate.

Several methods of triggering active user terminals Ta and idle terminals Ti to obtain information on the inactive

cell(s) and to report this information will now be discussed in further detail.

Generally, the terminals may be provided with measurement and/or reporting parameters in order to control measurement and reporting operations by the terminals in the active cell A1. The parameters may e.g. be provided over a connection via the active cell to an active terminal Ta or broadcasted in the active cell A1 to active and idle terminals Ta, Ti using e.g. system information blocks SIB.

An active terminal Ta receives instructions from the network about which measurements to perform and which events to report to the network (e.g. the event that a neighbour inactive cell B1 is detected with a signal strength/quality that is better by x dB than that of the currently serving active cell A1). When a measurement leads to one of the specified events, the terminal Ta reports the relevant information (e.g. an identification of the detected neighbour inactive cell B1, its measured present signal level/quality and the measured signal level/quality of the active cell A1) over the existing connection to the telecommunications infrastructure 1. Either in response to a report from a terminal Ta or autonomously, the telecommunications infrastructure 1 may instruct the terminal Ta to perform additional measurements of a same or different kind and to report the results.

Base station BS B may transmit a reporting identifier, hereinafter also referred to as 'probing flag', in the inactive cell B1. Active terminals Ta in the active cell A1 may receive the reporting identifier and transmit the reporting identifier with the report containing information regarding inactive cell B1. The active terminal Ta is thus configured to recognize the reporting identifier and to include this reporting identifier in the report containing the information on the inactive cell B1. This facilitates the processing system 5 of telecommunications infrastructure 1 to more easily distinguish between terminals Ta-ho (see FIG. 2) reporting in the context of a normal handover to another active cell (not shown in FIG. 2) and terminals Ta reporting information from the inactive cell B for assessing

whether the inactive cell should be activated. An alternative for enabling the telecommunications infrastructure 1 to distinguish between reports relating to normal handovers and reports to be analyzed towards a decision whether to activate an inactive cell is to inform the base station BS A (or at least the associated entity normally handling the handover-related reports) of the identity of the inactive cells transmitting presence signals, such that reports related to an identity of an inactive cell can be excluded from being processed towards a handover decision and can be forwarded to processing system 5.

In order for idle terminals in active cell A1 to be triggered to obtain information about inactive neighbour cell B1, various parameters may be broadcasted in the active cell A1 in the system information block SIB for cell reselection. One example of such a parameter is an absolute signal level threshold Ts,search. This threshold is used by idle terminals as a reference for the received signal level Srxlev, measured by the terminals, from the active cell A1 and to decide if neighbour measurements for cell reselection are needed. Different values might be assigned to Ts,search for the measurement of intra-frequency, inter-frequency and inter-RAT neighbours. If Srxlev < Ts,search, the terminal will search for corresponding (intra-frequency, inter-frequency or inter-RAT) neighbour cells and measure the received signal level Nrxlev and/or Nqual. Nrxlev is the received signal level of the presence signal from a neighbour cell, e.g. from the inactive cell B1. Nqual is the received signal quality from a neighbour cell, e.g. from inactive cell B1 (e.g. E_c/I_0 of the CPICH for UMTS cells or RSRQ of the reference symbols for LTE cells). Hysteresis parameter Qhyst for the active cell A1 and offset parameters Qoffset,n to be applied to each neighbour *n* specifically, can also be broadcasted in the active cell A1.

Next, exemplary methods will be discussed for instructing idle terminals Ti to perform measurements on inactive cells and to report this information to the telecommunications infrastructure 1.

In a first method, illustrated in the flow chart of FIG. 5, a location area update period (or a similar period) is decreased in the active cell A1 and the inactive cell B1. The embodiment is advantageous as it requires no modifications to currently existing networks.

In the active cell A1, in the system information (SIB) to be broadcast on the broadcast channel of the active cell A1, a relatively short value (e.g. 30 s, 1 min) is set for the periodic location area (LA) update (instead of a nominal value, e.g. 30 min, 1 hour, infinite). This is illustrated in step 5-I. A paging message may be issued in the cell A1 indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1.

As a consequence, an idle terminal Ti camping on the active cell A1 reads the modified SIB and starts providing frequent (e.g. every 30 s, 1 min) periodic LA updates. An LA Update message also includes information about the identity of the terminal. The telecommunications infrastructure 1 (more particularly processing system 5) receives the LA Update messages and may derive (e.g. every 30 s, 1 min) how many and which terminals Ti are currently camping on the active cell A1. This provides information about the initial situation regarding idle terminals in the active cell.

In step 5-II, the inactive cell(s) B1 set a periodic LA update value to a similarly short (e.g. 30 s, 1 min) value as used for the active cell A1. The presence signal P is transmitted in the inactive cell B1.

In the active cell A1, in the system information (SIB) to be broadcast on the broadcast channel of the cell, the absolute signal level threshold parameter Ts,search is set higher than nominal (e.g. nominal value +[5,10] dBm), step 5-III. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells B1. In the cell, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselec-

tion evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal Ti for which the received signal level of the active cell A1 is below the adjusted (increased) threshold Ts,search measures the neighbour cells, for example including inactive neighbour B1. For some RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active) neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell. The ranking mechanism may be dependent on the radio access technologies of the involved cells and possibly also on other conditions like environment characteristics. In the existing art it is for instance known that cell reselection in a network consisting of cells with different radio access technologies may be organised in a 2-step manner: For instance in a network consisting of both UMTS (UTRAN) and GSM (GERAN) cells, first a ranking based on received signal level (Srxlev for the serving cell and Nrxlev for the neighbour cells) may be performed, taking account of corresponding Qhyst and Qoffset,n (noted as Qhyst(1) and Qoffset,n(1)). If the highest ranked cell is a GSM cell, the terminal will reselect to this cell. However, for the ranking of the UMTS cells, received signal quality (e.g. E_c/I_0) is a better indicator of the suitability of a cell for cell reselection. Therefore, if a UMTS cell is the highest ranked in the first step, a second step follows, in which the UMTS cells are ranked based on received signal quality, still taking Qhyst and Qoffset,n (noted as Qhyst(2) and Qoffset,n(2)) into account. The terminal then reselects to the highest ranked UMTS cell in this second ranking.

Similarly, for different combinations of RATs different ranking methods may be devised.

It is also known from the existing art that differences in certain geographical environments may be used to select a ranking mechanism form a set of implemented ranking mechanisms.

The remainder of this text is based on applying the example of cell-ranking based on received signal level. It should however be understood that also other cell ranking mechanisms can be applied.

An idle terminal Ti persisting to camping on the active cell A1 continues providing frequent LA Updates messages to the active cell A1. An idle terminal Ti which has reselected to an inactive cell B1 (which is assumed to be configured for frequent LA Updates as indicated above) will provide its frequent LA Update messages to the relevant inactive cell B1. An idle terminal Ti which has reselected another active cell will adhere to the LA Update regime as broadcast by that cell (which may be a nominal value, e.g. 30 min, 1 hour, etc.)

After a transitional period (whose length may depend on the duration of the cell reselection procedure and the LA Update period), the processing system 5 may derive in step 5-IV from the received LA Update messages how many and which idle terminals remain camped on the active cell, how many and which idle terminals have reselected an inactive cell (and which cell) and how many and, possibly, which idle terminals have reselected from the active cell to other cells. This analysis provides an estimate about the situation regarding idle terminals Ti when each of the inactive cells B1 would be activated.

The information obtained from step 5-IV may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 5-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions. A paging message may be issued indicating modified system information. This pag-

ing message is also received by idle terminals still camping on the active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision obtained from the processing of step 5-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions. In these cells, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on any of the cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 5-V in FIG. 5 for both the active cell A1 and the activated cell B1.

Still further, after the decision obtained from the processing of step 5-IV, the inactive cells that are decided to be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped on such a cell will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read modified system information is RAT dependent.

In a second method, illustrated in the flow chart of FIG. 6, a location area update period (or a similar period) is decreased in the active cell A1 and a reporting identifier, also referred to here below as probing flag, is broadcast in the inactive cell B1 during a time interval.

The first step, indicated by 6-I, is equivalent to step 5-I in FIG. 5.

Different from the first method, the LA update period is not changed in the inactive cells B1. A reporting identifier is transmitted in the inactive cells B1 (step 6-II). The presence signal P, possibly including the probing flag, is transmitted in the inactive cells B1.

In the active cell A1, the absolute signal level threshold parameter Ts,search is set higher than nominal (e.g. nominal value +[5,10] dBm) in step 6-III and is broadcasted in the system information (SIB) on the broadcast channel of the cell. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells. A paging message may be issued indicating modified system information. This paging message is also received by idle terminals Ti camping on the cell. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselection evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal Ti for which the absolute received signal level of the active cell A1 is below the adjusted threshold Ts,search measures the neighbours. For some RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active) neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell.

An idle terminal Ti persisting to camping on the active cell A1 continues providing frequent LA Updates messages to the active cell A1. An idle terminal Ti which reselects to an inactive cell B1 (the terminal Ti may detect this from the probing flag in the inactive cell's broadcast channel) is configured to, shortly after performing the reselection, send a LA Update message to the selected inactive cell B1. This first LA Update message is sent, regardless the setting of the LA Update period in the inactive cell B1. An idle terminal reporting a cell reselection to an inactive neighbour cell may be further configured to also report the presence of the probing flag in its LA Update

message. This could ease bookkeeping at the processing system 5 regarding the neighbour state (inactive or active).

Different from the first method, the inactive cells B1 are configured with a nominal period for LA Updates. Consequently an idle terminal camping on an inactive cell provides (subsequent to the first LA Update message sent shortly after camping on a cell with its probing flag set) only nominal LA Update messages (e.g. 30 min, 1 hour, etc.) to the cell. An idle terminal Ti which has reselected another active cell will adhere to the LA Update regime as broadcast by that cell (which may be a nominal value, e.g. 30 min, 1 hour, etc.).

After of transitional period (whose length may depend on the duration of the cell reselection procedure and the selected LA Update period in the cell A1), the telecommunications infrastructure 1 (more specifically, the processing system 5) may derive from the received LA Update messages how many and which idle terminals remain camped on the active cell A1, how many and which idle terminals Ti have reselected an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals have reselected from the active cell A1 to other cells. This provides an estimate about the situation regarding idle terminals when each of the inactive cells B1 will be activated (step 6-IV).

It should be noted that in the second method, the LA area update messages used to obtain the processing result are reported to the inactive cell B1 (and then via interface 3 to processing system 5, see FIG. 2).

In order to decrease the burden on the inactive cell B1, a first alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, does not perform cell reselection to that cell as long as it has its probing flag set; it sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on (see the box beside 6-IV in FIG. 6). Different from the first method illustrated in FIG. 5, and

different from the second method's basis described above, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, an inactive cell in this first alternative needs not to support reception of LA Update messages as described above. Also different from the first method illustrated in FIG. 5, an idle terminal Ti in this first alternative of the second method does not reselect to an inactive cell (comparable to active terminals Ta not being handed over to inactive cell B1).

A second alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, first sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on and only subsequently performs cell reselection to the best cell (see the box beside 6-IV in FIG. 6). Different from the first method illustrated in FIG. 5, and different from the second method's basis described above, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, again, an inactive cell needs not to support reception of LA Update messages.

Different from the first method, the inactive cells are configured with a nominal period for LA Updates. In this case, to prevent that LA Updates are sent to the inactive cell, the inactive cell may be configured with an infinite LA Update period during the period(s) wherein the presence signal P is transmitted in the inactive cell.

The information obtained from step 6-IV (and possibly step 6-I) may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 6-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions. A paging message

may be issued indicating modified system information. This paging message is also received by idle terminals still camping on the original active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision in step 6-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions including removal of the probing flag. This system information modification may, but not necessarily needs be announced in the activated cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 6-V, including a reset to the nominal LA update value for cell A1 and to remove the probing flag in activated cell(s) B1 in FIG. 6.

Still further, after the decision obtained from the processing of step 6-IV, the inactive cells that are decided to be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped on such a cell will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read system information is RAT dependent.

In a third method, illustrated in the flow chart of FIG. 7, the reporting identifier, also referred to as probing flag, is broadcasted in both the active cell A1 and the inactive cell B1. This third method does not rely on frequent periodic LA updates.

In step 7-I, the system information (SIB) to be broadcasted on the broadcast channel of the active cell A1 comprises a probing flag. In the active cell, a paging message may be issued indicating modified system information. This paging message is also received by idle terminals camping on the active cell A1.

An idle terminal Ti, detecting the probing flag, is configured (see FIG. 9) to report information about its identity (e.g. IMSI) and best cell (in this case, likely the active cell A1) to the cell it camps on. The information about the cell identity is not necessarily included in the report but may be added by the cell via which the report is sent. The report is sent once, on first detection of the probing flag being set. It is an option that an idle terminal Ti which has reselected another active cell will not send a report, which would prevent unnecessary reports to be received in other active cells. The telecommunications infrastructure (more precisely the processing system 5) receives the reports and may derive how many and which terminals Ti are currently camping on the active cell. This provides the information about the situation regarding idle terminals before the probing period starts.

Then, in step 7-II, a probing flag is also transmitted in the inactive cell(s) B1 and the presence signal P is transmitted as well.

In the active cell A1, the absolute signal level threshold Ts,search parameter is set higher than nominal (e.g. nominal value +[5,10] dBm) and in step 7-III is broadcast in the system information (SIB) on the broadcast channel of the cell. This parameter controls the conditions when an idle terminal Ti searches for neighbour cells. A paging message may be issued indicating modified system information. This paging message is also received by idle terminals Ti camping on the cell. It should be appreciated that for some RATs (e.g. UMTS) an idle terminal Ti will execute the cell reselection evaluation process when triggered by a modification of the information on the BCCH used for the cell reselection evaluation procedure (i.e. when this particular SIB is modified).

As a consequence, an idle terminal for which the absolute received signal level of the active cell A1 is below the adjusted threshold Ts,search measures the neighbours. For some RATs (e.g. UMTS) a terminal will perform such measurements regardless the setting of Ts,search.

An idle terminal Ti for which the specified conditions are satisfied performs cell reselection. The condition for cell reselection may be based on ranking the active cell A1 (based on Srxlev or Squal and adding Qhyst) and all (inactive and active) neighbour cells (based on Nrxlev or Nqual and adding neighbour-specific Qoffset,n). If the highest-ranked cell is not the active cell A1, then the idle terminal Ti will make the cell reselection to the highest-ranked cell.

An idle terminal persisting to camping on the active cell A1 sends a report as described above for step 7-I regarding the active cell A1 to the active cell A1. An idle terminal Ti which reselects to an inactive cell (the terminal may detect this from the probing flag in the inactive cell's broadcast channel) is configured to, shortly after performing the reselection, send a report as described for step 7-I to the selected inactive cell (see FIG. 9). The report is sent once, on first detection of the probing flag being set in the cell it is camped on and to the cell it is camped on. It is an option that an idle terminal which has reselected another active cell will not send a report, which would prevent unnecessary reports to be received in other active cells. An idle terminal reporting a cell reselection to an inactive neighbour cell may be further configured to also report the presence of the probing flag in its report. This could ease bookkeeping at the processing system 5 regarding the neighbour state (probing or nominal).

After a transitional period (whose length may depend on the duration of the cell reselection procedure and time to send the associated reports), the telecommunications infrastructure 1 (more precisely, the processing system 5) may derive from the received reports how many and which idle terminals remain camped on the active cell A1, how many and which idle terminals have reselected an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals have reselected from the active cell to other cells. This provides an estimate about the situation regarding idle terminals when each of the inactive cells B1 will be activated.

Again, in order to decrease the burden on the inactive cell B1, a first alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, does not perform cell reselection to that cell as long as it has its probing flag set, yet may remain camping on such a cell; it sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on (see the box beside 7-IV in FIG. 7). Comparable to the second method's first alternative, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, an inactive cell in this first alternative needs not to support reception of reports as described above.

A second alternative would be to configure the idle terminal Ti (see FIG. 9) as follows. An idle terminal Ti which, in the procedure of ranking cells for cell reselection, detects the highest-ranking cell (best cell) to have its probing flag set, first sends a report (comprising an indication of the terminal identity and of the best cell identity) to the cell it currently camps on and only subsequently performs cell reselection to the best cell (see the box beside 7-IV in FIG. 7). Comparable to the second method's second alternative, terminals Ti will send their reports via active cell A1, instead of via inactive cell B1. Thus, again, an inactive cell B1 needs not to support reception of reports as described above.

The information obtained from step 7-IV (and possibly step 7-I) may be taken into account in the evaluation by the processing system 5 about which of the inactive cells should be activated and which of the inactive cells should not. The processing result can be analyzed against the at least one activation condition.

After sufficient information has been obtained in step 7-IV, in the active cell A1 the system information (SIBs) may be reverted to normal operating conditions (which also includes removal of the probing flag). A paging message may be issued indicating modified system information. This paging mes-

sage is also received by idle terminals still camping on the original active cell A1. An idle terminal camped on the active cell will remain camped there.

Also, after the decision in step 7-IV, in the inactive cells decided to be activated, the system information (SIBs) may be reverted to normal operating conditions including removal of the probing flag. This system information modification may, but not necessarily needs be announced in the activated cells. An idle terminal camped on any of the activated cells will remain camped there.

A reset to normal operating conditions is indicated in step 7-V including a removal of the probing flags in active cell A1 and activated cell(s) B1.

Still further, after the decision obtained from the processing of step 7-IV, the inactive cells that are decided to be not activated may be switched off, i.e. the presence signal P is no longer transmitted in these cells. Idle terminals camped on such a cell will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells B1, possibly reselecting another neighbour cell).

It should be appreciated that the need to issue a paging message in order to have idle terminals read system information is RAT dependent.

Finally, in a fourth method, illustrated in the flow chart of FIG. 8, a measurement-and-report paging message, hereinafter denoted as paging message, is transmitted in the active cell A1 instructing the idle terminals Ti to obtain and report information on the inactive cells B1. The idle terminals Ti listen to broadcast and paging channels and can be triggered, using these channel(s), to obtain information on the inactive cells B1. The method may be combined with probing flags transmitted in the inactive cells.

In a first optional step 8-I, a paging message is transmitted in the active cell A1. The paging message may optionally comprise configuration parameters (see below), which

configuration parameters are to be applied by the idle terminal Ti.

In response to step 8-I, an idle terminal receiving the paging message is configured (see FIG. 9) to perform measurements on the serving cell (in this case the active cell A1) and on its neighbour cells, regardless the criterion settings for initiating a search (such as parameter Ts,search), and to subsequently send a report, by default to the cell that issued the paging message (in this case the active cell A1). After sending the report, a cell reselection may be performed. The idle terminal can be configured to not performing cell reselection as long as the highest-ranked cell has the probing flag set (comparable to the first alternative of the second or third method).

As indicated above, the paging message may optionally comprise configuration parameters. Examples are parameters that further specify the measurements to be made (which terminals should measure, which cell(s) to be measured, which RAT to be measured, which characteristics, etc.), parameters that further specify the subsequent reselection (such as offset or hysteresis parameters) and parameters that further specify the report to be provided (whether or not to provide a report, how many of the best cells to be reported, which quantities – e.g. signal level/quality, path loss estimates – to be reported, destination of the report, etc.). The paging parameters may alternatively or in addition, include a reference where the (further) parameters may be obtained, e.g. a reference (link) to a broadcast channel or the like, for example when the set of parameters is impractically large to be sent in the paging message itself.

A terminal receiving configuration parameter values in (or associated with) the paging message applies the received values when performing the measurements, the cell reselection procedure and the reporting as commanded by the paging message. It may be that in case of a conflict with an existing parameter having been assigned a value, the value received in the paging message is only applied for the measurements etc. related to the present method. Other procedures continue to apply the already

assigned value and are not affected by the value in the paging message.

The reported information includes at least an indication about the terminal identity (e.g. IMSI) and about the identity of the best cell. The report is sent once, on detection of the paging message, and by default (unless instructed otherwise) to the cell that issued the paging message, regardless the cell reselection that may be the result of the search.

The telecommunications infrastructure 1 (more precisely, the processing system 5) receives the reports and may derive how many and which terminals were camping on the active cell A1 and received the paging message and also may derive how many and which terminals are likely to remain camping on the active cell A1 after the paging message. This provides the information about the situation regarding idle terminals before the probing period starts.

Step 8-I is an optional step that may e.g. be omitted if the processing system 5 has no particular interest in obtaining information about the situation regarding idle terminals Ti in the active cell A1 before the start of transmitting the presence signal P in the inactive cell(s) B1.

Step 8-II involves the transmission of the presence signal P in the inactive cell(s). A probing flag may also be transmitted. Optionally, one or more of the inactive cells may be configured with system information parameters different from the normal operating conditions, e.g. values set specifically for the method.

Optionally, as described for previous methods illustrated in FIGS. 5-7, the active cell A1 may be configured with system information parameters different from the normal operating conditions, e.g. values set specifically for the probing phase. It is, however, envisaged that the possibility to specify configuration parameters in (or associated with) the paging message, has advantages over making temporary modifications to system information parameters.

In step 8-III, again a paging message is transmitted in the active cell A1. The paging message may optionally comprise

configuration parameters as described above. The values of these parameters may be different from those in the paging message optionally transmitted in step 8-I in active cell A1.

In order to decrease the load of reports, the paging message may also instruct only a fraction f of the idle terminals Ti in the active cell A1 to perform measurements and to provide a report. Mechanisms, such a paging groups, can be used to address or to instruct a particular fraction f (subset) of the idle terminals Ti. A fraction f of the idle terminals may also be established by configuring the idle terminal Ti to, randomly or deterministically determined, only provide the requested reports for a fraction f of the requests.

In response to step 8-III, an idle terminal receiving a paging message is configured to perform measurements on the serving cell (in this case the active cell A1) and on its neighbour cells, regardless the criterion settings for initiating a search, and to subsequently send a report (in this case to the default which is the cell that issued the paging message, i.e. active cell A1). The report is sent once, on detection of the paging message. After sending the report a cell reselection may be performed. The idle terminal can be configured to not performing cell reselection as long as the highest-ranked cell has the probing flag set.

The report includes at least an indication about the identity of the best cell and preferably an indication about the terminal identity (e.g. IMSI). The report may additionally include the status of the probing flag, if any, of the reported best cell.

The telecommunications infrastructure 1 (or more precisely, the processing system 5) receives the reports and may derive from the received reports how many and which idle terminals are likely to remain camped on the active cell, how many and which idle terminals are likely to reselect to an inactive cell (and which inactive cell) and, possibly, how many and which idle terminals are likely to reselect to another cell (and which other cell). This provides an estimate about the situation re-

garding idle terminals when each of the inactive cells will be activated (step 8-IV).

The information obtained from step 8-IV (and possibly step 8-I, when performed) may be taken into account in the evaluation by the telecommunications infrastructure 1 (more precisely processing system 5) about which of the inactive cells to activate and which not.

If the system information of the active cell A1 has been set differently for the execution of the method than during normal operating conditions, then the system information for the active cell may be reverted back to normal operating conditions (not shown in FIG. 8).

If the inactive cell B1 is activated the following applies. If a probing flag was set, the probing flag may be removed. This system information change need not be announced by a paging message in the relevant cell(s). If the system information of the inactive cell has been set differently for the probing phase than during normal operating conditions, then the system information for the cell may be reverted back to normal operating conditions. If a probing flag was not set, an idle terminal camped there, will remain camped there.

If the inactive cell B1 is decided to not be activated, it may be switched off. If a probing flag was not set in the cell, an idle terminal camped there will perform cell selection and find a suitable cell (possibly reselecting the active cell A1, possibly reselecting one of the activated neighbour cells, possibly reselecting another neighbour cell).

A paging message may be transmitted again after activating inactive cells wherein a probing flag was transmitted. In this case a primary objective is to actually let an idle terminal camped on the active cell A1 perform a reselection to one of the activated neighbour cells B1, when such reselection is still applicable. The processing system 5 may choose to either ignore the reports or to process the reports to assess the final configuration or to have it confirmed. If the system has no interest in assessing / confirming the final configuration, this

paging message may advantageously specify a configuration parameter indicating that no reports are to be sent.

It should be appreciated that 3GPP already specified functions for information gathering by a terminal such as described in 3GPP TS 37.320 "Radio Measurement collection for Minimization of Drive Tests (MDT)", which allows to configuring active terminals and/or idle terminals to perform measurements and to report the result to the network. With the described approaches, the responsiveness of the MDT measurements may be greatly improved and be made better suited to also gather information for the purpose of deciding which inactive cell(s) to activate.

In some of the methods and alternatives for triggering idle terminals Ti as described above, it may occur that an idle terminal Ti which camps on an inactive cell B1 initiates a session (e.g. initiates a voice or a data call). There are various ways to handle this situation.

When the inactive cell, despite its 'inactive' status, is to a sufficiently large extent operational, it may choose to accept the request and to support the call in the normal way, at least temporarily. Subsequently, the inactive cell may attempt to handover the call to an active cell; alternatively it may continue serving the call until a decision has been taken about the activation (or not) of that cell. If activated, it may continue to serve the call as an active cell; if not activated, it may handover the call to an active cell before the inactive cell is switched off.

When the inactive cell has insufficient capabilities to accept and/or support a call, or when it is otherwise undesirable to do so, the inactive cell may deny the call request. Various wireless access technologies provide a mechanism to elegantly and quickly refer a refused caller to an alternative, e.g. 'directed retry'. In that case, the inactive cell only needs to support the corresponding signalling.

Finally, note that by using a probing flag in an inactive cell and by using an idle terminal configured to not actually reselect to or camp on a cell which has its probing

flag set (also see the first alternative of the second and third method and see the fourth method), it can be prevented that idle terminals actually camp on an inactive cell.

In each of the above methods, the process of counting how many idle terminals will perform cell reselection may use a hysteresis Qhyst in the terminal for the measurement result.

Similarly, a neighbour-specific offset Qoffset,n can be applied to (e.g. added to) the measurement result in the terminal. By means of these cell-specific offsets a cell may be either be promoted or demoted in the ranking of cells for cell reselection.

In the above-described methods, conditions for cell reselection have been frequently addressed. In addition to these conditions, there may be various other conditions that determine whether a cell is suitable to be camped on by the idle terminal. It is assumed that all inactive neighbours are classified as a 'suitable cell', e.g. their Nrxlev and Nqual are sufficiently high to consider them for camping. It is also assumed that suitable averaging is applied to the measurements. Additionally, it is assumed that a (minimum) period is taken into account for which a highest-ranked cell has to be different from the current (active) cell before actually performing a cell reselection. This minimum period (timer) may also broadcasted via the broadcast channel of the cell in the same SIB.

For the measurement of inter-frequency or inter-RAT neighbour cells, active terminals Ta need some (measurement) time gaps to carry out the measurement. This might be managed by using the idle period provided by discontinuous reception (DRX) or radio resource scheduling. One example is the so called "compressed mode" in UMTS networks, where the data rate (and also transmit power) is temporarily doubled, so the data can be sent twice as fast and the resulting time gap could be used for inter-frequency of inter-RAT measurement.

Whereas the disclosed method and telecommunications infrastructure use existing measurement and reporting capabilities of wireless terminals, in at least some of the above-described embodiments the capabilities of wireless terminals should be

adapted to participate in these embodiments. Examples have been indicated above and include the recognition, processing and actions performed for cell reselection, in response to the reporting identifier (probing flag) and/or the measurement-and-reporting paging message of the above-described fourth method. Most of these enhanced capabilities will be obtained by software modifications in the wireless terminals. Therefore, FIG. 9 is a highly schematic illustration of a wireless terminal T comprising storage S and processor uP configured for storing and operating the modified software. For a base station BS A, BS B similar considerations apply.

Other network elements and signalling may also be affected, depending on how and where the modules 2~6 (as shown in Fig. 2) are deployed. One option is that the modules are deployed in a centralized fashion in the operation and management centre (OMC), the main impact may then be to the signalling messages that are carried between the OMC and base stations BS A and BS B.

Another option is that the modules are deployed in a distributed fashion in the radio network, e.g. in RNC (Radio Network Controller) of UMTS or eNodeB (LTE term for base station) of LTE. Then, additional signalling between these network nodes is required. For example, if BS A is an UMTS base station and BS B is an LTE base station, additional signalling between RNC and eNodeB is required for the purpose of this invention.

CLAIMS

1. A method for activating at least one inactive cell in a wireless telecommunications infrastructure, the telecommunications infrastructure comprising an active cell containing a plurality of terminals, the method comprising the steps of:

- transmitting a presence signal in the at least one inactive cell;
- receiving reports from the plurality of terminals detecting the presence signal;
- processing information contained in the reports received from the plurality of terminals in a processing system of the telecommunications infrastructure to provide a processing result; and
- activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

2. The method according to claim 1, further comprising the steps of:

- terminating transmission of the presence signal in the at least one inactive cell when the processed information does not fulfil the at least one activation condition
- transmitting the presence signal in the at least one inactive cell again at a later time.

3. The method according to claim 1 or 2, further comprising the step of providing the terminals in the active cell with measurement parameters and/or reporting parameters to obtain the information regarding the presence signal from the inactive cell.

4. The method according to one or more of the preceding claims, wherein the telecommunications infrastructure contains a plurality of inactive cells, the method comprising

the step of concurrently or sequentially transmitting the presence signal in the plurality of inactive cells

5. The method according to one or more of the preceding claims, wherein the at least one activation condition includes at least one of energy reduction for the telecommunications infrastructure, load reduction for the active cell or reduction of electromagnetic radiation from the telecommunications infrastructure or from a particular set of cells in the infrastructure.

6. The method according to one or more of the preceding claims, comprising the step of transmitting a reporting identifier in at least one of the active cell and the inactive cell.

7. The method according to one or more of the preceding claims, wherein at least some of the plurality of terminals in the active cell are idle terminals when gathering information for the report.

8. The method according to claim 7, further comprising the step of temporarily decreasing a location area update period in at least one of the active cell and the inactive cell.

9. The method according to claim 7 or 8, wherein the reports are received via the active cell.

10. The method according to claim 7, further comprising the step of transmitting a paging message in the active cell instructing the idle terminals to obtain and/or report the information.

11. A computer program comprising software code portions configured, when executed on one or more processing units, to perform the method according to one more of the claims 1-10.

12. A wireless access telecommunications infrastructure comprising an active cell and at least one inactive cell,

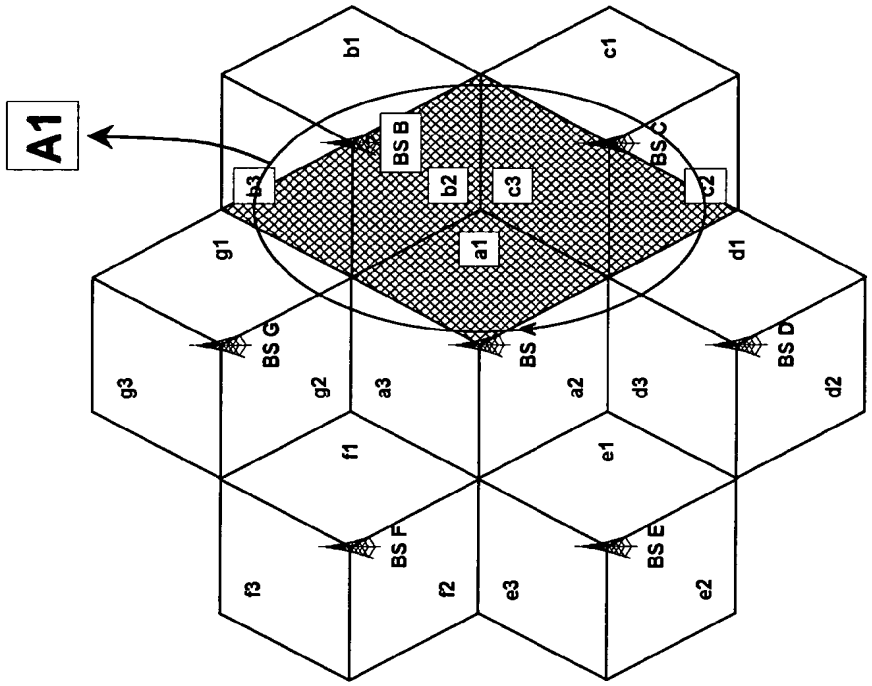
the active cell containing a plurality of terminals, wherein the infrastructure comprises:

- a presence signal generator configured for transmitting a presence signal in the at least one inactive cell;
- a receiver configured for receiving reports from the plurality of terminals detecting the presence signal;
- a processor system configured for processing information contained in the reports received from the plurality of terminals to provide a processing result; and
- an activator configured for activating the inactive cell when the processing result fulfils at least one activation condition such that at least one of the plurality of terminals is within a coverage area of the activated cell.

13. The wireless access telecommunications infrastructure configured for performing the method according to one or more of the claims 1-10.

14. A signal transmitted in a cell of the wireless access telecommunication of claim 12 or 13, wherein the signal contains a reporting identifier indicating that the cell is an inactive cell.

15. A terminal configured for operating in the wireless access telecommunications infrastructure of claim 12 or 13 and for processing the signal according to claim 14 or operating in the method according to claim 10.


A1
b1
c1
BS B
BS C
b3
b2
c3
c2
a1
g1
d1
BS G
BS A
BS D
g3
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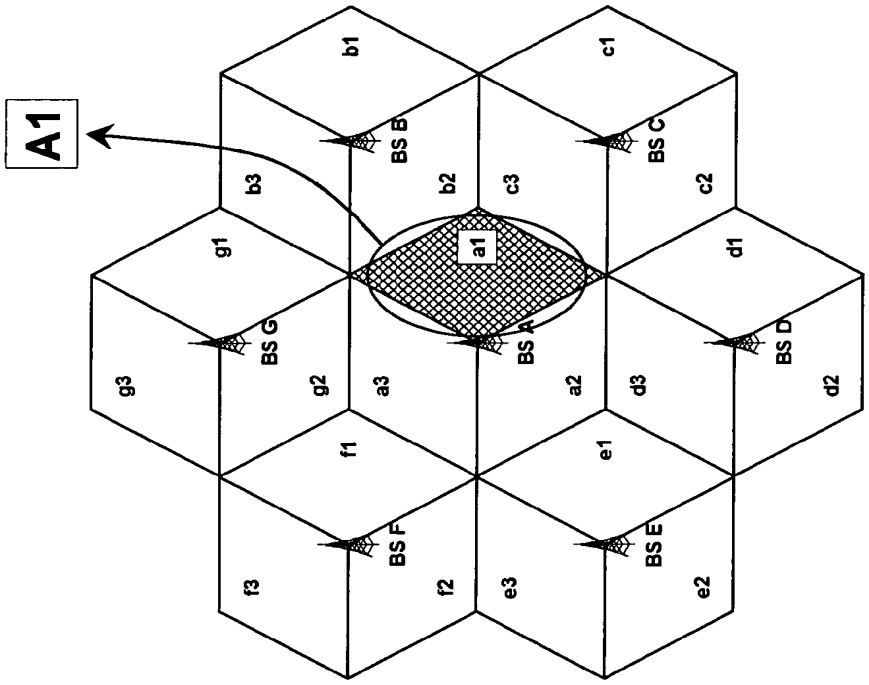
f2
e3
e2

FIG. 1B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c1
BS B
BS C
b3
b2
c3
c2
a1
g1
d1
BS G
BS A
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g3
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f3
f2
e3
e2

FIG. 1A

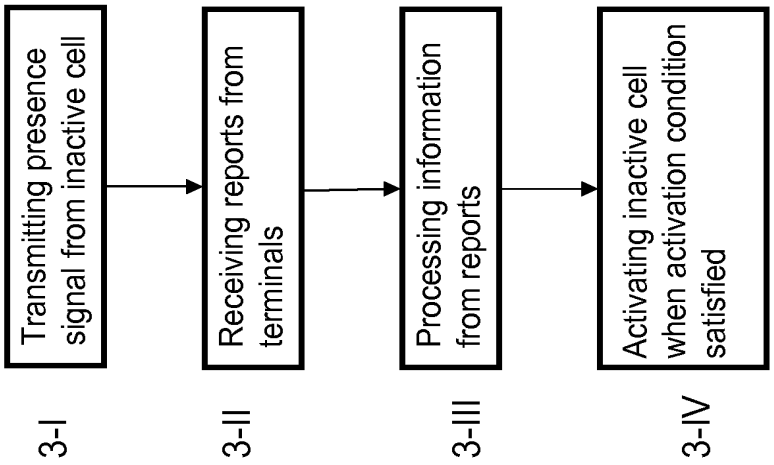
Transmitting presence signal from inactive cell
Receiving reports from terminals
Processing information from reports
Activating inactive cell when activation condition satisfied
3-I
3-II
3-III
3-IV

FIG. 3

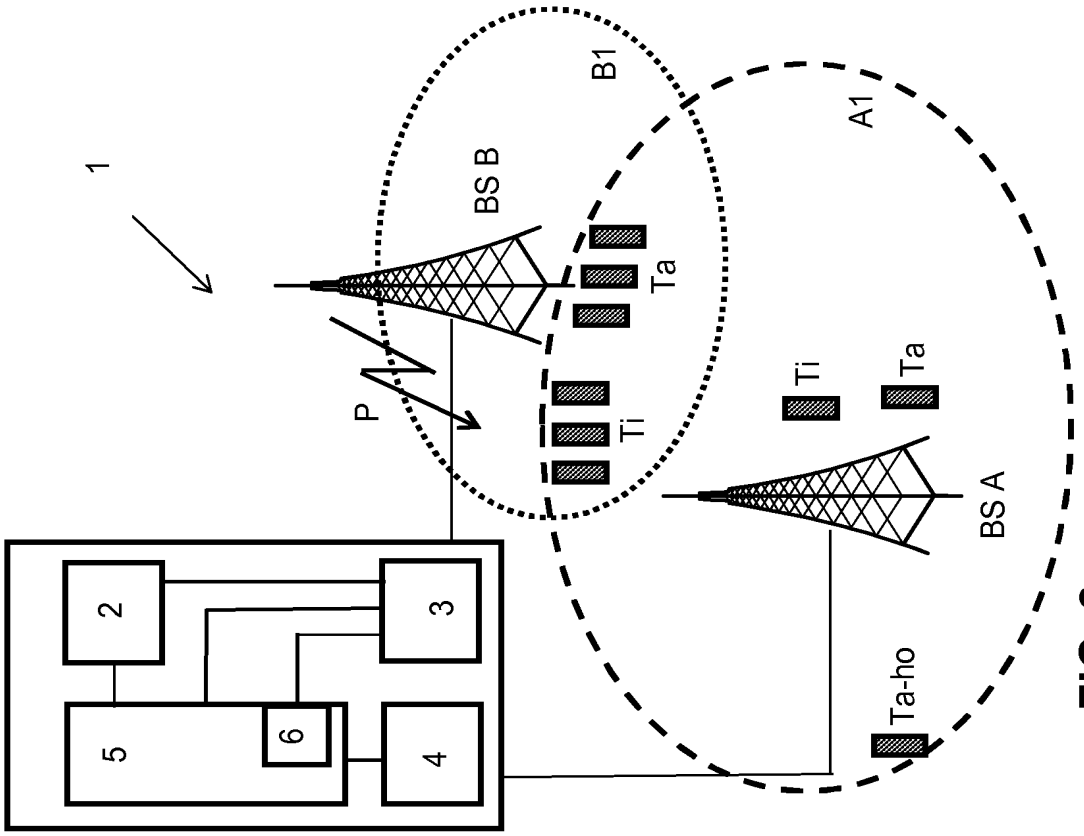
1
BS B
B1
Ta
Ti
P
A1
Ti
Ta
BS A
Ta-ho
2
3
4
5
6

FIG. 2

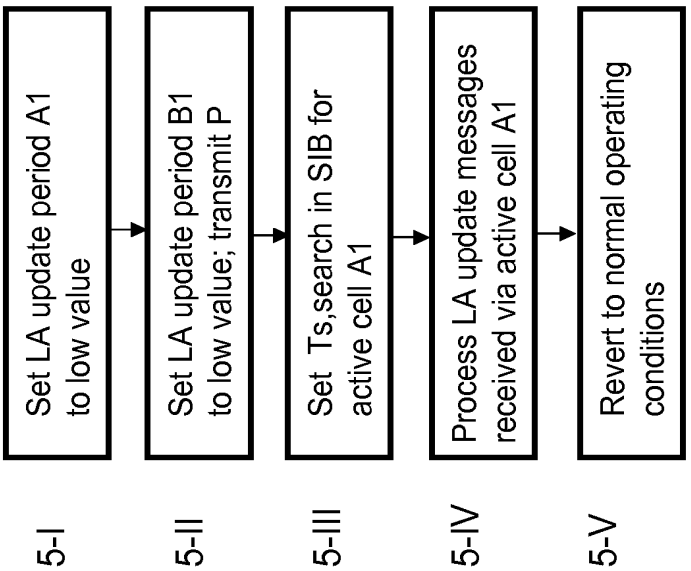
Set LA update period A1 to low value
Set LA update period B1 to low value; transmit P
Set Ts,search in SIB for active cell A1
Process LA update messages received via active cell A1
Revert to normal operating conditions
5-I
5-II
5-III
5-IV
5-V

FIG. 5

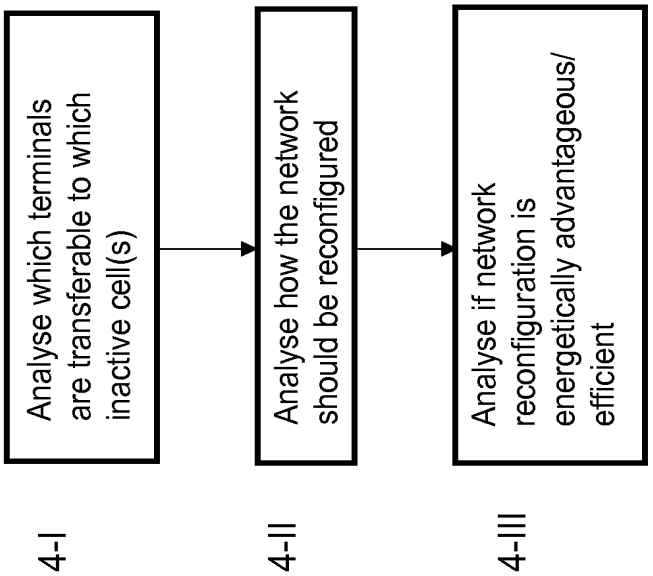
Analyse which terminals are transferable to which inactive cell(s)
Analyse how the network should be reconfigured
Analyse if network reconfiguration is energetically advantageous/ efficient
4-I
4-II
4-III

FIG. 4

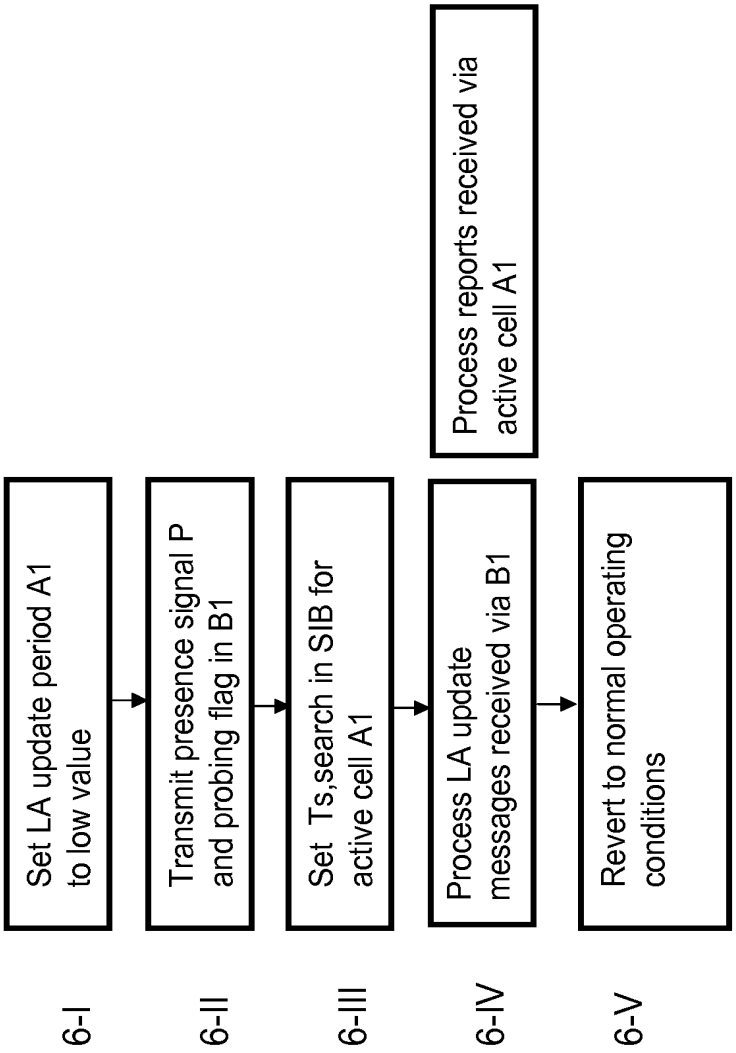
Set LA update period A1 to low value
Transmit presence signal P and probing flag in B1
Set Ts,search in SIB for active cell A1
Process LA update messages received via B1
Revert to normal operating conditions
Process reports received via active cell A1
6-I
6-II
6-III
6-IV
6-V

FIG. 6

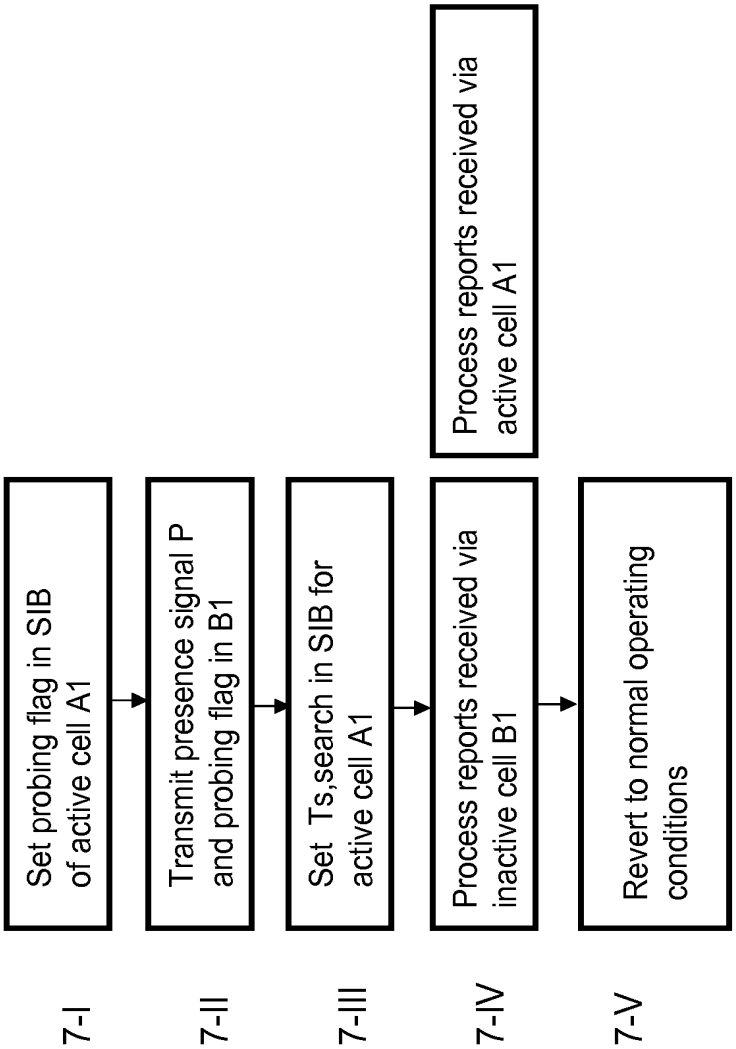
Set probing flag in SIB of active cell A1
Transmit presence signal P and probing flag in B1
Set Ts,search in SIB for active cell A1
Process reports received via inactive cell B1
Process reports received via active cell A1
Revert to normal operating conditions
7-I
7-II
7-III
7-IV
7-V

FIG. 7

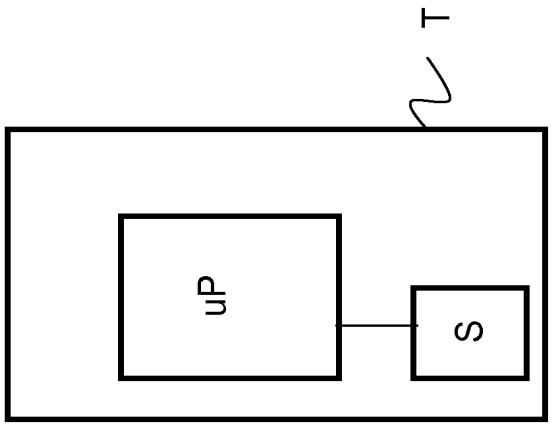
T
uP
S

FIG. 9

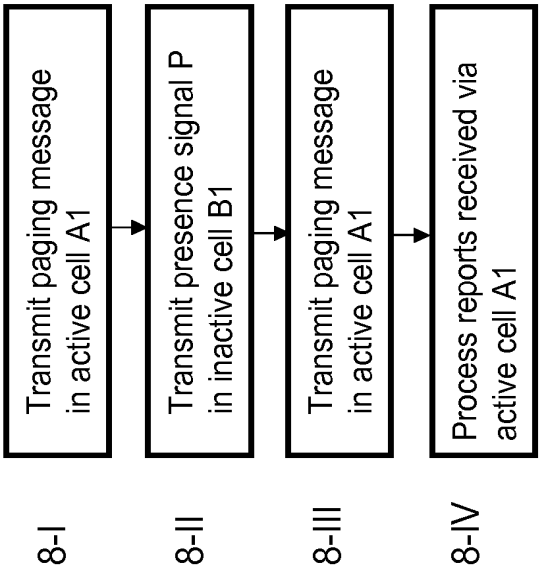
Transmit paging message in active cell A1
Transmit presence signal P in inactive cell B1
Transmit paging message in active cell A1
Process reports received via active cell A1
8-I
8-II
8-III
8-IV

FIG. 8