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*[Continued on next page]*

(54) Title: METHODS FOR SYNCHRONIZING MACRO CELL AND SMALL CELL SYSTEMS

(57) Abstract: Example embodiments are directed to a method including transmitting, by a small cell, a pilot signal to a user equipment (UE) based on a first training signal received from the UE, and receiving, by the small cell, a second training signal from the UE. The second training signal is offset by a time based on the pilot signal transmitted by the small cell. The time offset represents a difference in time between the UE receiving a reference signal transmitted by a macro cell and the UE receiving the pilot signal transmitted by the small cell. The small cell adjusts a local reference timing based on the second training signal.

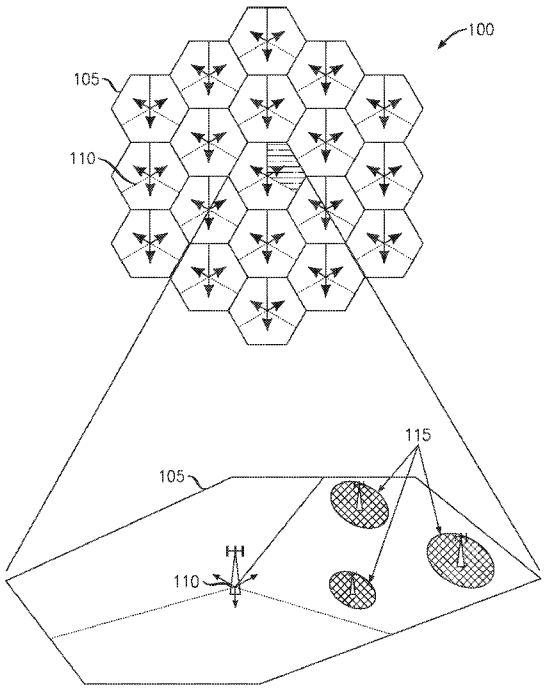



*FIG. 1*

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**(84) Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, 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).

**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))*

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# INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W56/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 2010/157906 A1 (YANG XIANGYING [US] ET AL) 24 June 2010 (2010-06-24) | 3-7,9,10 |
| Y | paragraph [0013] - paragraph [0048]; | 8 |
| A | figures 2,3 | 1,2 |
| | ----- | |
| Y | WO 2010/025147 A1 (NTT DOCOMO INC [JP]; GUVENC ISMAIL [US]; SAHIN MUSTAFA E [US]) 4 March 2010 (2010-03-04) | 8 |
| A | abstract<br>page 4 | 1,2,9,10 |
| | ----- | |
| | -/-- | |

[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 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)

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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 September 2012 | 27/09/2012 |

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

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | MEDIATEK: "Timing Synchronization for Home eNB", 3GPP DRAFT; R4-094909, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, no. Jeju; 20091109, 9 November 2009 (2009-11-09), XP050394363, [retrieved on 2009-11-17] paragraphs [0001] - [0003] | 3-8 |
| A | QUALCOMM EUROPE: "HeNB Timing Requirements", 3GPP DRAFT; R4-091902 TIMING REQUIREMENTS, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, no. San Francisco; 20090427, 27 April 2009 (2009-04-27), XP050342629, [retrieved on 2009-04-27] paragraphs [0002], [0003] | 3-8 |
| A | CMCC: "TD-LTE HeNB synchronization schemes and requirements", 3GPP DRAFT; R4-093396, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, no. Shenzhen, China; 20090824, 24 August 2009 (2009-08-24), XP050393016, [retrieved on 2009-08-31] paragraphs [0002], [0003] | 3-8 |

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/028877

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/** 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1, 2, 9, 10

receiving, by the small cell, a second training signal from the UE, the second training signal being offset by a time based on the pilot signal transmitted by the small cell, the time offset representing a difference in time between the UE receiving a reference signal transmitted by a macro cell and the UE receiving the pilot signal transmitted by the small cell and adjusting a reference timing of the small cell based on the second training signal.

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2. claims: 3-8

the small cell base station receiving the time offset information from a macro cell configured to communicate with the UE, the receiving receives the time offset information if at least one of the following occur, a measured power of the small cell is above a threshold, the difference in time between the UE receiving the signal transmitted by the macro cell and the UE receiving the pilot signal exceeds a time threshold and if a period of time ends.

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2012/028877

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 2010157906 A1 | 24-06-2010 | NONE | |
| WO 2010025147 A1 | 04-03-2010 | JP 2012501589 A | 19-01-2012 |
| | | US 2010054236 A1 | 04-03-2010 |
| | | WO 2010025147 A1 | 04-03-2010 |