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- (71) **Applicant (for all designated States except US):** **INTER-DIGITAL PATENT HOLDINGS, INC.** [US/US]; 3411 Silverside Road, Concord Plaza, Suite 105, Hagley Building, Wilmington, DE 19810 (US).
- (72) **Inventors; and**
- (75) **Inventors/Applicants (for US only):** **FREDA, Martino** [CA/CA]; 7131 Du Cabernet, Laval, QC H7A 0A8 (CA). **DEMIR, Alpaslan, Y.** [TR/US]; 1714 Coral Road, East Meadow, NY 11554 (US). **MURRAY, Joseph, M.** [US/US]; 12 Ashley Drive, Schwenksville, PA 19473 (US).
- (74) **Agents:** **ROCCIA, Vincent, J.** et al.; Woodcock Washburn LLP, Cira Center, 12th Floor, 2929 Arch Street, Philadelphia, PA 19104-2891 (US).

- (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.
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- 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))
- (88) **Date of publication of the international search report:**  
20 October 2011

(54) **Title:** BLIND TIMING SYNCHRONIZATION AND LOW COMPLEXITY CHANNEL ESTIMATION IN ACO-OFDM SYSTEMS

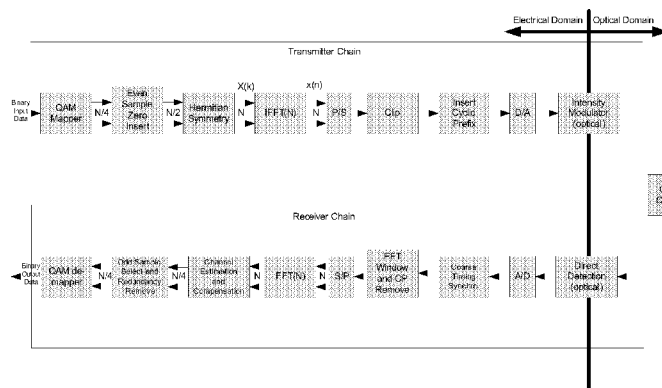
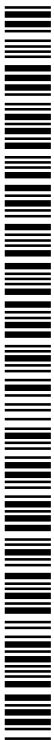


FIG. 2

(57) **Abstract:** A wireless transmit/receive unit (WTRU) that may receive an asymmetrically clipped optical orthogonal frequency-division multiplexing (ACO-OFDM) signal is disclosed. The ACO-OFDM signal may include an ACO-OFDM symbol and the ACO-OFDM signal may be generated with or without a pilot or training data. Where the ACO-OFDM signal may not include a pilot or training data, the WTRU may determine a correlation minimum between a first part of N samples of the ACO-OFDM symbol and a second part of N samples of the ACO-OFDM symbol. The correlation minimum may indicate an estimated boundary of the ACO-OFDM symbol which may provide the WTRU with timing synchronization information. Where the ACO-OFDM signal may include one or more ACO-OFDM pilot symbols on one or more pilot subcarriers, the WTRU may interpret an amount of training data included in the one or more ACO-OFDM pilot symbols that may provide information for channel estimation.



**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/US2011/026214

**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. H04L27/26  
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)  
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 practical, search terms used)  
EPO-Internal, COMPENDEX, INSPEC, IBM-TDB, 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         | SARAH KATE WILSON: "Non-pilot based synchronization for ACO-OFDM", SIGNALS, SYSTEMS AND COMPUTERS, 2009 CONFERENCE RECORD OF THE FORTY-THIRD ASILOMAR CONFERENCE ON, IEEE, PISCATAWAY, NJ, USA, 1 November 2009 (2009-11-01), pages 1631-1635, XP031679697, ISBN: 978-1-4244-5825-7 Section: III<br><br>-----<br><br>-/-- | 1-10,<br>12-14        |

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  | "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   |
| "E" earlier document but published on or after the international filing date  | "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  |
| "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) | "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. |
| "O" document referring to an oral disclosure, use, exhibition or other means  | "&" document member of the same patent family   |
| "P" document published prior to the international filing date but later than the priority date claimed  |   |

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| Date of the actual completion of the international search<br><br>8 June 2011 | Date of mailing of the international search report<br><br>19/08/2011 |
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| Name and mailing address of the ISA/<br>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 | Authorized officer<br><br>Farese, Luca |
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# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2011/026214

## 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.:

1-14

### 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.

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2011/026214

| C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |   |                       |
|--|---|-----------------------|
| Category*  | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No. |
| A  | JAN-JAAP VAN DE BEEK ET AL: "ML Estimation of Time and Frequency Offset in OFDM Systems",<br>IEEE TRANSACTIONS ON SIGNAL PROCESSING,<br>IEEE SERVICE CENTER, NEW YORK, NY, US,<br>vol. 45, no. 7, 1 July 1997 (1997-07-01),<br>XP011057861,<br>ISSN: 1053-587X<br>page 1803, left-hand column, line 3<br>-----            | 1,8                   |
| X,P  | FREDA M M ET AL: "Low-complexity blind timing synchronization for ACO-OFDM-based optical wireless communications",<br>GLOBECOM WORKSHOPS (GC WKSHP), 2010 IEEE,<br>IEEE, PISCATAWAY, NJ, USA,<br>6 December 2010 (2010-12-06), pages<br>1031-1036, XP031858985,<br>ISBN: 978-1-4244-8863-6<br>the whole document<br>----- | 1-10,<br>12-14        |

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

1. claims: 1-14

Improvement of symbol frame detection

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2. claims: 15-20

Channel estimation through the use of pilot symbols

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