# *Exhibit 2*

US010833908B2

(12) **United States Patent**
**Li et al.**

(10) **Patent No.: US 10,833,908 B2**
(45) **Date of Patent: *Nov. 10, 2020**

(54) **CHANNEL PROBING SIGNAL FOR A BROADBAND COMMUNICATION SYSTEM**

(71) Applicant: **NEO WIRELESS LLC**, Wayne, PA (US)

(72) Inventors: **Xiaodong Li**, Kirkland, WA (US); **Titus Lo**, Bellevue, WA (US); **Kemin Li**, Bellevue, WA (US); **Haiming Huang**, Bellevue, WA (US)

(73) Assignee: **NEO WIRELESS LLC**, Wayne, PA (US)

( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/902,740**

(22) Filed: **Jun. 16, 2020**

(65) **Prior Publication Data**

US 2020/0313948 A1 Oct. 1, 2020

**Related U.S. Application Data**

(63) Continuation of application No. 15/953,950, filed on Apr. 16, 2018, now Pat. No. 10,771,302, which is a (Continued)

(51) **Int. Cl.**
***H04L 12/26*** (2006.01)
***H04L 27/26*** (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ..... ***H04L 27/2626*** (2013.01); ***H04B 1/707*** (2013.01); ***H04B 1/711*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC ..... H04L 12/26; H04L 5/0007; H04L 5/0028; H04L 25/03834; H04L 27/0008; H04L 27/0012
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,825,807 A 10/1998 Kumar
5,828,650 A * 10/1998 Malkamaki ..... H04L 5/0007 370/203
(Continued)

FOREIGN PATENT DOCUMENTS

CN 1407745 4/2003
CN 1445949 10/2003
(Continued)

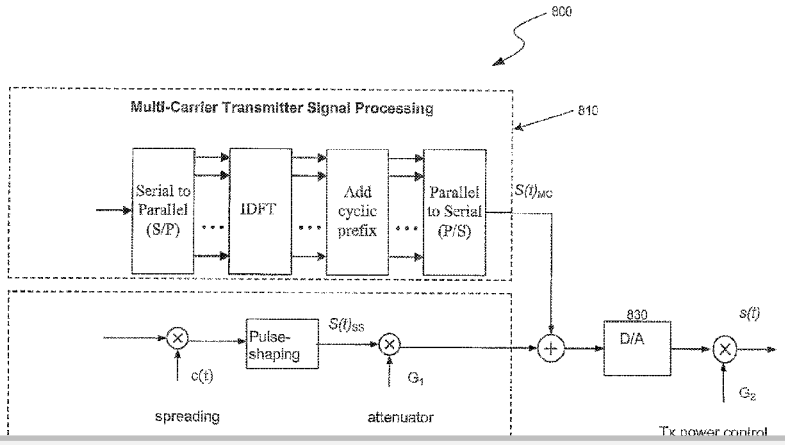
OTHER PUBLICATIONS

European Telecommunications Standards Institute, Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television, ETSI EN 300 744 V1.5.1 (Jun. 2004).
(Continued)

*Primary Examiner* — Dmitry Levitan
(74) *Attorney, Agent, or Firm* — Volpe Koenig

(57) **ABSTRACT**

In a broadband wireless communication system, a spread spectrum signal is intentionally overlapped with an OFDM signal, in a time domain, a frequency domain, or both. The OFDM signal, which inherently has a high spectral efficiency, is used for carrying broadband data or control information. The spread spectrum signal, which is designed to have a high spread gain for overcoming severe interference, is used for facilitating system functions such as initial random access, channel probing, or short messaging. Methods and techniques are devised to ensure that the mutual interference between the overlapped signals is minimized to
(Continued)



have insignificant impact on either signal and that both signals are detectable with expected performance by a receiver.

**30 Claims, 18 Drawing Sheets**

**Related U.S. Application Data**

continuation of application No. 14/321,615, filed on Jul. 1, 2014, now Pat. No. 9,948,488, which is a continuation of application No. 13/861,942, filed on Apr. 12, 2013, now Pat. No. 8,767,522, which is a continuation of application No. 13/347,644, filed on Jan. 10, 2012, now Pat. No. 8,428,009, which is a continuation of application No. 12/975,226, filed on Dec. 21, 2010, now Pat. No. 8,094,611, which is a continuation of application No. 10/583,229, filed as application No. PCT/US2005/003518 on Jan. 27, 2005, now Pat. No. 7,864,725.

(60) Provisional application No. 60/540,586, filed on Jan. 30, 2004, provisional application No. 60/540,032, filed on Jan. 29, 2004.

(51) **Int. Cl.**

| | |
|---|---|
| ***H04L 5/00*** | (2006.01) |
| ***H04L 25/03*** | (2006.01) |
| ***H04L 27/00*** | (2006.01) |
| ***H04B 1/707*** | (2011.01) |
| ***H04B 1/711*** | (2011.01) |
| *H04L 25/02* | (2006.01) |

(52) **U.S. Cl.**

CPC ..... ***H04L 5/0007*** (2013.01); ***H04L 5/0028*** (2013.01); ***H04L 25/03834*** (2013.01); ***H04L 27/0008*** (2013.01); ***H04L 27/0012*** (2013.01); ***H04L 27/2602*** (2013.01); ***H04L 27/2647*** (2013.01); *H04L 5/0016* (2013.01); *H04L 25/0228* (2013.01); *H04L 27/2607* (2013.01); *H04L 27/2655* (2013.01)

(58) **Field of Classification Search**

USPC ..... 370/241, 252, 310, 328, 330, 464, 532

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 5,867,478 | A | 2/1999 | Baum et al. | |
| 5,909,436 | A | 6/1999 | Engstrom et al. | |
| 6,141,546 | A | 10/2000 | Thomas | |
| 6,175,550 | B1 * | 1/2001 | van Nee | H04L 1/0002 370/206 |
| 6,434,364 | B1 | 8/2002 | O'Riordain | |
| 6,480,558 | B1 | 11/2002 | Ottosson et al. | |
| 6,515,960 | B1 | 2/2003 | Usui et al. | |
| 6,567,383 | B1 * | 5/2003 | Bohnke | H04L 5/005 370/280 |
| 6,643,281 | B1 | 11/2003 | Ryan | |
| 6,731,673 | B1 | 5/2004 | Kotov et al. | |
| 6,741,578 | B1 | 5/2004 | Moon et al. | |
| 6,771,706 | B2 | 8/2004 | Ling et al. | |
| 6,847,678 | B2 | 1/2005 | Berezdivin et al. | |
| 6,922,388 | B1 * | 7/2005 | Laroia | H04J 3/0682 370/208 |
| 6,940,827 | B2 | 9/2005 | Li et al. | |
| 7,035,663 | B1 | 4/2006 | Linebarger et al. | |
| 7,123,934 | B1 | 10/2006 | Linebarger et al. | |
| 7,149,239 | B2 | 12/2006 | Hudson | |
| 7,161,985 | B2 | 1/2007 | Dostert et al. | |
| 7,161,987 | B2 | 1/2007 | Webster et al. | |
| 7,218,666 | B2 | 5/2007 | Baum et al. | |
| 7,260,054 | B2 | 8/2007 | Olszewski | |
| 7,274,652 | B1 | 9/2007 | Webster et al. | |
| 7,317,931 | B2 | 1/2008 | Guo | |
| 7,342,974 | B2 | 3/2008 | Chiou | |
| 7,386,055 | B2 | 6/2008 | Morita et al. | |
| 7,403,556 | B2 | 7/2008 | Kao et al. | |
| 7,411,897 | B2 * | 8/2008 | Yoo | H04L 27/2605 370/208 |
| 7,418,042 | B2 | 8/2008 | Choi et al. | |
| 7,443,829 | B2 | 10/2008 | Rizvi et al. | |
| 7,471,667 | B2 * | 12/2008 | Hirsch | H04L 5/1453 370/312 |
| 7,548,506 | B2 | 6/2009 | Ma et al. | |
| 7,555,268 | B2 | 6/2009 | Trachewsky et al. | |
| 7,567,624 | B1 | 7/2009 | Schmidl et al. | |
| 7,646,747 | B2 | 1/2010 | Atarashi et al. | |
| 7,693,032 | B2 | 4/2010 | Li et al. | |
| 7,724,720 | B2 | 5/2010 | Korpela et al. | |
| 7,738,437 | B2 | 6/2010 | Ma et al. | |
| 7,864,725 | B2 | 1/2011 | Li et al. | |
| 7,873,009 | B2 | 1/2011 | Larsson et al. | |
| 7,907,592 | B2 | 3/2011 | Han et al. | |
| 8,009,660 | B2 | 8/2011 | Li et al. | |
| 8,089,887 | B2 | 1/2012 | Lippman et al. | |
| 8,094,611 | B2 | 1/2012 | Li et al. | |
| 8,102,832 | B2 | 1/2012 | Agrawal et al. | |
| 8,363,691 | B2 | 1/2013 | Hasegawa et al. | |
| 8,428,009 | B2 | 4/2013 | Li et al. | |
| 8,432,891 | B2 | 4/2013 | Li et al. | |
| 8,767,522 | B2 | 7/2014 | Li et al. | |
| 2001/0021182 | A1 | 9/2001 | Wakutsu | |
| 2002/0141483 | A1 | 10/2002 | Doetsch et al. | |
| 2002/0159422 | A1 | 10/2002 | Li et al. | |
| 2003/0072255 | A1 | 4/2003 | Ma et al. | |
| 2003/0081538 | A1 | 5/2003 | Walton et al. | |
| 2003/0179776 | A1 | 9/2003 | Sumasu et al. | |
| 2004/0085946 | A1 | 5/2004 | Morita et al. | |
| 2004/0171357 | A1 | 9/2004 | Lobinger | |
| 2004/0264600 | A1 | 12/2004 | Kao et al. | |
| 2005/0111397 | A1 | 5/2005 | Attar et al. | |
| 2006/0114815 | A1 | 6/2006 | Hasegawa | |
| 2006/0245409 | A1 | 11/2006 | Korpela | |
| 2008/0304551 | A1 | 12/2008 | Li et al. | |
| 2011/0211617 | A1 | 9/2011 | Li et al. | |
| 2011/0299474 | A1 | 12/2011 | Li et al. | |
| 2012/0106513 | A1 | 5/2012 | Li et al. | |
| 2013/0242937 | A1 | 9/2013 | Li et al. | |

FOREIGN PATENT DOCUMENTS

| | | |
|---|---|---|
| CN | 1452326 | 10/2003 |
| EP | 1650891 | 4/2006 |
| JP | 09-233047 | 9/1997 |
| JP | 10-210002 | 8/1998 |
| KR | 2001-0083789 | 9/2001 |
| KR | 2003-0060892 | 7/2003 |
| KR | 2009-0040929 | 4/2009 |
| WO | 2003/058881 | 7/2003 |

OTHER PUBLICATIONS

Examination Report, European Application No. 05711777.2, dated Oct. 29, 2012, 6 pages.

Examination Report, European Application No. 05712825.8, dated Aug. 16, 2012, 6 pages.

Extended European Search Report received for counterpart European Patent Application No. 18196596.3, dated Feb. 20, 2019 (8 pages).

IEEE Standard for Local and metropolitan area networks; Part 16: Air Interface for Fixed Broadband Wireless Access Systems—Amendment 2: Medium Access Control Modifications and Addi-

(56) **References Cited**

OTHER PUBLICATIONS

International Search Report and Written Opinion for International Application No. PCT/US05/01939, dated Apr. 26, 2005, 7 pages.
International Search Report and Written Opinion; International Patent Application No. PCT/US05/03518; Filed Jan. 27, 2005; Applicant: Waltical Solutions, Inc.; dated May 23, 2005; 8 pages.
Notice of Allowance, U.S. Appl. No. 13/347,644, filed Mar. 7, 2013, 17 pages.
Notice of Allowance, U.S. Appl. No. 13/861,942, filed May 16, 2014, 14 pages.
Supplementary European Search Report, European Application No. 05711777, dated May 7, 2012, 6 pages.
Supplementary European Search Report, European Application No. 05712825, dated Mar. 26, 2012, 4 pages.
Tufvesson et al. "OFDM Time and Frequency Synchronization by Spread Spectrum Pilot Technique," Communication Theory Mini-Conference, Vancouver, B.C., Canada, Jun. 6-10, 1999, pp. 115-119.

* cited by examiner

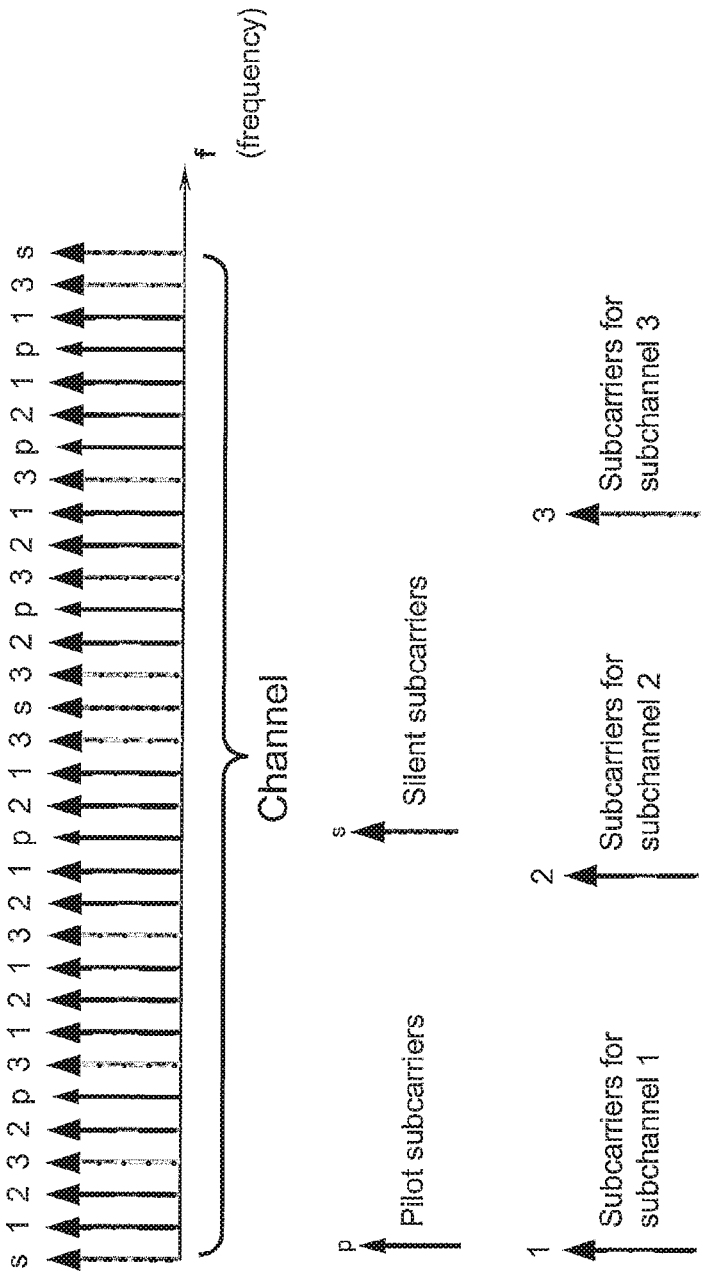



*FIG. 1*

DOCKET ALARM

# Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

## Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

## Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

## Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

## API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

**LAW FIRMS**
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

**FINANCIAL INSTITUTIONS**
Litigation and bankruptcy checks for companies and debtors.

**E-DISCOVERY AND LEGAL VENDORS**
Sync your system to PACER to automate legal marketing.