

Exhibit 2



(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**

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

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(Continued)

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(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)

(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.

FOREIGN PATENT DOCUMENTS

CN 1407745 4/2003
CN 1445949 10/2003

(Continued)

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

OTHER PUBLICATIONS

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

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).

(65) **Prior Publication Data**

US 2020/0313948 A1 Oct. 1, 2020

(Continued)

Related U.S. Application Data

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

(57) **ABSTRACT**

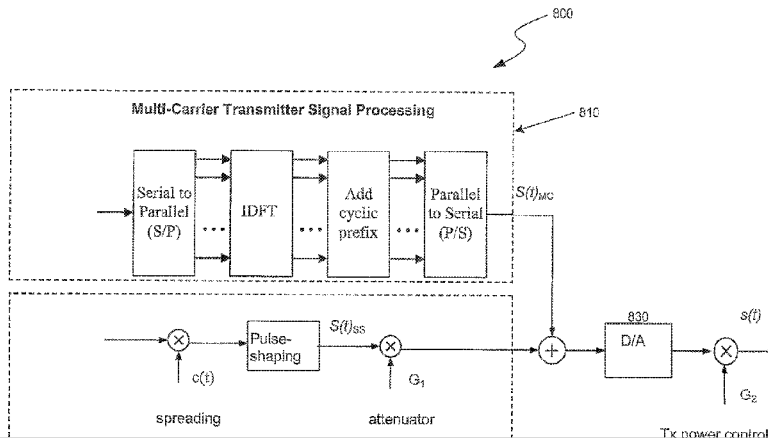
In a broadband wireless communication system, a spread spectrum signal is intentionally overlapped with an OFDM signal, in a time domain, a frequency domain, or both. The OFDM signal, which inherently has a high spectral efficiency, is used for carrying broadband data or control information. The spread 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)

(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)



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

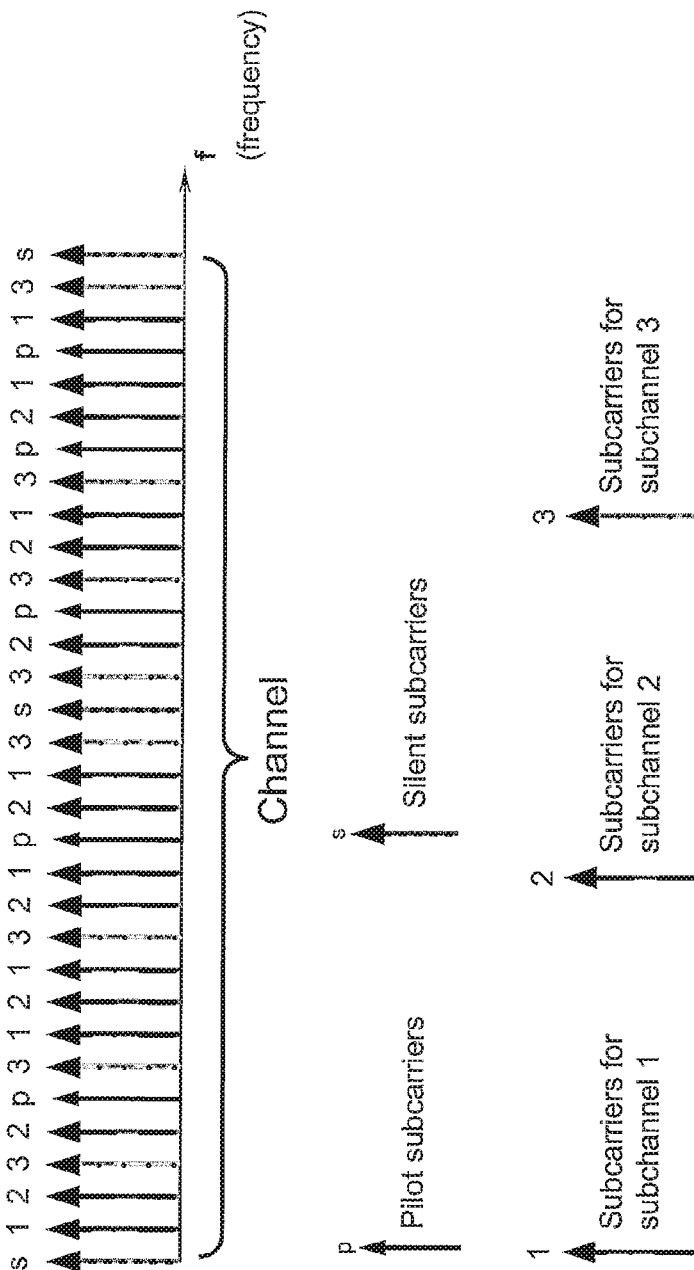


FIG. 1

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