



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

(10) **Patent No.:** **US 8,934,473 B2**  
(45) **Date of Patent:** **\*Jan. 13, 2015**

(54) **METHOD AND APPARATUS USING CELL-SPECIFIC AND COMMON PILOT SUBCARRIERS IN MULTI-CARRIER, MULTI-CELL WIRELESS COMMUNICATION NETWORKS**

USPC ..... 370/350, 324, 331-332, 319, 344, 329, 370/338, 328, 203, 280, 342, 335; 455/67.11-67.13, 423, 503, 115.1, 455/436-444, 502, 552.1, 562.1, 422.1, 455/434, 525

See application file for complete search history.

(71) Applicant: **Neocific, Inc.**, Bellevue, WA (US)  
(72) Inventors: **Xiaodong Li**, Kirkland, WA (US); **Titus Lo**, Bellevue, WA (US); **Kemin Li**, Bellevue, WA (US); **Haiming Huang**, Bellevue, WA (US)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,825,807 A 10/1998 Kumar  
5,867,478 A 2/1999 Baum et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP 1650891 A1 4/2006  
JP 9233047 A 9/1997

(Continued)

OTHER PUBLICATIONS

U.S. Appl. No. 13/861,942, filed Apr. 12, 2013, Li et al.

(Continued)

*Primary Examiner* — Babar Sarwar

(74) *Attorney, Agent, or Firm* — Perkins Coie LLP

(57) **ABSTRACT**

A multi-carrier cellular wireless network (400) employs base stations (404) that transmit two different groups of pilot subcarriers: (1) cell-specific pilot subcarriers, which are used by a receiver to extract information unique to each individual cell (402), and (2) common pilots subcarriers, which are designed to possess a set of characteristics common to all the base stations (404) of the system. The design criteria and transmission formats of the cell-specific and common pilot subcarriers are specified to enable a receiver to perform different system functions. The methods and processes can be extended to other systems, such as those with multiple antennas in an individual sector and those where some subcarriers bear common network/system information.

**12 Claims, 13 Drawing Sheets**

(73) Assignee: **Neocific, Inc.**, Bellevue, WA (US)  
(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 119 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/874,278**

(22) Filed: **Apr. 30, 2013**

(65) **Prior Publication Data**

US 2013/0242937 A1 Sep. 19, 2013

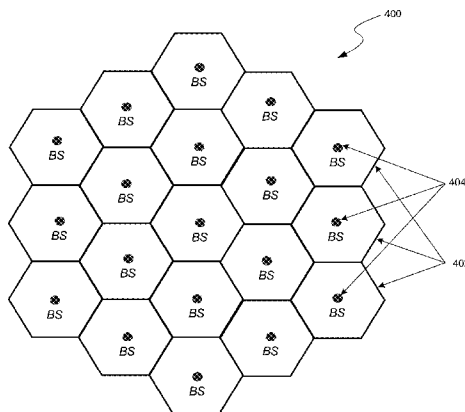
**Related U.S. Application Data**

(63) Continuation of application No. 13/212,116, filed on Aug. 17, 2011, now Pat. No. 8,432,891, which is a (Continued)

(51) **Int. Cl.**  
**H04J 3/06** (2006.01)  
**H04W 72/04** (2009.01)  
(Continued)

(52) **U.S. Cl.**  
CPC ..... **H04W 72/0446** (2013.01); **H04W 16/02** (2013.01); **H04L 27/2613** (2013.01);  
(Continued)

(58) **Field of Classification Search**  
CPC ..... H04B 1/707; H04L 25/0228; H04L 25/03834; H04L 27/0008; H04L 27/0012; H04L 27/2602; H04L 27/2607; H04L 27/2613; H04L 27/2655; H04L 27/2657; H04L 5/0007; H04L 5/0016; H04L 5/0028



**Related U.S. Application Data**

- continuation of application No. 10/583,530, filed as application No. PCT/US2005/001939 on Jan. 20, 2005, now Pat. No. 8,009,660.
- (60) Provisional application No. 60/540,032, filed on Jan. 29, 2004.
- (51) **Int. Cl.**  
*H04W 16/02* (2009.01)  
*H04L 27/26* (2006.01)  
*H04B 1/707* (2011.01)  
*H04L 5/00* (2006.01)  
*H04L 25/03* (2006.01)  
*H04L 27/00* (2006.01)  
*H04L 25/02* (2006.01)
- (52) **U.S. Cl.**  
 CPC ..... *H04B1/707* (2013.01); *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 27/2657* (2013.01); *H04L 5/0016* (2013.01); *H04L 25/0228* (2013.01); *H04L 27/2607* (2013.01); *H04L 27/2655* (2013.01)  
 USPC ..... 370/350; 370/331; 370/332; 370/324; 370/344; 370/319; 455/422.1; 455/552.1; 455/502; 455/561; 455/434

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,480,558	B1 *	11/2002	Ottosson et al. ....	375/350
6,515,960	B1 *	2/2003	Usui et al. ....	370/203
6,567,383	B1 *	5/2003	Bohnke .....	370/280
6,643,281	B1 *	11/2003	Ryan .....	370/350
6,731,673	B1 *	5/2004	Kotov et al. ....	375/145
6,741,578	B1 *	5/2004	Moon et al. ....	370/335
6,847,678	B2	1/2005	Berezdivin et al.	
6,922,388	B1 *	7/2005	Laroia et al. ....	370/208
6,940,827	B2	9/2005	Li et al.	
7,035,663	B1	4/2006	Linebarger et al.	
7,039,001	B2 *	5/2006	Krishnan et al. ....	370/203

7,062,002	B1 *	6/2006	Michel et al. ....	375/354
7,123,934	B1	10/2006	Linebarger et al.	
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	
7,342,974	B2	3/2008	Chiou	
7,386,055	B2	6/2008	Morita et al.	
7,403,556	B2	7/2008	Kao et al.	
7,418,042	B2	8/2008	Choi et al.	
7,443,829	B2 *	10/2008	Rizvi et al. ....	370/342
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.	
7,907,592	B2 *	3/2011	Han et al. ....	370/350
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.	
8,428,009	B2	4/2013	Li et al.	
2003/0081538	A1 *	5/2003	Walton et al. ....	370/206
2004/0085946	A1 *	5/2004	Morita et al. ....	370/342
2005/0111397	A1	5/2005	Attar et al.	
2011/0299474	A1	12/2011	Li et al.	

FOREIGN PATENT DOCUMENTS

JP	10210002	A	8/1998
KR	20010083789	A	9/2001
KR	1020030060892		7/2003
KR	20090040929		4/2009

OTHER PUBLICATIONS

- Examination Report, European Application No. 05711777.2, Mail Date Oct. 29, 2012, 6 pages.
- International Search Report and Written Opinion for International Application No. PCT/US05/01939, Mail Date Apr. 26, 2005, 7 pages.
- Supplementary European Search Report, European Application No. 05711777, May 7, 2012, 6 pages.
- Tufvesson, F., 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

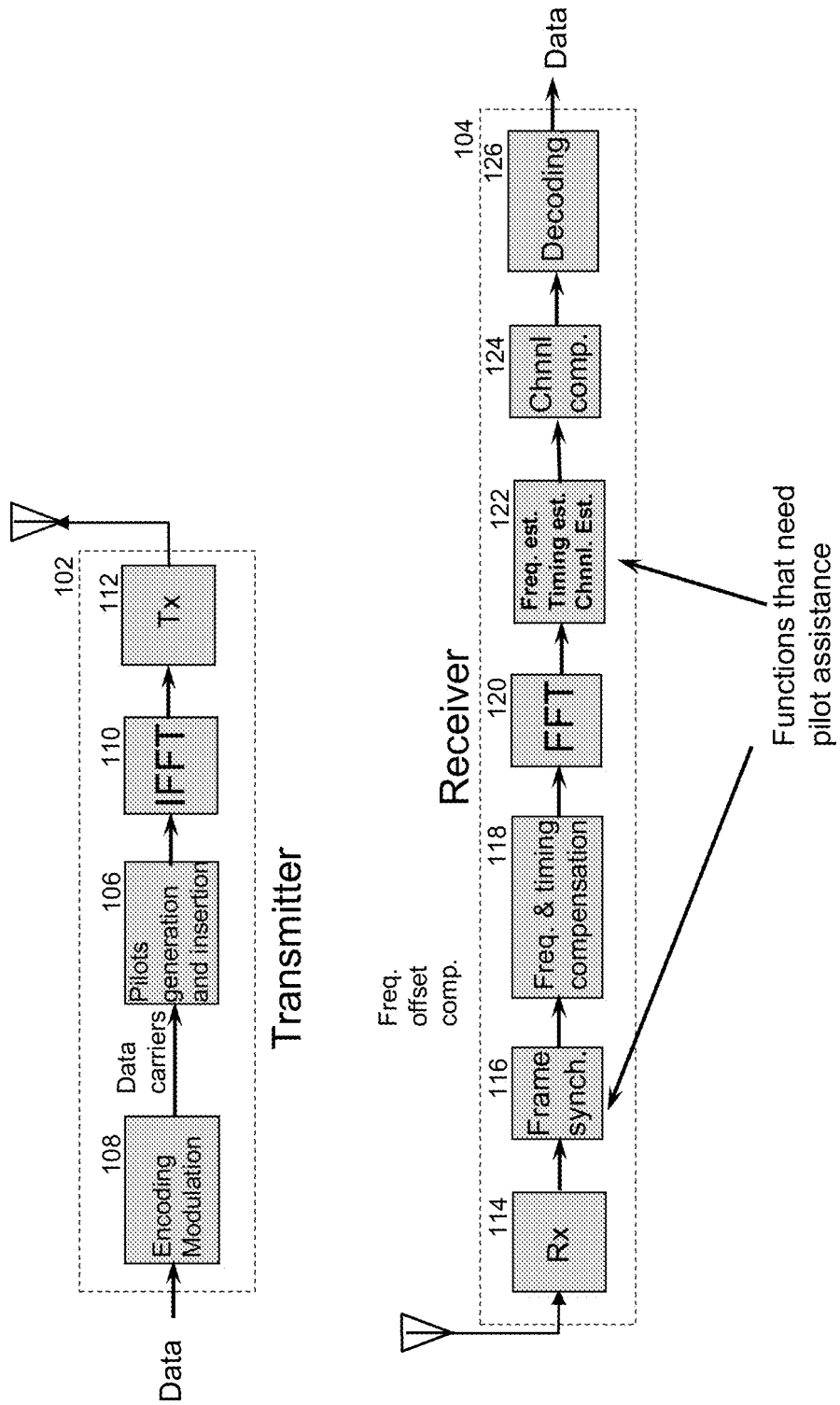


FIG. 1



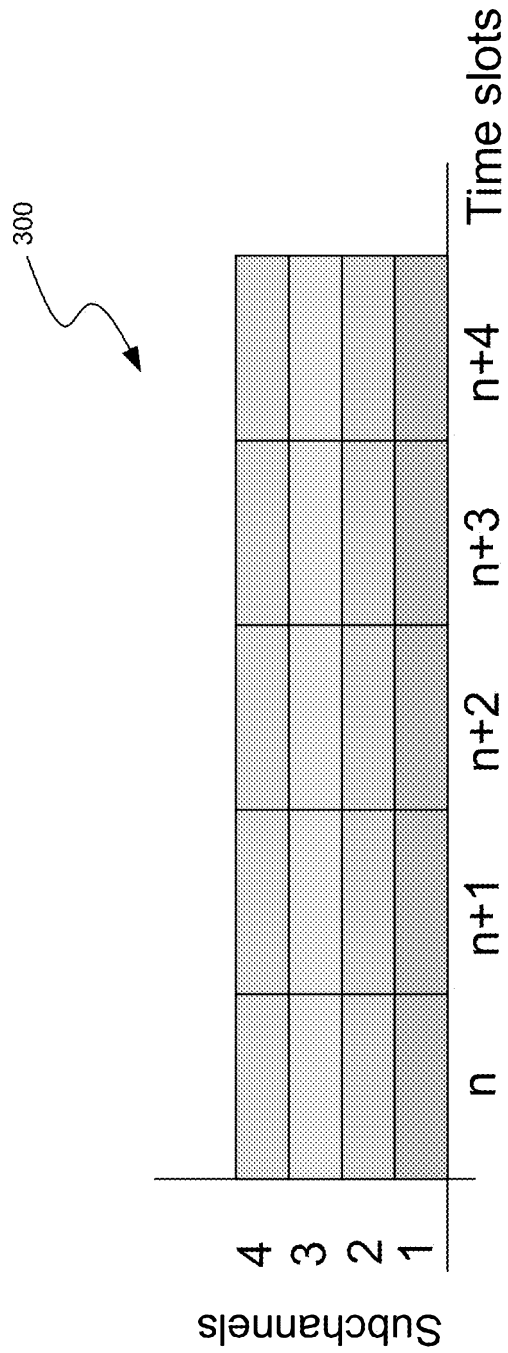


FIG. 3

# 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.