



US006904283B2

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

(10) **Patent No.:** **US 6,904,283 B2**
(45) **Date of Patent:** **Jun. 7, 2005**

(54) **MULTI-CARRIER COMMUNICATIONS WITH GROUP-BASED SUBCARRIER ALLOCATION**

5,507,034 A 4/1996 Bodin et al.
5,515,378 A 5/1996 Roy, III et al.
5,555,268 A 9/1996 Fattouche et al.
5,588,020 A * 12/1996 Schilling 370/337
5,708,973 A 1/1998 Ritter

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(Continued)

FOREIGN PATENT DOCUMENTS

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DE 198 00 953 C1 7/1999
EP 0 869 647 A2 * 10/1998 H04L/27/26
EP 0 926 912 A2 6/1999
EP 0 929 202 A1 7/1999
EP 0 999 658 A2 * 5/2000 H04B/7/02
FR 2 777 407 A1 10/1999
GB 2 209 858 A 8/1997
JP 06029922 2/1994
WO WO 98/16077 A2 4/1998
WO WO 98/30047 A1 7/1998
WO WO 02 49305 A2 6/2002

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 727 days.

OTHER PUBLICATIONS

(21) Appl. No.: **09/837,337**

Vittoria Mignone et al., "CD3-OFDM: A Novel Demodulation Scheme for Fixed and Mobile Receivers," IEEE Transactions on Communications, Sep. 1996, pp. 1144-1151, vol. 44, No. 9, IEEE.

(22) Filed: **Apr. 17, 2001**

(Continued)

Prior Publication Data

US 2003/0169681 A1 Sep. 11, 2003

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/738,086, filed on Dec. 15, 2000.

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(51) **Int. Cl.**⁷ **H04B 7/00**; H04B 1/38; H04Q 7/20; H04M 1/00; H04J 11/00
(52) **U.S. Cl.** **455/450**; 455/69; 455/447; 455/448; 455/561; 455/550.1; 370/208
(58) **Field of Search** 375/133, 135, 375/260, 267; 370/203, 208, 210, 482, 484, 431, 319-321, 328, 329, 332, 342, 344, 345; 455/69, 434, 455, 463, 422.1, 447-450, 452.1, 452.2, 453, 42, 500, 512, 513, 102-105

(57) **ABSTRACT**

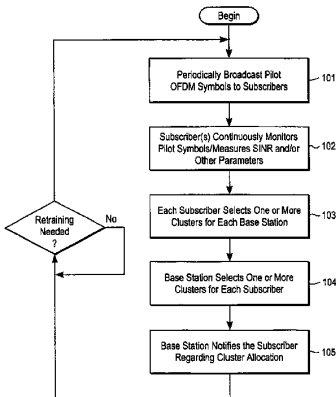
A method and apparatus for subcarrier selection for systems is described. In one embodiment, a method for subcarrier selection for a system employing orthogonal frequency division multiple access (OFDMA) comprises partitioning subcarriers into groups of at least one cluster of subcarriers, receiving an indication of a selection by the subscriber of one or more groups in the groups, and allocating at least one cluster in the one or more groups of clusters selected by the subscriber for use in communication with the subscriber.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,280,630 A 1/1994 Wang
5,479,447 A * 12/1995 Chow et al. 375/260
5,504,775 A 4/1996 Chouly et al.

119 Claims, 7 Drawing Sheets



U.S. PATENT DOCUMENTS

5,726,978	A	3/1998	Frodigh et al.	
5,734,967	A	3/1998	Kotzin et al.	
5,774,808	A	6/1998	Sarkioja et al.	
5,822,372	A	* 10/1998	Emami	375/260
5,867,478	A	2/1999	Baum et al.	
5,886,988	A	3/1999	Yun et al.	
5,887,245	A	3/1999	Lindroth et al.	
5,909,436	A	* 6/1999	Engstrom et al.	370/343
5,914,933	A	* 6/1999	Cimini et al.	370/208
5,933,421	A	8/1999	Alamouti et al.	
5,956,642	A	* 9/1999	Larsson et al.	455/449
5,973,642	A	10/1999	Li et al.	342/378
5,991,273	A	11/1999	Abu-Dayya	
6,005,876	A	12/1999	Cimini, Jr. et al.	370/525
6,009,553	A	* 12/1999	Martinez et al.	714/784
6,026,123	A	2/2000	Williams	
6,041,237	A	3/2000	Farsakh	455/450
6,052,594	A	4/2000	Chuangu et al.	455/450
6,061,568	A	5/2000	Dent	
6,064,692	A	5/2000	Chow	375/219
6,064,694	A	5/2000	Clark et al.	375/224
6,067,290	A	5/2000	Paulraj et al.	370/329
6,108,374	A	8/2000	Balachandran et al.	
6,111,919	A	* 8/2000	Yonge, III	375/260
6,131,016	A	10/2000	Greenstein et al.	
6,141,565	A	10/2000	Feuerstein et al.	
6,144,696	A	11/2000	Shively et al.	
6,226,320	B1	5/2001	Hakkinen et al.	
6,282,185	B1	* 8/2001	Hakkinen et al.	370/335
6,298,092	B1	10/2001	Heath, Jr. et al.	
6,307,851	B1	10/2001	Jung et al.	
6,327,472	B1	12/2001	Westroos et al.	
6,330,460	B1	12/2001	Wong et al.	
6,366,195	B1	4/2002	Harel et al.	
6,377,632	B1	4/2002	Paulraj et al.	
6,377,636	B1	4/2002	Paulraj et al.	
6,449,246	B1	9/2002	Barton et al.	
6,473,467	B1	10/2002	Wallace et al.	
6,477,158	B1	11/2002	Take	
6,545,997	B1	* 4/2003	Bohnke et al.	370/347
6,567,383	B1	* 5/2003	Bohnke	370/280
6,657,949	B1	12/2003	Jones, IV et al.	
6,726,297	B1	* 4/2004	Uesugi	375/260
2002/0114269	A1	* 8/2002	Onggosanusi et al.	370/208
2003/0067890	A1	4/2003	Goel et al.	
2003/0169681	A1	9/2003	Li et al.	
2003/0169824	A1	9/2003	Chayat	

OTHER PUBLICATIONS

Bender et al., *CDMA/HDR: A Bandwidth-Efficient High-Speed Wireless Data Service for Nomadic Users*, IEEE Communications Magazine, Jul. 2000, pp. 70-87.

Tsoulos, G.V., *Smart Antennas For Mobile Communication Systems: Benefits And Challenges*, Electronics & Communication Engineering Journal, Apr. 1999, pp. 84-94.

Shad et al., *Indoor SDMA Capacity Using a Smart Antenna Basestation*, 1997 IEEE, pp. 868-872.

Farsakh, Christof and Nosseck, Josef A., *On the Mobile Radio Capacity Increase Through SDMA*, no date (after 1997).

Frullone et al., *PRMA Performance in Cellular Environments with Self-Adaptive Channel Allocation Strategies*, IEEE Transactions on Vehicular Technology, Nov. 1996, pp. 657-665 vol. 45, No. 4.

Xu, Guanghan and Li, San-Qi, *Throughput Multiplication of Wireless Lans for Multimedia Services: SDMA Protocol Design*, 1994 IEEE, pp. 1326-1332.

Ward, James and Compton, R. Ted, Jr., *High Throughput Slotted ALOHA Packet Radio Networks with Adaptive Arrays*, IEEE Transactions on Communications, Mar. 1993, pp. 460-470, vol. 41, No. 3.

Farsakh, C. et al., "Maximizing the SDMA Mobile Radio Capacity Increase by DOA Sensitive Channel Allocation", Wireless Personal Communications, Kluwer Academic Publishers, NL, vol. 11, No. 1, Oct. 1999, pp. 63-76, XP000835062, ISSN: 0929-6212.

Wong, C.Y., et al., *Multiuser OFDM With Adaptive Subcarrier, Bit, and Power Allocation*, IEEE Journal on Selected Areas in Communications, Oct. 1999, IEEE Inc., New York, USA, vol. 17, Nr. 10, pp. 1747-1758, XP000854075, ISSN: 0733-8716 Sections I and II abstract.

Gruenheid, R. et al: "Adaptive Modulation and Multiple Access for the OFDM Transmission Technique", Wireless Personal Communications, Kluwer Academic Publishers, NL, vol. 13, NR. 1/2, Year 2000, pp. 5-13 XP000894156, ISSN: 0929-6212.

Motegi, M. et al.: "Optimum Band Allocation According to Subband Condition for BST-OFDM" 11th IEEE International Symposium on Personal Indoor and Mobile Radio Communications, vol. 2, Sep. 18-21, 2000, pp. 1236-1240, XP002213669, Piscataway, NJ, USA, ISBN: 0-7803-6463-5.

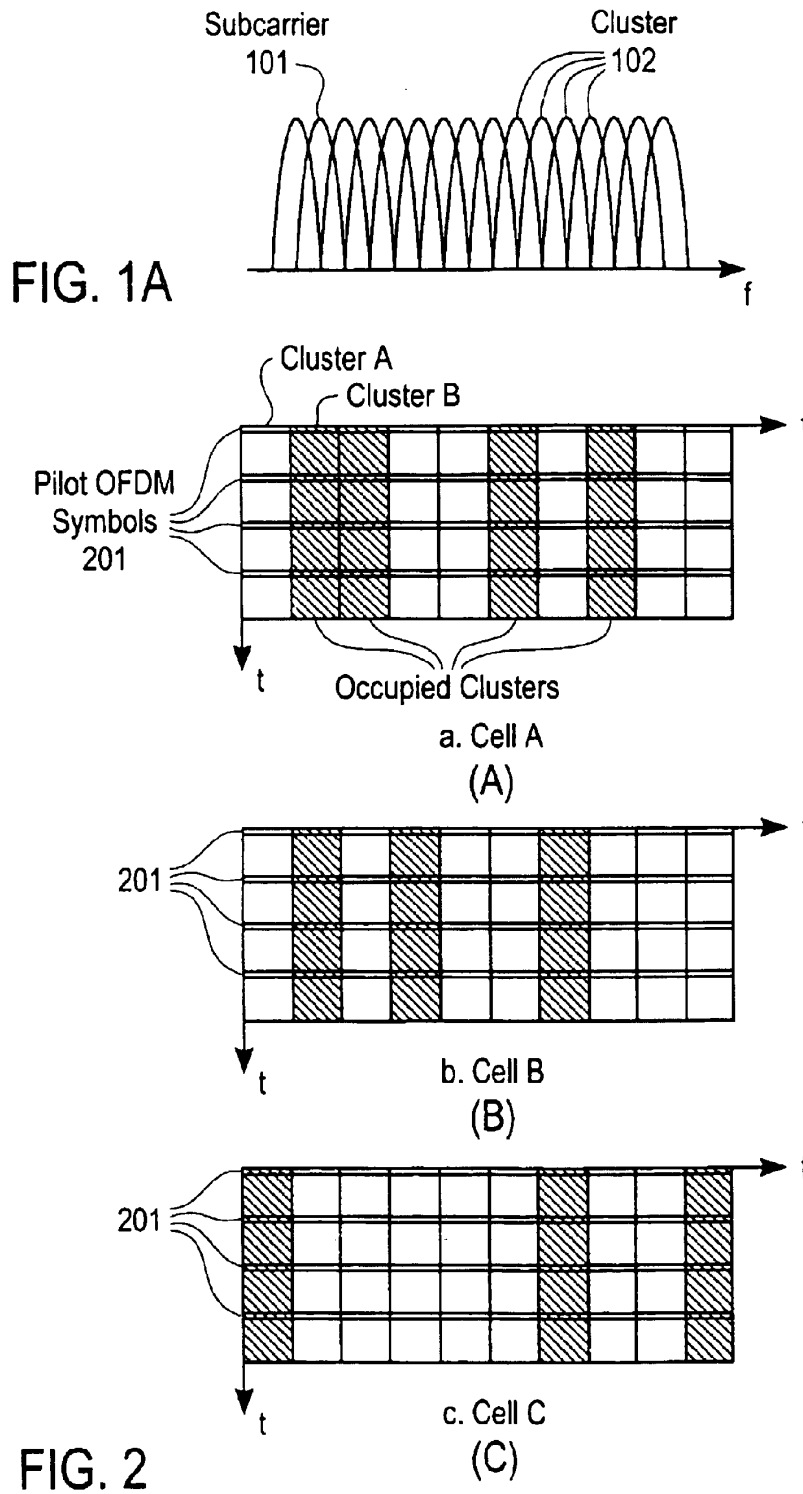
Kapoor, S. et al.: "Adaptive Interference Suppression in Multiuser Wireless OFDM Systems Using Antenna Arrays" IEEE Transactions on Signal Processing, vol. 47, No. 12, Dec. 1999, pp. 3381-3391, XP000935422, IEEE, New York, USA, ISSN: 1053-587X.

Ye Li, et al.: "Clustered OFDM with channel estimation for high rate wireless data", Mobile Multimedia Communications, 1999. (MOMUC '99). 1999 IEEE International Workshop on San Diego, CA, USA, IEEE, US, Nov. 15, 1999, pp. 43-50, XP010370695, ISBN: 0-7803-5904-6.

Nogueroles, R. et al.: "Improved Performance of a Random OFDMA Mobile Communication System" Vehicular Technology Conference, 1998. VTC 98. 48th IEEE Ottawa, Ontario, Canada, May 18-21, 1998, pp. 2502-2506, XP010288120, ISBN: 0-7803-4320-4.

Kinugawa, Y. et al.: "Frequency and Time Division Multiple Access with Demand-Assignment Using Multicarrier Modulation for Indoor Wireless Communications Systems", IEICE Transactions on Communications, Institute of Electronics Information and Comm. Eng. Tokyo, Japan, vol. E77-B, NR. 3, Mar. 1994, pp. 396-402, XP000451014, ISSN: 0916-8516.

* cited by examiner



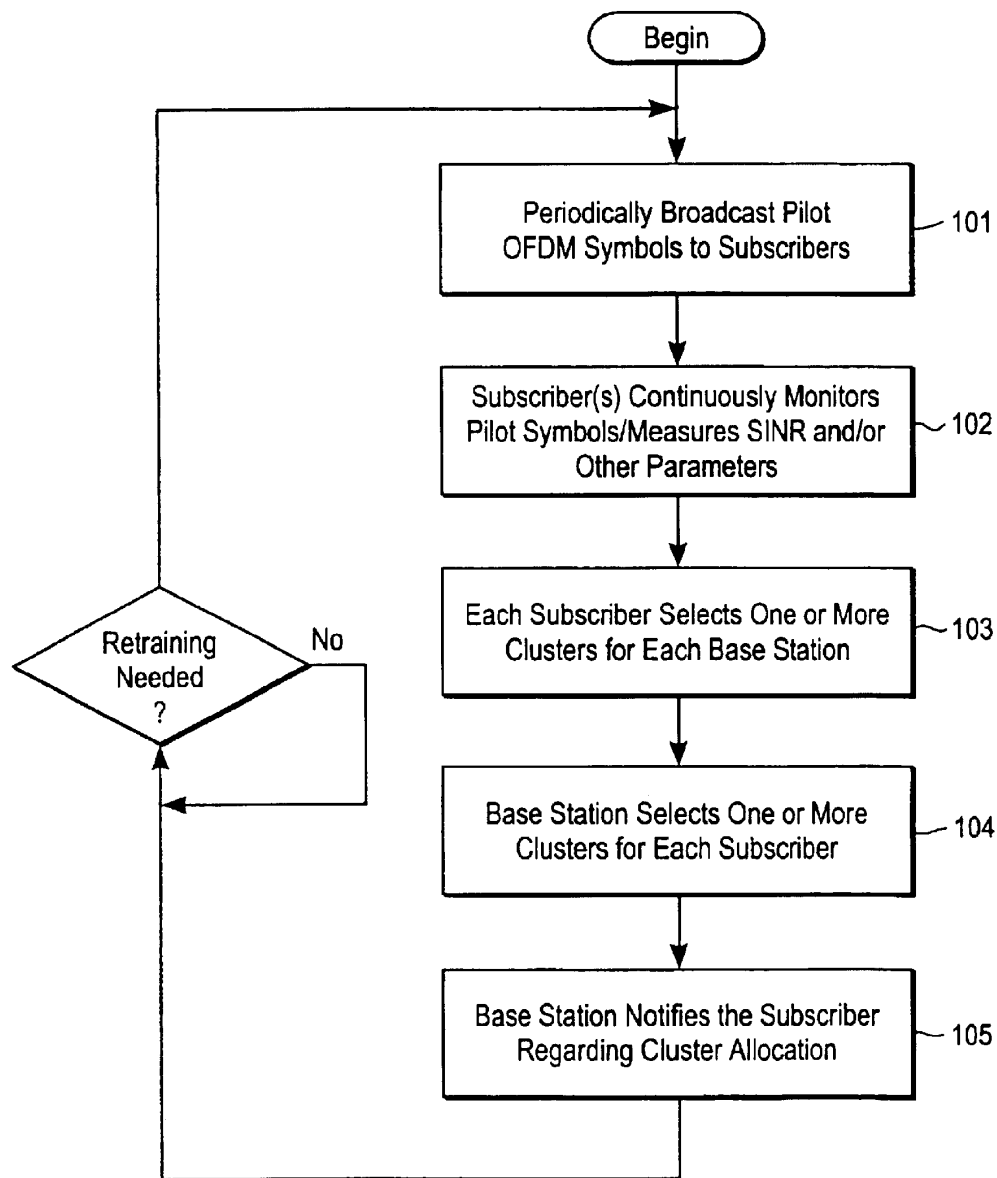


FIG. 1B

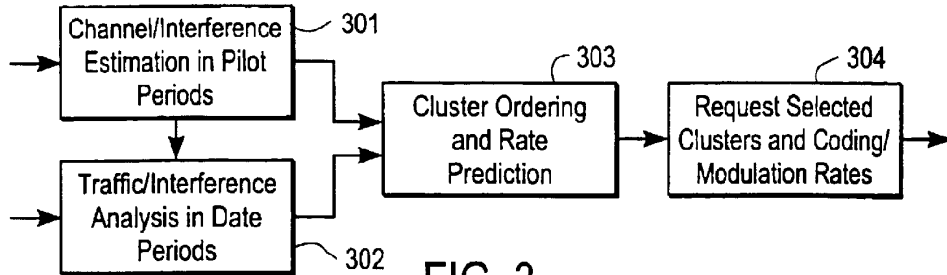


FIG. 3

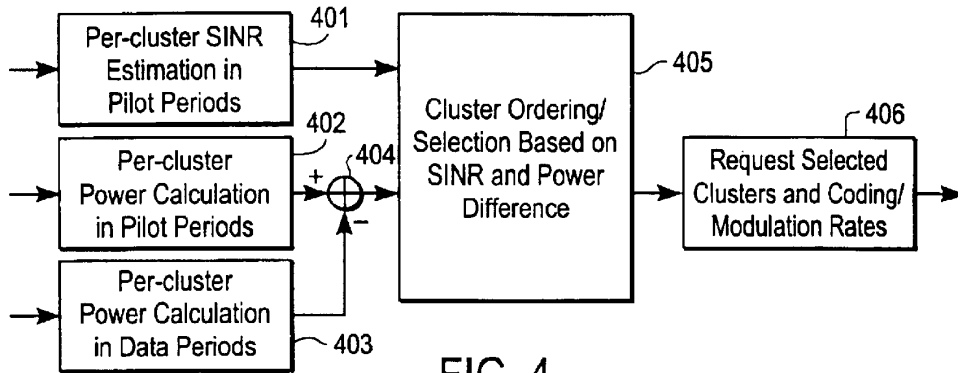


FIG. 4

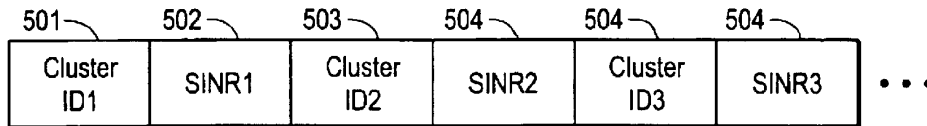


FIG. 5

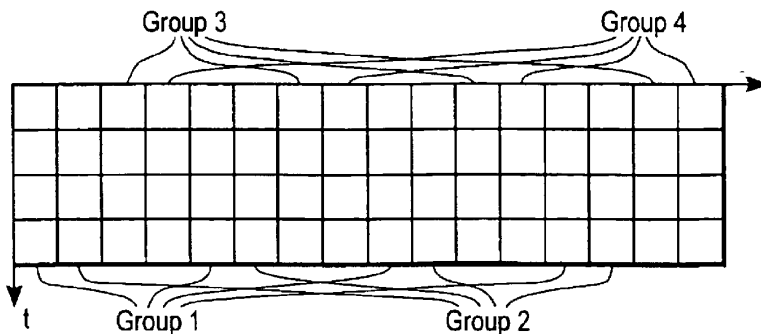


FIG. 6

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