

(19) World Intellectual Property Organization
International Bureau(43) International Publication Date
23 February 2006 (23.02.2006)

PCT

(10) International Publication Number
WO 2006/019579 A3

(51) International Patent Classification:

H04L 25/02 (2006.01) **H04B 7/04** (2006.01)
H04L 27/26 (2006.01)

(21) International Application Number:

PCT/US2005/023979

(22) International Filing Date: 7 July 2005 (07.07.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

10/896,277 20 July 2004 (20.07.2004) US

(71) Applicant (for all designated States except US): **QUALCOMM Incorporated** [US/US]; 5775 Morehouse Drive, San Diego, California 92121 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **WALTON, Jay, Rodney** [US/US]; 85 Highwoods Lane, Carlisle, Massachusetts 01741 (US). **WALLACE, Mark, S.** [US/US]; 4 Madel Lane, Bedford, Massachusetts 01730 (US).(74) Agents: **WADSWORTH, Phillip, R.** et al.; 5775 Morehouse Drive, San Diego, California 92121 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,

CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

Published:

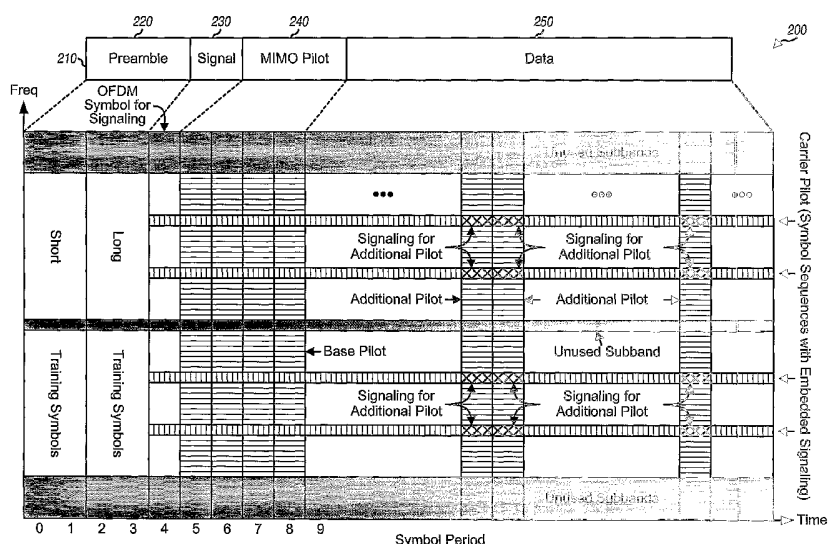
- with international search report

(88) Date of publication of the international search report:

8 June 2006

[Continued on next page]

(54) Title: ADAPTIVE PILOT INSERTION FOR A MIMO-OFDM SYSTEM



(57) **Abstract:** A transmitting entity transmits a "base" pilot in each protocol data unit (PDU). A receiving entity is able to derive a sufficiently accurate channel response estimate of a MIMO channel with the base pilot under nominal (or most) channel conditions. The transmitting entity selectively transmits an additional pilot if and as needed, e.g., based on channel conditions and/or other factors. The additional pilot may be adaptively inserted in almost any symbol period in the PDU. The receiving entity is able to derive an improved channel response estimate with the additional pilot. The transmitting entity sends signaling to indicate that additional pilot is being sent. This signaling may be embedded within pilot symbols sent on a set of pilot subbands used for a carrier pilot that is transmitted across most of the PDU. The signaling indicates whether additional pilot is being sent and possibly other pertinent information.



WO 2006/019579 A3



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2005/023979

A. CLASSIFICATION OF SUBJECT MATTER

H04L25/02 H04L27/26 H04B7/04

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 H04B

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)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2004/038988 A (QUALCOMM, INCORPORATED) 6 May 2004 (2004-05-06)	1-3, 7-20, 37-39, 41-46, 48-50
Y	abstract; figure 2; table 1 paragraphs '1117! - '1119!; table 9 -----	23,30, 32,34,36
P,X	WO 2005/018180 A (INTEL CORPORATION) 24 February 2005 (2005-02-24) page 6, line 3 - page 7, line 11; figure 2 page 8, line 30 - page 9, line 3; figure 5 ----- -/--	1-3, 7-20, 37-39, 41-46, 48-50



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
- "E" earlier document but published on or after the international filing date
- "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)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "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
- "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
- "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.
- "&" document member of the same patent family

Date of the actual completion of the international search

31 January 2006

Date of mailing of the international search report

15.02.2006

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Horbach, C

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2005/023979

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 083 719 A (SONY CORPORATION) 14 March 2001 (2001-03-14) abstract paragraphs '0085! - '0098!; figures 6,7 paragraphs '0186!, '0190!, '0191!; figures 18,20 -----	1-51
A	DE 101 41 971 A1 (SIEMENS AG) 27 March 2003 (2003-03-27) abstract paragraphs '0022! - '0025! -----	1-51
X	WO 03/034646 A (NORTEL NETWORKS LIMITED) 24 April 2003 (2003-04-24) abstract -----	21,22, 29,33
Y	page 23, line 25 - page 24, line 24; figures 2,10 -----	23,30, 32,34,36
X	US 2001/014101 A1 (SPRUYT PAUL M.P ET AL) 16 August 2001 (2001-08-16) paragraphs '0022!, '0036!; claims 1,4,6; figure 2 -----	21,22, 29,33
X	US 6 707 856 B1 (GARDNER JAMES M ET AL) 16 March 2004 (2004-03-16) column 2, lines 14-21 column 4, lines 18-38 column 5, line 58 - column 6, line 15 -----	21,22, 29,33
X	US 2004/101046 A1 (YANG LIN ET AL) 27 May 2004 (2004-05-27) paragraph '0287! -----	21,22, 29,33

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2005/023979

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 allsearchable 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.:

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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-20,37-51

Methods and apparatuses for a multiple-input multiple-output MIMO communication system of transmitting an additional pilot signal in a physical layer protocol data unit PDU in order to improve the MIMO channel response.

2. claims: 21-36

Methods and apparatuses for a multiple-input multiple-output MIMO OFDM communication system of transmitting signalling by selection of from among a plurality of sets of pilot symbols.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2005/023979

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 2004038988	A	06-05-2004	NONE	
WO 2005018180	A	24-02-2005	NONE	
EP 1083719	A	14-03-2001	JP 2001077788 A US 6888789 B1	23-03-2001 03-05-2005
DE 10141971	A1	27-03-2003	WO 03028323 A1	03-04-2003
WO 03034646	A	24-04-2003	CN 1605171 A EP 1438800 A2 US 2003072395 A1	06-04-2005 21-07-2004 17-04-2003
US 2001014101	A1	16-08-2001	NONE	
US 6707856	B1	16-03-2004	NONE	
US 2004101046	A1	27-05-2004	NONE	