



- (51) **International Patent Classification:**
H04W 72/04 (2009.01)
- (21) **International Application Number:**
PCT/US2013/039000
- (22) **International Filing Date:**
1 May 2013 (01.05.2013)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
61/640,798 1 May 2012 (01.05.2012) US
13/874,259 30 April 2013 (30.04.2013) US
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- (81) **Designated States** (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,

BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP,
KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD,
ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI,
NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU,
RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ,
TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA,
ZM, ZW.

- (84) **Designated States** (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments (Rule 48.2(h))

- (88) **Date of publication of the international search report:**
27 December 2013

(54) **Title:** METHODS AND APPARATUS FOR MANAGING CONTROL AND DATA TRANSMISSIONS FOR LOW COST USER EQUIPMENTS

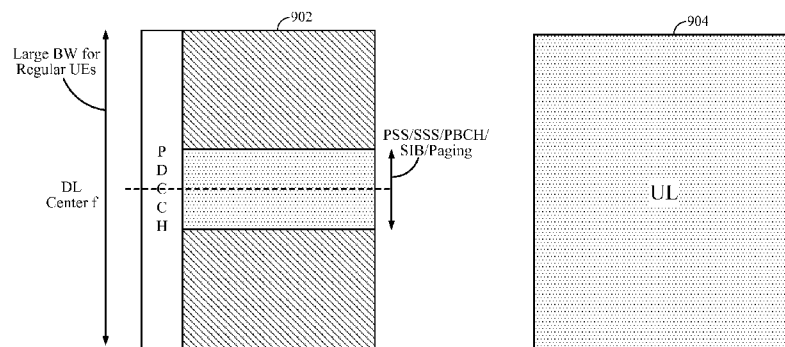


FIG. 9

(57) **Abstract:** Certain aspects of the present disclosure relate to methods and apparatus for managing control and data transmissions for low cost UEs. In certain aspects, multiplexing of a control channel and data channel may be allowed in a Physical Resource Block (PRB) pair of a subframe. An indication may be provided to the UE regarding whether a portion of resources of the PRB pair not used to transmit the control channel is available for transmitting the data channel. In alternative aspects, control and data may be scheduled in different subframes, such that there is no need to multiplex them in a subframe or a PRB pair in a same subframe.

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A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W72/04
ADD.

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)
H04W H04L

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 practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	QUALCOMM INCORPORATED: "Multiplexing e-PDCCH with PDSCH", 3GPP DRAFT; R1-114124 MULTIPLEXING EPDCCH WITH PDSCH, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. San Francisco, USA; 20111114 - 20111118, 8 November 2011 (2011-11-08), XP050562099, [retrieved on 2011-11-08]	1,13, 25-27, 39,51,52
A	the whole document ----- -/--	2-12, 14-24, 28-38, 40-50, 53-96



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 application or patent 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

24 October 2013

Date of mailing of the international search report

31/10/2013

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INTERNATIONAL SEARCH REPORT

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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 all searchable 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.

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2013/039000

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LG ELECTRONICS: "Multiplexing PDSCH and E-PDCCH within a PRB pair", 3GPP DRAFT; R1-120449, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Dresden, Germany; 20120206 - 20120210, 31 January 2012 (2012-01-31), XP050562937, [retrieved on 2012-01-31]	1-3, 8-10, 13-15, 20-22, 25-29, 34-36, 39-41, 46-48, 51,52
Y	page 1, line 1 - page 2, line 18 figures 1,2	4-7,11, 12, 16-19, 23,24, 30-33, 37,38, 42-45, 49,50, 54,55, 64,65, 76,77, 86,87
A		53, 56-63, 66-75, 78-85, 88-96
Y	----- SAMSUNG: "Discussion on ePDCCH Design Issues", 3GPP DRAFT; R1-112517 EPDCCH, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Athens, Greece; 20110822, 16 August 2011 (2011-08-16), XP050537597, [retrieved on 2011-08-16]	6,7,18, 19,32, 33,44,45
A	page 2, lines 6-9,17-21 page 3, lines 38-40 figures 1(b),2(b)	1-5, 8-17, 20-31, 34-43, 46-96
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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2013/039000

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	PANASONIC: "Multiplexing between ePDCCH and PDSCH", 3GPP DRAFT; R1-120235, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Dresden, Germany; 20120206 - 20120210, 31 January 2012 (2012-01-31), XP050562792, [retrieved on 2012-01-31]	4,5,16, 17,30, 31,42, 43,62, 72,84,94
A	page 2, lines 13,14,24-31,38-44 figures 1,2 table 1	1-3, 6-15, 18-29, 32-41, 44-61, 63-71, 73-83, 85-93, 95,96
Y	----- QUALCOMM INCORPORATED: "Impact of Reduction of Maximum Bandwidth on MTC", 3GPP DRAFT; R1-120563 IMPACT OF REDUCTION OF MAXIMUM BW FOR MTC, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Dresden, Germany; 20120206 - 20120210, 31 January 2012 (2012-01-31), XP050563001, [retrieved on 2012-01-31]	11,12, 23,24, 37,38, 49,50, 60,70, 82,92
A	the whole document	1-10, 13-22, 25-36, 39-48, 53-59, 61-69, 71-81, 83-91, 93-96
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International application No

PCT/US2013/039000

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	NEC GROUP: "Maximum bandwidth reduction for low-cost MTC UE based on LTE", 3GPP DRAFT; R1-120259, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Dresden, Germany; 20120206 - 20120210, 31 January 2012 (2012-01-31), XP050562813, [retrieved on 2012-01-31]	11,12, 23,24, 37,38, 49,50
A	page 2, lines 1-9 page 3, lines 1-6 figure 1 table 1	1-10, 13-22, 25-36, 39-48, 51-96
X	----- HTC: "E-PDCCH Design Considerations on Multiplexing with PDSCH", 3GPP DRAFT; R1-120266, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Dresden, Germany; 20120206 - 20120210, 1 February 2012 (2012-02-01), XP050563176, [retrieved on 2012-02-01]	53, 57-59, 61,63, 67-69, 71, 73-75, 79-81, 83,85, 89-91, 93,95,96
Y	page 3, lines 8-10,16 figure "Alt. 2"	54-56, 60,62, 64-66, 70,72, 76-78, 82,84, 86-88, 92,94
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International application No

PCT/US2013/039000

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HTC: "E-PDCCH Design Considerations on Multiplexing with PDSCH", 3GPP DRAFT; R1-114354 E-PDCCH DESIGN ASPECTS, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. San Francisco, USA; 20111114 - 20111118, 21 November 2011 (2011-11-21), XP050562464, [retrieved on 2011-11-21]	53, 57-59, 61,63, 67-69, 71, 73-75, 79-81, 83,85, 89-91, 93,95,96
Y	page 1, lines 19-20 page 2, lines 32-37 figures 3,4	54-56, 60,62, 64-66, 72, 76-78, 82,84, 86-88, 92,94
Y	----- MOTOROLA MOBILITY: "E-PDCCH Design Aspects", 3GPP DRAFT; R1-114029 - ENHANCED PDCCH DESIGN ASPECTS F, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. San Francisco, USA; 20111114 - 20111118, 10 November 2011 (2011-11-10), XP050562396, [retrieved on 2011-11-10]	56,66, 78,88
A	the whole document ----- -/--	1-55, 57-65, 67-77, 79-87, 89-96

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2013/039000

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CATT: "Considerations on E-PDCCH multiplexing with PDSCH", 3GPP DRAFT; R1-120110, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Dresden, Germany; 20120206 - 20120210, 31 January 2012 (2012-01-31), XP050562690, [retrieved on 2012-01-31]	62,72, 84,94
A	the whole document	1-61, 63-71, 73-83, 85-93, 95,96
A	----- INTEL CORPORATION: "Performance evaluation of cost reduction strategies for low-cost MTC UEs based on LTE", 3GPP DRAFT; R1-120210, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Dresden, Germany; 20120206 - 20120212, 1 February 2012 (2012-02-01), XP050563169, [retrieved on 2012-02-01] page 6, lines 16-27 table 6	1-96
A	----- INTERDIGITAL COMMUNICATIONS ET AL: "On ePDCCH Multiplexing", 3GPP DRAFT; R1-121319 EPDCCH MULTIPLEXING FINAL, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Jeju, Korea; 20120326 - 20120330, 20 March 2012 (2012-03-20), XP050599609, [retrieved on 2012-03-20] page 1, line 1 - page 3, line 5 figures 1,2 ----- -/--	1-96

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International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	QUALCOMM INCORPORATED: "Multiplexing of different DCI messages for e-PDCCH", 3GPP DRAFT; R1-120562 MULTIPLEXING OF DIFFERENT DCI MESSAGES FOR E-PDCCH, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Dresden, Germany; 20120206 - 20120210, 31 January 2012 (2012-01-31), XP050563000, [retrieved on 2012-01-31] the whole document	1-96
X,P	----- QUALCOMM INCORPORATED: "Indication to the UE of ePDCCH PRB Pairs", 3GPP DRAFT; R1-123697 INDICATION TO THE UE OF EPDCCH PRB PAIRS, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG1, no. Qingdao, China; 20120813 - 20120817 5 August 2012 (2012-08-05), XP050661571, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_70/Docs/ [retrieved on 2012-08-05] the whole document	1-10, 13-22, 25-36, 39-48, 51,52
Y,P		11,12, 23,24, 37,38, 49,50 53-96
A,P	----- -/--	

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2013/039000

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	QUALCOMM INCORPORATED: "Downlink transmission modes for MTC", 3GPP DRAFT; R1-122802 DOWNLINK TRANSMISSION MODES FOR MTC, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Prague, Czech Republic; 20120521 - 20120525, 12 May 2012 (2012-05-12), XP050600980, [retrieved on 2012-05-12]	11,12, 23,24, 37,38, 49,50, 60,70, 82,92
A,P	page 3, line 4 - page 5, line 2 figure 1	1-10, 13-22, 25-36, 39-48, 51-59, 61-69, 71-81, 83-91, 93-96
A,P	----- QUALCOMM INCORPORATED: "On cross-carrier scheduling with EPDCCH", 3GPP DRAFT; R1-125112 ON CROSS-CARRIER SCHEDULING WITH EPDCCH, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG1, no. New Orleans, USA; 20121112 - 20121116 3 November 2012 (2012-11-03), XP050662973, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_71/Docs/ [retrieved on 2012-11-03] the whole document ----- -/--	53-96

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/039000

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,P	QUALCOMM INCORPORATED: "Remaining details of search space and aggregation levels", 3GPP DRAFT; R1-125107 REMAINING DETAILS OF SEARCH SPACE AND AGGREGATION LEVELS, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS , vol. RAN WG1, no. New Orleans, USA; 20121112 - 20121116 3 November 2012 (2012-11-03), XP050662968, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_71/Docs/ [retrieved on 2012-11-03] the whole document -----	1-96
A,P	QUALCOMM INCORPORATED: "Additional Comments on Cost Evaluation for MTC", 3GPP DRAFT; R1-122804 ADDITIONAL COMMENTS ON COST EVALUATION FOR MTC, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Prague, Czech Republic; 20120521 - 20120525, 12 May 2012 (2012-05-12), XP050600981, [retrieved on 2012-05-12] page 2, line 8 - page 3, line 4 figures 1,2 -----	1-96

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-52

A method of wireless communication by a base station (BS), comprising: transmitting a control channel using a first portion of resources of at least one Physical Resource Block (PRB) pair of a subframe; and providing an indication regarding whether a second portion of resources of the PRB pair not used to transmit the control channel is available for transmitting a data channel.

2. claims: 53-96

A method of wireless communications by a base station (BS), comprising: transmitting control information in a subframe of a first subset of subframes to schedule data transmissions in one or more subframes of a second subset of subframes, wherein the first subset of subframes is designated for transmitting control information without transmitting data and the second subset of subframes is designated for transmitting data without transmitting control information; and transmitting the data in the one or more subframes of the second subset in accordance with the transmitted control information.
