(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 March 2024 (28.03.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/063682 A3

(51) International Patent Classification:
H04B 7/0456 (2017.01) *H04B 7/06* (2006.01)

(21) International Application Number:
PCT/SE2023/050887

(22) International Filing Date:
08 September 2023 (08.09.2023)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
63/409,425 23 September 2022 (23.09.2022) US

(71) Applicant: **TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)** [SE/SE]; 164 83 Stockholm (SE).

(72) Inventors: **ATHLEY, Fredrik**; Källängsgatan 14, SE-426 79 VÄSTRA FRÖLUNDA (SE). **ZHANG, Xinlin**; Lunnefågelgången 21, SE-426 69 VÄSTRA FRÖLUNDA (SE). **WINGES, Johan**; Bergskroken 8, SE-431 37 MÖLNDAL (SE). **KUMAR NAGALAPUR, Keerthi**; Soldathemsgatan 30 Lgh 1003, SE-415 28 GÖTEBORG (SE). **MURUGANATHAN, Siva**; 275 Denali Way, STITTSVILLE, Ontario K2S 0R3 (CA).

(74) Agent: **BOU FAICAL, Roger**; Ericsson AB, Patent Unit Kista RAN 1, 164 80 Stockholm (SE).

(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, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO,

(54) Title: INDICATION OF NON-ZERO COEFFICIENTS IN REL-18 TYPE II CODEBOOK FOR HIGH VELOCITY

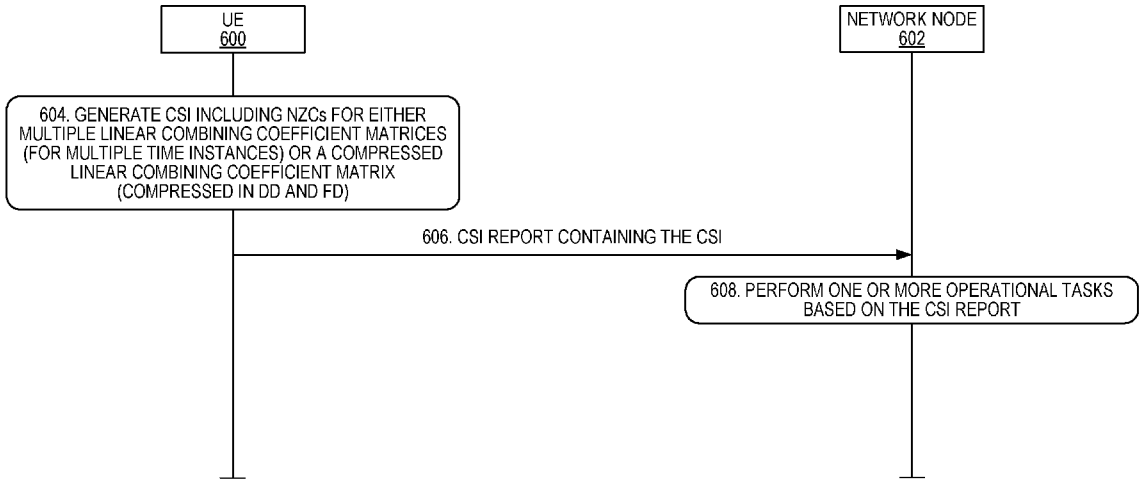

FIG. 6

(57) **Abstract:** Systems and methods for indication of Non-Zero Coefficients (NZCs) in a codebook for User Equipments (UEs) are disclosed. In one embodiment, a method performed by a UE comprises generating Channel State Information (CSI) comprising NZCs of a set of linear combining coefficients, wherein the set of linear combining coefficients are associated with a number, L, of selected Discrete Fourier Transform (DFT) basis vectors in spatial domain (SD), a number, M, of selected DFT basis vectors in frequency domain (FD), and MVDD selected DFT basis vectors in Doppler Domain (DD). The CSI further comprises, for each reported layer, a set of MVDD NZC bitmaps that indicates positions of the NZCs, wherein the set of MVDD NZC bitmaps comprises a separate bitmap for each selected DFT basis vector in DD in the set of MVDD selected DFT basis vectors in DD. The method further comprises reporting the CSI to a network node.

WO 2024/063682 A3

[Continued on next page]

RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, 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, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, 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))*

— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

(88) Date of publication of the international search report:
02 May 2024 (02.05.2024)

INTERNATIONAL SEARCH REPORT

International application No
PCT/SE2023/050887

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04B7/0456 H04B7/06
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)
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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ZTE: "CSI enhancement for high/medium UE velocities and CJT", 3GPP DRAFT; R1-2205920, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG1, no. Toulouse, France; 20220822 - 20220826 12 August 2022 (2022-08-12), XP052273850, Retrieved from the Internet: URL:https://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_110/Docs/R1-2205920.zip R1-2205920 CSI enhancement for high medium UE velocities and CJT_final.docx [retrieved on 2022-08-12]	1-4, 10-15, 26-28
Y	sections 2.1.1, 2.1.2; pages 1-6	5-9

-/--

[X] Further documents are listed in the continuation of Box C.

[X] 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	Date of mailing of the international search report
11 March 2024	19/03/2024

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Helms, Jochen

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2023/050887

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.:

1-15, 26-28

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.

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	pages 17, 21 -----	
X	EP 3 780 410 A1 (FRAUNHOFER GES FORSCHUNG [DE]) 17 February 2021 (2021-02-17) -----	1-4, 10-15, 26-28
Y	abstract paragraphs [0010], [0039] - [0046], [0070], [0087] - [0098], [0162] - [0172], [0179], [0181] figures 4, 7, 8a,b -----	5-9
Y	WO 2022/144778 A1 (ERICSSON TELEFON AB L M [SE]) 7 July 2022 (2022-07-07) abstract page 33, line 24 - page 37, line 2 page 56, lines 1-11 page 60, line 10 - page 67, line 14 -----	5-9
Y	CATT: "CSI Enhancements for Rel-17", 3GPP DRAFT; R1-2104488, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG1, no. e-Meeting; 20210519 - 20210527 12 May 2021 (2021-05-12), XP052010811, Retrieved from the Internet: URL:https://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_105-e/Docs/R1-2104488.zip R1-2104488.docx [retrieved on 2021-05-12] section 2.5; pages 12-14 -----	5-9

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/SE2023/050887

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 3780410 A1	17-02-2021	EP 3780410 A1	17-02-2021
		EP 4014340 A1	22-06-2022
		WO 2021028331 A1	18-02-2021
WO 2022144778 A1	07-07-2022	EP 4268380 A1	01-11-2023
		JP 2024503263 A	25-01-2024
		US 2024007164 A1	04-01-2024
		WO 2022144778 A1	07-07-2022

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-4, 10-15, 26-28

Independent claim 1 relates to a method performed by a User Equipment, UE, the method comprising: generating Channel State Information, CSI, comprising: non-zero coefficients, NZCs, of a set of linear combining coefficients, wherein the set of linear combining coefficients are associated with: a number, L, of selected Discrete Fourier Transform, DFT, basis vectors in spatial domain, SD; a number, M, of selected DFT basis vectors in frequency domain, FD; and MDvDD selected DFT basis vectors in Doppler Domain, DD; and for each reported layer, a set of MDvDD NZC bitmaps that indicates positions of the NZCs, wherein the set of MDvDD NZC bitmaps comprises a separate bitmap for each selected DFT basis vector in DD in the set of MDvDD selected DFT basis vectors in DD; and reporting the CSI to a network node.
Independent claims 12, 14 and 26-28 correspond to claim 1.
Dependent claim 2 states that each NZC bitmap of the set of MvDD NZC bitmaps has a size of 2LM bits.

---

2. claims: 16-25, 29-31

Independent claim 16 relates to a method performed by a User Equipment, UE, the method comprising:
generating Channel State Information, CSI, comprising:
non-zero coefficients, NZCs, of a plurality of linear combining coefficient matrices W2sfor a plurality of time instances, respectively; and
at least one NZC bitmap that indicates positions of the NZCs in the plurality of W2s for the plurality of time instances, the at least one NZC bitmap comprising either:
a common NZC bitmap for all of the plurality of time instances per each reported layer; or
a common NZC bitmap for all of the plurality of times for all reported layers; or
a first common NZC bitmap for all of the plurality of time instances for a first set of reported layers and separate NZC bitmaps for all of the plurality of time instances for a second set of report layers; or
two or more common NZC bitmaps for two or more sets of reported layers, respectively; and
reporting the CSI to a network node.

---

3. claims: 5-9

Dependent claim 5 states that the CSI further comprises, for each reported layer, a single strongest coefficient indicator that indicates a position of a strongest coefficient for that layer.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210
