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**Datasheet for the decision
of 28 April 2023**

Case Number: T 1910/21 - 3.5.03

Application Number: 17866591.5

Publication Number: 3533146

IPC: H03M13/11, H03M13/00

Language of the proceedings: EN

Title of invention:

Method and apparatus for encoding and decoding LDPC codes

Applicant:

Huawei Technologies Co., Ltd.

Headword:

Punctured columns in LDPC codes/HUAWEI

Relevant legal provisions:

EPC Art. 56

RPBA 2020 Art. 12(4), 13(2)

Keyword:

Admittance of claim amendments after summons - main request
(no): no exceptional circumstances

Inventive step - first auxiliary request (no)

Admittance of claim amendments on appeal - second auxiliary
request (no): no reasons provided for submitting amendment in
appeal proceedings



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Case Number: T 1910/21 - 3.5.03

D E C I S I O N
of Technical Board of Appeal 3.5.03
of 28 April 2023

Appellant: Huawei Technologies Co., Ltd.
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Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted on 23 June 2021
refusing European patent application
No. 17866591.5 pursuant to Article 97(2) EPC**

Composition of the Board:

Chair K. Bengi-Akyürek
Members: R. de Man
F. Bostedt

Summary of Facts and Submissions

I. The appellant (applicant) appealed against the decision of the examining division refusing the present European patent application.

II. The contested decision cited the following prior-art documents:

D2: US 2008/0155385 A1, 26 June 2008;

D3: US 2005/0283709 A1, 22 December 2005.

The examining division decided that the subject-matter of the claims of the main request and of the first and second auxiliary requests lacked an inventive step over document D2.

III. With its statement setting out the grounds of appeal, the appellant replaced its claim requests with a new main request and new first and second auxiliary requests.

IV. In a communication under Article 15(1) RPBA 2020, the board expressed its preliminary opinion that the subject-matter of claim 1 of the main request lacked an inventive step over document D2 and that the first auxiliary request should not be admitted into the appeal proceedings.

V. With a letter filed in preparation for the oral proceedings, the appellant replaced its claim requests with a new main request and new first and second auxiliary requests. It filed the following documents as annexes:

- A:** "LDPC design for eMBB data", 3GPP TSG RAN WG1 NR Ad-Hoc Meeting, 16-20 January 2017, RI-1700092;
- B:** "LDPC design for base graph 1", 3GPP TSG RAN WG1 Meeting AH#2, 27-30 June 2017, RI-1711436;
- C:** "LDPC design for base graph 2", 3GPP TSG RAN WG1 Meeting AH#2, 27-30 June 2017, RI-1711437.

VI. Oral proceedings took place as scheduled. At the end of those proceedings, the board's decision was announced.

VII. The appellant's final requests were that the decision under appeal be set aside and that a patent be granted on the basis of the claims of the **main request** or, in the alternative, of either of the **first and second auxiliary requests**.

VIII. Claim 1 of the **main request** reads as follows:

"A method for wireless communication, comprising:

obtaining a sequence of information bits to be encoded; and

encoding the sequence of information bits based on a base matrix of an irregular quasi-cyclic low density parity check code,

wherein the base matrix comprises a core part having multiple rows and columns,

the multiple columns of the core part comprising at least one punctured column and non-punctured columns, wherein only the first two columns are the punctured columns,

wherein a punctured column is a column in which the corresponding information bits are used by the encoder and are not transmitted;

wherein the base matrix comprises an extension part having at least one punctured column and non-punctured columns and each of the at least one

punctured column of the extension part have a substantially higher weight than all other non-punctured columns of the extension part,

the rows of the core part and extension part of the base matrix being dividable into a first set of rows and a second set of rows, and the first set of rows having a higher weight than the second set of rows,

the second set of rows comprising at least one group, each of the at least one group comprising at least two consecutive rows, the at least two consecutive rows consisting of a first part and a second part,

the first part being a portion of the at least one punctured column, and rows of the first part being non-orthogonal, and

the second part being a portion of the non-punctured columns, and rows of the second part being orthogonal, each row of the second part comprising a plurality of non-zero entries corresponding to information bits;

wherein a matrix consisting of a subset of columns of a matrix formed by the rows of the first set has a dual diagonal structure and a matrix consisting of a subset of columns of the matrix formed by the rows of the second set has an identity matrix structure."

IX. Claim 1 of the **first auxiliary request** differs from claim 1 of the main request in that the text ", each row of the second part comprising a plurality of non-zero entries corresponding to information bits" has been removed from the definition of "the second part".

X. Claim 1 of the **second auxiliary request** differs from claim 1 of the first auxiliary request in that the following text has been added at the end of the claim:

"wherein the base matrix comprises a plurality of entries representing blocks of the matrix, and each block of the matrix either represents a shifted circulant matrix or a zero matrix;

wherein the shifted circulant matrix is indicated by a shift value, and the shift value defines the number of times for an identity matrix to be cyclically right-shifted;

wherein the base matrix comprises 46 rows and 68 columns, and wherein for column 3 to 68, starting from row 9, there are multiple group of orthogonal rows wherein the orthogonal rows are the rows not overlapped from a columnwise point of view; and

wherein rows 9 and 10 are orthogonal, and rows 11 and 12 are orthogonal."

Reasons for the Decision

1. The application relates to encoding and decoding data using low-density parity-check (LDPC) error-correcting codes.
2. *Main request - admittance*
 - 2.1 The main request was filed for the first time after the notification of the board's summons to oral proceedings. Its claim 1 corresponds to claim 1 of the main request filed with the statement of grounds of appeal with the addition of the feature "each row of the second part comprising a plurality of non-zero entries corresponding to information bits" (cf. point VIII above).
 - 2.2 The appellant argued that the added feature amounted to a clarification of the feature "the second part being a

portion of the non-punctured columns, and rows of the second part being orthogonal" (i.e. feature (h) according to point 4.4 below). The need for this clarification had only come to light upon reading the board's communication under Article 15(1) RPBA 2020, which had suggested, in point 8.7, that a certain part of a matrix disclosed in document D2, which had almost no non-zero entries, had rows which were "orthogonal". The first-instance proceedings had focused on added matter and clarity rather than inventive step.

The board notes, however, that the examining division refused the application for lack of inventive step, and the board's reasoning for feature (h) in point 8.7 of its communication did not deviate from the examining division's reasoning for the same feature (see Reasons 1.3 of the appealed decision, feature (I)). Moreover, the board does not agree that the amendment is merely a "clarification". On the contrary, the added feature represents a limitation which was not present in claim 1 of the previous main request. In fact, the concept of "orthogonality" of rows does not require that the rows include a plurality of non-zero entries.

2.3 The board concludes that no exceptional circumstances exist which could justify the admittance of the main request (Article 13(2) RPBA 2020). Consequently, the main request was not admitted into the appeal proceedings.

3. *First auxiliary request - admittance*

3.1 The first auxiliary request corresponds to the main request filed with the statement of grounds of appeal, with an amendment to independent claim 9 correcting an

inconsistency with the wording of independent claim 1 (cf. point IX above).

3.2 Since the inconsistency had not been spotted previously and, more importantly, since its correction does not raise any new issues, the board accepts that the admittance of the first auxiliary request into the appeal proceedings is justified here (Article 13(2) RPBA 2020).

4. *First auxiliary request - interpretation of claim 1*

4.1 Claim 1 is directed to a method for wireless communication and includes steps of obtaining a sequence of information bits and encoding the sequence on the basis of a "base matrix of an irregular quasi-cyclic LDPC code".

4.2 As explained on page 2, first and third paragraphs, of the present application as published, the entries of a base matrix represent blocks of a quasi-cyclic LDPC matrix, each block being either a *zero matrix* or an *identity matrix* right-shifted by the value of the corresponding entry of the base matrix.

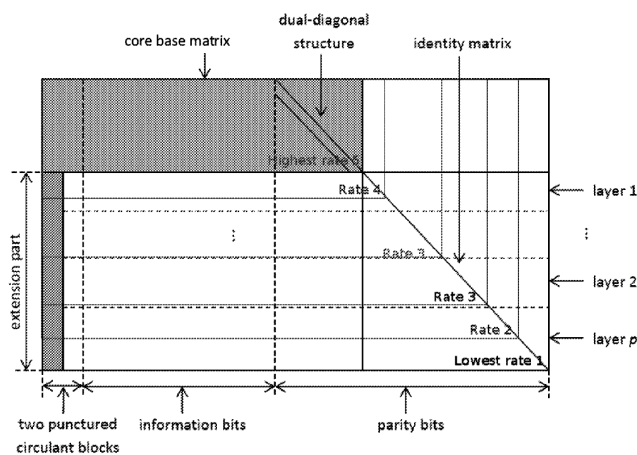
4.3 The board further notes that an "irregular" LDPC code is a code for which the LDPC matrix does not have identical row weights and identical column weights (see e.g. document **D3**, paragraph [0018]).

4.4 The remaining features of claim 1 define properties of the "base matrix". In particular, the base matrix includes the following features:

(a) a "core part" having multiple rows and columns;

- (b) the first two columns are "punctured columns", meaning that the corresponding bits are used by the encoder but not transmitted;
- (c) an "extension part" having at least one punctured column and non-punctured columns, the at least one punctured column having a substantially higher weight than the non-punctured columns;
- (d) the rows of the core part and the extension part can be divided into a first and second sets, the rows in the first set having a higher weight than the rows in the second set;
- (e) the second set of rows comprises at least one group with at least two consecutive rows;
- (f) the at least two consecutive rows consist of a first and second part;
- (g) the first part is a portion of the punctured columns and has non-orthogonal rows;
- (h) the second part is a portion of the non-punctured column and has orthogonal rows;
- (i) a part of the first set of rows forms a matrix with a dual-diagonal structure;
- (j) a part of the second set of rows forms an identity matrix.

4.5 Figure 4 of the application illustrates the structure of a base matrix according to the invention:



In this figure, the "core part" (a) includes the "dual-diagonal matrix" (i) (see page 15, lines 19 to 21 of the application as filed) and is part of the first set of rows. The "extension part" (c) and the "identity matrix" (j) are part of the second set of rows (apart from the portion of the *extension part* to the right of the *core part*). The two left-most columns are the "punctured columns", both for the *core part* and the *extension part*. The layers 1 to p are "groups" of rows (e). The "first part" of these rows is the portion intersecting the two punctured columns, the "second part" being the remaining portion.

5. *First auxiliary request - inventive step*

5.1 Document **D2** discloses a method for wireless communication which involves encoding the sequence of information bits to be transmitted by means of an LDPC encoding scheme (see paragraphs [0035] and [0036] and Figure 1). The LDPC encoding scheme is based on a parity-check matrix which is formed of blocks of size $N_s \times N_s$, each block P_{ij} being either a *zero matrix* or an *identity matrix* right-shifted by a number a_{ij} (paragraphs [0040], [0042] and [0043]). The board notes that the matrix formed by the numbers a_{ij} , referred to as "shift sizes" below, is a "base matrix" defining a quasi-cyclic LDPC matrix (see point 4.2 above).

5.2 The examining division based its inventive-step reasoning on the LDPC matrix shown in Figure 6 of D2 with the blocks A1, A2, B, T, C1, C2, D, E, F, G and H as defined in Figures 12A to 12H of D2:

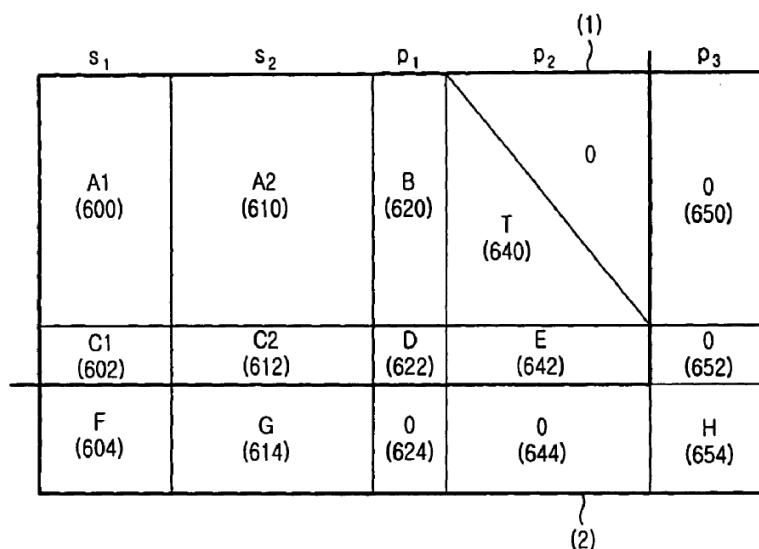


FIG.6

5.3 In that regard, the board notes that the entries of the blocks shown in Figures 12A to 12H are "shift sizes" and therefore define the base matrix of a quasi-cyclic LDPC code when arranged as shown in Figure 6. This base matrix corresponds to an "irregular" LDPC code in that it does not have identical row weights and identical column weights (see point 4.3 above).

According to the scheme of D2, the base matrix includes the following features:

- a core part (blocks A1, A2, B, T, C1, C2, D, E) and its complementary extension part;
- the core part has multiple rows and columns and includes a dual-diagonal structure (blocks T, E) (see Figure 12C);
- the rows in the first set of ten rows which contains the core part have higher weight (weight 5 or 6) than the rows in the second set of the remaining five rows (weight 3 or 4);
- the second set of rows includes a 5x5 identity matrix (block H).

5.4 The appellant argued that the base matrix according to Figures 6 and 12A to 12H of document D2 did not include a "dual-diagonal structure" identical in detail to the dual-diagonal structure formed by the intersection of rows 1 to 3 and columns 18 and 19 of Figure 5 of the present application. In particular, the last row of block T in Figure 12C of D2 included *two* "shift sizes" of zero, whereas the last row of the dual-diagonal structure of Figure 5 included only a *single* "shift size" of zero.

However, the board notes that claim 1 does not specify these details of the dual-diagonal structure. Moreover, the dual-diagonal structure depicted in Figure 6 of document D2 is formed by the combination of blocks T and E and is in fact identical in structure (except for being of size 10x9 instead of 3x2) to the dual-diagonal structure of Figure 5 of the application, including a last row (block E) having only one "shift size" of zero.

5.5 As to feature (b) of claim 1, paragraph [0066] of document D2 discloses that the information bits corresponding to the columns formed by the blocks A1, C1 and F, i.e. the first four columns, are not transmitted. These columns are therefore "punctured columns" within the meaning of claim 1.

5.6 As to feature (c), each of the punctured columns in the extension part (i.e. block F with column weights 3, 4, 3 and 2) has a substantially higher weight than all other non-punctured columns of the extension part (weight 0 or 1).

5.7 As to features (d) to (h), the second set of rows comprises a group of five consecutive rows. The part of

these rows intersecting the first four punctured columns (i.e. block F) has *non-orthogonal* rows. The other part (from blocks G to H) has *orthogonal* rows. The appellant argued that the fact that the rows in blocks G to H were orthogonal could only be derived from the figures of D2. This was, however, an "accidental anticipation" which did not "teach" that the rows in this part of the matrix had indeed to be orthogonal. The test for novelty required not only that the drawings showed the structure of the disputed feature sufficiently clearly, but also that its technical function was derivable. The appellant further noted that, according to paragraph [0071] of document D2, the blocks (624) and (644) in Figure 6 could be replaced with matrices different from the zero matrix, and it argued that such a replacement could destroy the orthogonality of rows.

In that context, the board first notes that the only technical function specified in claim 1 is the use of the base matrix for encoding information bits in a method of wireless communication. The base matrix of document D2 is used for the same purpose (see point 5.1 above). The features of claim 1 defining the properties of the base matrix (see point 4.4 above) do not specify any technical function but merely list a number of conditions on the values of the entries of the base matrix. However, the specific base matrix disclosed in Figures 6 and 12A to 12H of document D2 satisfies the conditions set forth in features (d) to (h). The fact that paragraph [0071] mentions that this specific matrix can be modified does not remove this matrix (nor a method of wireless communication based on this matrix) from the disclosure of document D2.

5.8 Hence, the board agrees with the examining division that the subject-matter of claim 1 differs from the disclosure of document D2 only in that the claimed base matrix has two punctured columns instead of four.

5.9 In the board's view, restricting the number of punctured columns in the base matrix to two does not achieve any unexpected technical effect(s), and the distinguishing feature therefore does not contribute to an inventive step. In particular, there is no reason why having two instead of four punctured columns gives "ideal" decoding performance over the whole scope of the claim. Rather, the skilled person is aware of the expected advantages and disadvantages of increasing or reducing the number of punctured columns.

5.10 In that respect, the appellant argued that the selection of two punctured columns was not arbitrary and provided a technical effect in that the number of different groups could be kept as high as possible.

However, the number of different groups depends on the particular base matrix chosen and is not directly related to the number of *punctured* columns. Claim 1 merely requires "at least one group" (see feature (e)). Deleting two of the four punctured columns of the base matrix of document D2 would indeed not increase the number of groups.

5.11 The appellant also submitted that annexes A, B and C, which were copies of 3GPP standardisation submissions, showed that the distinguishing feature indeed provided a technical effect. Annex A set out the merit of restricting the structure of the extension part as claimed. Annex B included a performance evaluation of candidate matrices and set out "the agreed Base Graph".

Annex C set out a further "agreed base graph" and performance results.

The board notes that claim 1 is not limited to either of the "agreed base graphs" of annexes B and C. As for annex A, the appellant referred to Figure 2 and Appendix 1, which likewise show base matrices to which claim 1 is not limited. The appellant also referred to page 2, which shows a copy of Figure 4 of the present application (see point 4.5 above) and hence discloses the structure of a base matrix with two punctured columns. However, it does not indicate any particular technical advantage of choosing two punctured columns over, say, four punctured columns.

- 5.12 The appellant further argued that the base matrix of document D2 was not beneficial to the parallel-decoding hardware implementation described in the present application.

However, claim 1 does not refer to any parallel-decoding hardware implementation, let alone require the claimed base matrix to be beneficial to the hardware implementation described in the application.

- 5.13 Hence, the subject-matter of claim 1 lacks an inventive step over document D2 (Article 56 EPC).

6. *Second auxiliary request - admittance*

- 6.1 The second auxiliary request corresponds to the first auxiliary request filed with the statement setting out the grounds of appeal, with an amendment to independent claim 6 intended to correct an inconsistency with the wording of claim 1.

Claim 1 of the second auxiliary request, identical to claim 1 of the first auxiliary request filed with the statement setting out the grounds of appeal, adds to claim 1 of the main request considered in the decision under appeal that:

- (k) the base matrix comprises a plurality of entries representing blocks of the matrix, and each block of the matrix either represents a shifted circulant matrix or a zero matrix;
- (l) the shifted circulant matrix is indicated by a shift value, and the shift value defines the number of times for an identity matrix to be cyclically right-shifted;
- (m) the base matrix comprises 46 rows and 68 columns,
 - (i) wherein for columns 3 to 68, starting from row 9, there are multiple groups of orthogonal rows wherein in the orthogonal rows are the rows not overlapped from a columnwise point of view;
 - (ii) wherein rows 9 and 10 are orthogonal, and rows 11 and 12 are orthogonal.

6.2 Since the first auxiliary request filed with the statement setting out the grounds of appeal did not correspond to any of the claim requests on which the decision under appeal was based, the admittance of what is now the second auxiliary request is at the board's discretion under Article 12(4) RPBA 2020.

6.3 Contrary to the requirement set out in Article 12(4), third sentence, RPBA 2020, in its statement of grounds of appeal, the appellant did not provide any reasons for submitting the then first auxiliary request only at the appeal stage.

6.4 Moreover, the amendments made in this request, in particular amendment (m), represent an attempt to overcome the inventive-step objection raised in the contested decision. Since the examining division had already raised that objection in its communication annexed to its summons to oral proceedings, the appellant could and should have filed these amendments already with its written submissions in preparation for those oral proceedings (Article 12(6), second sentence, RPBA 2020).

6.5 In response to the board's communication under Article 15(1) RPBA 2020, the appellant explained that the first-instance proceedings had been spent trying to resolve added-matter and clarity issues. It was therefore reasonable that amendments dealing with inventive step might not reveal themselves until these issues had been fully addressed. It was only then that "the amendment to address inventive step based on an issue of interpretation" could have been expected to be made.

The board is not persuaded. Amendment (m) does in fact not deal with an issue of interpretation but is intended to further restrict the scope of claim 1. While the communication annexed to the examining division's summons to oral proceedings indeed contained objections under Articles 84 and 123(2) EPC in addition to an objection of lack of inventive step, this does not justify postponing such narrowing amendments until the appeal stage.

6.6 For these reasons, the board did not admit the second auxiliary request into the appeal proceedings (Article 12(4) and (6) RPBA 2020).

7. Since the only claim request admitted into the appeal proceedings is not allowable, the appeal is to be dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chair:



B. Brückner

K. Bengi-Akyürek

Decision electronically authenticated