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(54) Title: UPLINK HARQ-ACK FEEDBACK FOR MTC

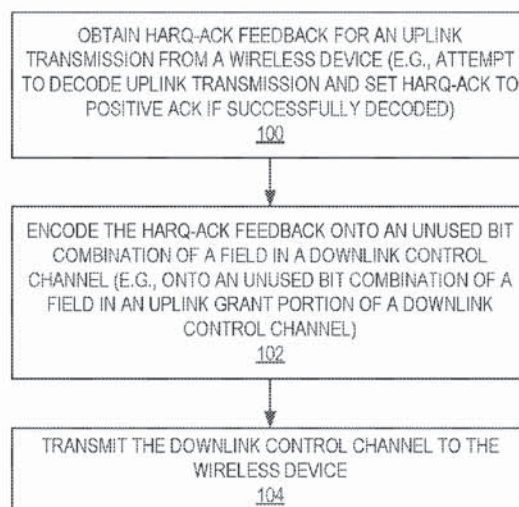


FIG. 2

(57) Abstract: Systems and methods for efficient signaling Hybrid Automatic Repeat Request Acknowledgement (HARQ-ACK) for an uplink data transmission are disclosed. In some embodiments, a method of signaling HARQ-ACK feedback for an uplink data transmission sent from a wireless device to a radio network node comprises obtaining HARQ-ACK feedback for the uplink data transmission, encoding the obtained HARQ-ACK feedback on to an unused bit combination of a field in a downlink control channel, and transmitting the downlink control channel to the wireless device. Embodiments of the present disclosure enable wireless device power saving using positive HARQ-ACK feedback without increasing the static downlink control signaling overhead and without reducing coverage for downlink control information.

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,  
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# PATENT COOPERATION TREATY

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

## PCT

### NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY (PCT Rule 71.1)

To:

BEVINS, R. Chad  
106 Pinedale Springs Way  
Cary NC 27511  
ETATS-UNIS D'AMERIQUE

Date of mailing  
(day/month/year)

24.06.2019

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#### IMPORTANT NOTIFICATION

International application No.  
PCT/IB2018/051776

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24.03.2017

Applicant  
Telefonaktiebolaget LM Ericsson (PUBL)

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary report on patentability and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.
4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary report on patentability. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international  
preliminary examining authority:



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# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Applicant's or agent's file reference<br>3000-614-WO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                          | FOR FURTHER ACTION                                                                                                                                                           | See Form PCT/IPEA/416 |
| International application No.<br>PCT/IB2018/051776                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | International filing date (day/month/year)<br>16.03.2018 | Priority date (day/month/year)<br>24.03.2017                                                                                                                                 |                       |
| International Patent Classification (IPC) or national classification and IPC<br>INV. H04L1/00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                          |                                                                                                                                                                              |                       |
| Applicant<br>Telefonaktiebolaget LM Ericsson (PUBL)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                          |                                                                                                                                                                              |                       |
| <p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of <u>10</u> sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input type="checkbox"/> (sent to the applicant and to the International Bureau) a total of      sheets, as follows:</p> <p><input type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and/or sheets containing rectifications authorized by this Authority, unless those sheets were superseded or cancelled, and any accompanying letters (see Rules 46.5, 66.8, 70.16, 91.2, and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets containing rectifications, where the decision was made by this Authority not to take them into account because they were not authorized by or notified to this Authority at the time when this Authority began to draw up this report, and any accompanying letters (Rules 66.4bis, 70.2(e), 70.16 and 91.2).</p> <p><input type="checkbox"/> superseded sheets and any accompanying letters, where this Authority either considers that the superseding sheets contain an amendment that goes beyond the disclosure in the international application as filed, or the superseding sheets were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in item 4 of Box No. I and the Supplemental Box (see Rule 70.16(b)).</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s))      , containing a sequence listing, in the form of an Annex C/ST.25 text file, as indicated in the Supplemental Box Relating to Sequence Listing (see paragraph 3ter of Annex C of the Administrative Instructions).</p> |                                                          |                                                                                                                                                                              |                       |
| <p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I      Basis of the report</p> <p><input type="checkbox"/> Box No. II      Priority</p> <p><input type="checkbox"/> Box No. III      Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV      Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V      Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI      Certain documents cited</p> <p><input checked="" type="checkbox"/> Box No. VII      Certain defects in the international application</p> <p><input checked="" type="checkbox"/> Box No. VIII      Certain observations on the international application</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                          |                                                                                                                                                                              |                       |
| Date of submission of the demand<br><br>23.01.2019                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                          | Date of completion of this report<br><br>24.06.2019                                                                                                                          |                       |
| Name and mailing address of the international preliminary examining authority:<br> European Patent Office P.B. 5818 Patentlaan 2<br>NL-2280 HV Rijswijk - Pays Bas<br>Tel. +31 70 340 - 2040<br>Fax: +31 70 340 - 3016                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                          | Authorized officer<br><br>Papantoniou, Antonis<br><br>Telephone No. +31 70 340-4116<br> |                       |

**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/IB2018/051776

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**Box No. I Basis of the report**

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1. With regard to the **language**, this report is based on
- ☒ the international application in the language in which it was filed
  - ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of:
    - ☐ international search (under Rules 12.3(a) and 23.1(b))
    - ☐ publication of the international application (under Rule 12.4(a))
    - ☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a) and (b))
2. With regard to the **elements\*** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

**Description, Pages**

1-21 as originally filed

**Claims, Numbers**

1-36 as originally filed

**Drawings, Sheets**

1/8-8/8 as originally filed

- ☐ a sequence listing - see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
  - ☐ the claims, Nos.
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since either they are considered to go beyond the disclosure as filed, or they were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in the Supplemental Box (Rules 70.2(c) and (c-bis)):
- ☐ the description, pages
  - ☐ the claims, Nos.
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
5. ☐ This report has been established:
- ☐ taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rules 66.1(d-bis) and 70.2(e)).
  - ☐ without taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91(Rules 66.4bis and 70.2(e)).

**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/IB2018/051776

6. ☒ With regard to top-up searches (Rules 66.1 *ter* and 70.2(f)):
- ☒ A top-up search was carried out by this Authority on 14.06.2019 (all discovered documents are listed in the Supplemental Box Relating to Top-up Search).
  - ☐ Additional relevant documents have been discovered during the top-up search.
  - ☐ No top-up search was carried out by this Authority because it would serve no useful purpose.
7. ☐ Supplementary international search report(s) from Authority(ies) has/have been received and taken into account in establishing this report (Rule 45bis.8(b) and (c)).

\* If item 4 applies, some or all of those sheets may be marked "superseded".

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**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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1. Statement

|                               |             |                         |
|-------------------------------|-------------|-------------------------|
| Novelty (N)                   | Yes: Claims | <u>7, 10, 20-36</u>     |
|                               | No: Claims  | <u>1-6, 8, 9, 11-19</u> |
| Inventive step (IS)           | Yes: Claims |                         |
|                               | No: Claims  | <u>1-36</u>             |
| Industrial applicability (IA) | Yes: Claims | <u>1-36</u>             |
|                               | No: Claims  |                         |

2. Citations and explanations (Rule 70.7):

see separate sheet

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**Box No. VII Certain defects in the international application**

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The following defects in the form or contents of the international application have been noted:

see separate sheet

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**Box No. VIII Certain observations on the international application**

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The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

**Re Item V.**

1. The following documents (D) are referred to hereby:

- D1 WO 2011/013986 A2 (LG ELECTRONICS INC [KR]; KIM EUN SUN [KR]; KIM HAK SEONG [KR]; SEO HAN) 3 February 2011 (2011-02-03)
- D2 US 2015/092645 A1 (TABET TARIK [US] ET AL) 2 April 2015 (2015-04-02)

2. The present application does not meet the requirements of Article 33 PCT, because the subject matter of claims 1-6, 8, 9, 11-19 is not new in the sense of Article 33(2) PCT.

**2.1 Claim 1:** Document D1 discloses a method of operation of a network node for signaling Hybrid Automatic Repeat Request Acknowledgment, HARQ-ACK, feedback for an uplink data transmission sent from a wireless device to a radio network node, the method comprising:

obtaining HARQ-ACK feedback for the uplink data transmission ( par.5 and 62, ACK/NACK for received transmissions. Par.5 clearly discusses uplink transmission for which downlink HARQ is provided "Also, the base station transmits uplink UL scheduling information of uplink data to the corresponding user equipment to notify time and frequency domains that can be used by the corresponding user equipment, and information related to encoding, data size, HARQ". This is verified in par.62 which discloses the downlink transmission using PHICH of an ACK/NACK response to an uplink transmission, "The PHICH is a response of uplink transmission and carries an HARQ acknowledgment ACK not-acknowledgment NACK signal" );

encoding the obtained HARQ-ACK feedback on to an unused bit combination of a field in a downlink control channel ( par.121-127, par.134-137, Tables 4 and 5, Combined MCS and ACK/NACK encoding using more combinations than those normally used for MCS. The broad formulation of present claim 1 that states the "encoding the obtained HARQ-ACK feedback on to an unused bit combination of a field in a downlink control channel", implies that the bits representing the HARQ-ACK feedback are encoded in a field using a bit combination that has not been used to represent any other information. D1 provides in par.121-127, par.134-137, Tables 4

and 5, the combined MCS and ACK/NACK encoding. With respect to Table 5, while the MCS would normally require only one bit in order to indicate an increase or decrease in the MCS, the combined ACK/NACK and MCS of Table 5 uses 2 bits i.e. using one more bit than the single bit that would have been originally used for indicating the MCS increase / decrease and as a result, the combined MCS ACK/NACK CQI of table 5 uses a previously unused bit to implement the ACK/NACK transmission ); and

transmitting the downlink control channel to the wireless device ( par.5, 62 and 150, ACK/NACK and MCS transmission applicable for both DL and UL transmission ).

**2.2 Claims 13, 15 and 17-19:** Claims 13, 15 and 17-19 have features corresponding to those of claim 1. Therefore the arguments of par.2.1 of this section, which are not repeated for reasons of economy, are also valid here, and as a result, document D1 discloses the features of claims 13, 15 and 17-19.

**2.3 Dependent Claims:** Dependent claims 2-6, 8, 9, 11, 12, 14 and 16 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT with respect to novelty. Document D1 discloses the additional features of claims 2 ( par.44 disclosing enhanced data rates ), 3 ( par.50-52 UEs and cells with different bandwidths are discussed for LTE ), 4-6, 8, 9, 11, 14, 16 ( par.121-127, par.134-137, Tables 4 and 5, Combined MCS and ACK/NACK encoding using more combinations than those normally used for MCS ), 12 ( par.150, ACK/NACK and MCS transmission applicable for both DL and UL transmission ).

3. The present application does not meet the requirements of Article 33 PCT, because the subject matter of claims 7, 10 and 20-36 is not inventive in the sense of Article 33(3) PCT.

**3.1 Claim 20:** D1 discloses the receiving features of claim 20 corresponding to the transmitting features of claim 1 as discussed in par.2.1 of this section.

However, D1 fails to disclose that upon determining that a positive HARQ-ACK feedback is encoded onto the unused bit combination of the field in the downlink control channel, entering a sleep mode.

The problem to be solved by the present invention may therefore be regarded as the additional static downlink control signaling overhead and/or reduced coverage for the DCI as a result of the introduction of uplink HARQ-ACK feedback signaling in the downlink ( as discussed in par.10 of the description of the application ).

The solution proposed in claim 20 of the present application cannot be considered as involving an inventive step (Article 33(3) PCT) for the following reasons.

While D1 solves the above problem of the invention as discussed in par.121-127, par. 134-137, Tables 4 and 5, Combined MCS and ACK/NACK of D1 encoding using more combinations than those normally used for MCS corresponding to the encoded ACK/NACK in the unused bit combination of claim 20 of the invention ( see also par.2.1 of this section ) upon reception of a positive ACK, D1 fails to specify the entering in a sleep mode.

Entering a sleep mode when there no more transmissions to be carried out after an ACK reception is an obvious action to be carried out by a HARQ transmitter such as that of D1.

D2 provides HARQ transmission with ACK/NACK and MCS feedback ( D2, par. 114-115 ) as that of claim 20 of the invention and D1 and enters a sleep mode for received ACKs ( D2, par.70-73, 76, 85-90 and 119 ) as in claim 20 of the invention.

While D2 does not disclose the "unused bit combination" of claim 1, this is clearly disclosed by document D1 as discussed in par.2 above. The skilled person would then carry out the sleep mode of document D2 for the positive ACK of D1 without exercising inventive step as an obvious consequence of the received ACK of D1 and no more data being available for transmission.

**3.2 Claims 30, 32-34 and 36:** Claims 30, 32-34 and 36 have features corresponding to those of claim 20. Therefore the arguments of par.3.1 of this section, which are not repeated for reasons of economy, are also valid here, and as a result, claims 30, 32-34 and 36 are also not inventive.

**3.3 Dependent Claims:** Dependent claims 7, 10, 21-29, 31 and 35 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT with respect to inventive step.

Document D1 discloses the additional features of claims 21 ( par.44 disclosing enhanced data rates ), 22 ( par.50-52 UEs and cells with different bandwidths are discussed for LTE ), 23-25, 27, 28, 31, 35 ( par.121-127, par.134-137, Tables 4 and 5, Combined MCS and ACK/NACK encoding using more combinations than those normally used for MCS ).

The use of an unused bit combination of a plurality of bit combinations of D1, although is not specified for all UL HARQ processes including a specific UL HARQ process, such use of a plurality of HARQ processes of dependent claims 7, 10, 26 and 29 is not considered to be inventive as it is an integral function of any HARQ protocol such as that of par.5 and 129-130 of D1. D2 provided hereby as an example of HARQ with ACK/NACK and MCS feedback ( D2, par.114-115 ) as the invention and D1, clearly discloses in par.76-78 in combination with Fig.6 the transmission of ACK/NACK for a plurality of HARQ processes, which the skilled person could correspondingly apply in the HARQ protocol of D1 as a matter of optional arrangement of HARQ without exercising inventive step.

**Re Item VII**

1. The requirements of Rule 5.1(a)(ii) PCT are not met since the document D1 is not identified in the description and the relevant background art disclosed therein is not briefly discussed.
2. The requirements of Rule 6.3(b) PCT are not met, since the two-part form is not used for the independent claims.
3. The "incorporated by reference" statement on page 1, par.1 of the description of the application, are referring to documents that are not essential for carrying in the invention.

**Re Item VIII**

1. Although claims 13, 15 and 19 have been drafted as separate independent network node claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought and in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness. Moreover, lack of clarity of the claims as a whole arises, since the plurality of independent claims makes it difficult, if not impossible, to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection.

Hence, claims 13, 15 and 19 do not meet the requirements of Article 6 PCT.

The same objection also holds for claims 30, 34 and 36, which do not meet the requirements of Article 6 PCT since they all under the same category ( wireless device claims ), relate effectively to the same subject-matter and differ from each other only with regard to the definition of the subject-matter for which protection is sought and in respect of the terminology used for the features of that subject-matter.

In accordance with Rule 6.4 PCT the subject matter must be defined in terms of a single independent network node claim and a single wireless device claim followed by dependent claims covering features which are merely optional.

2. The application does not meet the requirements of Article 6 PCT, because claims 1, 13, 15, 20, 30 and 34 are not clear.

**2.1 Claim 1:** The step "encoding the obtained HARQ-ACK feedback on to an unused bit combination of a field in a downlink control channel" of claim 1 is unclear in that

- claim 1 fails to specify the nature of encoding and contrary to the opinion of the applicant it is not obvious to the skilled person which of the multitude of possible encoding techniques ( e.g. channel coding, modulation, vocoding, scrambling, etc ) to use for the obtained HARQ-ACK

- while the HARQ-ACK is encoded in an "unused bit combination of a field in a downlink control channel", neither the "unused bit combination of a field in a downlink control channel" nor the the format and use of the so called "field in a downlink control channel" are defined in claim 1, it is not obvious to the skilled person how such an "unused bit combination" may be determined for such an undefined field.

**2.2 Claims 13, 15, 20, 30 and 34:** The clarity problems of claim 1 are also valid for claims 13, 15, 20, 30 and 34. Therefore, the reasoning of par.2.1 of this section is also valid for claims 13, 15, 20, 30 and 34 and is not repeated for reasons of economy.

**2.3 Claims 2 and 21:** The "coverage enhancement mode" is not defined in claims 2 and 21 and as a result it is not presently apparent to the reader how such coverage enhancement is actually achieved and how it is actually related to the encoding of the HARQ feedback.

**2.4 Claims 3 and 22:** The "bandwidth-reduced low-complexity" device is undefined in claims 3 and 23 and as a result it is not apparent to the skilled person how this reduced bandwidth and low complexity is actually achieved.