

(43) International Publication Date  
23 September 2010 (23.09.2010)(10) International Publication Number  
**WO 2010/105669 A1**(51) International Patent Classification:  
*H04W 72/12* (2009.01)(21) International Application Number:  
PCT/EP2009/053146(22) International Filing Date:  
17 March 2009 (17.03.2009)

(25) Filing Language: English

(26) Publication Language: English

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AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, 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, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

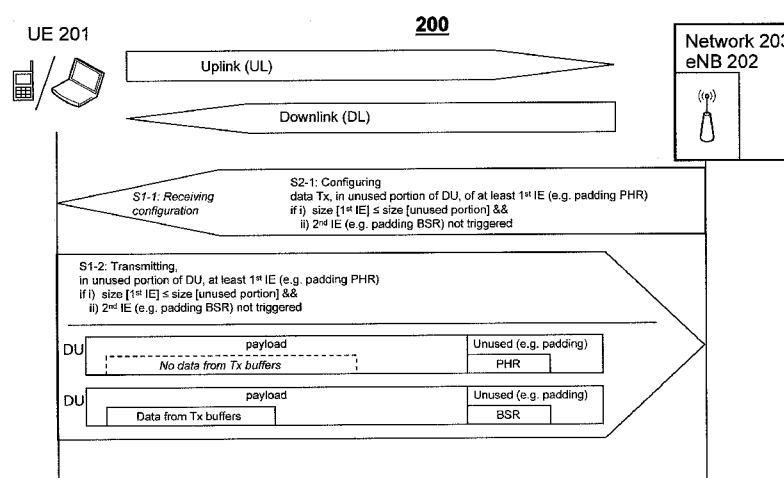
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, 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))

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

(54) Title: METHODS, APPARATUSES, SYSTEM, RELATED COMPUTER PROGRAM PRODUCT AND DATA STRUCTURE FOR UPLINK SCHEDULING

**Fig. 1D**

(57) Abstract: It is disclosed a method (and related apparatus) comprising transmitting, in an unused portion of a data unit, at least a first information element indicating a difference between a nominal maximum transmit power and an estimated transmit power if i) a size of the unused portion is equal to or greater than a size of the first information element and ii) a second information element indicating an amount of available transmission data has not been triggered; and a method (and related apparatus) comprising configuring data transmission, in the unused portion of the data unit, of at least the first information element if i) the size of the unused portion is equal to or greater than the size of the first information element and ii) the second information element has not been triggered.

TITLE OF THE INVENTION

METHODS, APPARATUSES, SYSTEM, RELATED COMPUTER PROGRAM  
PRODUCT AND DATA STRUCTURE FOR UPLINK SCHEDULING

## FIELD OF THE INVENTION

[0001] Examples of the present invention relate to uplink (UL) scheduling. More specifically, the examples of the present invention relate to methods, apparatuses, a system, a related computer program product and a data structure for UL scheduling. The examples of the present invention may be applicable to voice over internet protocol (VoIP) and/or the UL scheduling employed e.g. in evolved universal mobile telecommunications system (UMTS) terrestrial radio access network (E-UTRAN).

## BACKGROUND

[0002] In the UL scheduling employed e.g. in E-UTRAN, in order to assist a scheduler, an evolved nodeB (eNB) may configure UEs to send buffer status reports (BSR) and power headroom reports (PHR) in the uplink. The BSRs may indicate an amount of data available for the UE for transmission, while the PHRs may provide the eNB with information about the difference between a nominal UE maximum transmit power and the estimated power e.g. for UL shared channel (UL-SCH) transmission. BSRs may be used by the eNB to choose e.g. an appropriate transport block size, while the PHRs may be used to select and appropriate coding scheme, such as a modulation and coding scheme (MCS).

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[0003] Various triggers exist to send BSRs and PHRs. One of them may be related to the occurrence of padding bits, i.e. when a number of padding bits is equal to or larger than the size of the BSR, a padding BSR may be sent.

[0004] However, the transport block sizes agreed e.g. for E-UTRAN may allow for a few bytes padding e.g. in case of VoIP, for example in order to take into account a possible variation in a compressed IP header. When VoIP services are used in E-UTRAN, a padding BSR is therefore likely to be sent along every VoIP packet in the UL.

[0005] In consideration of the above, according to examples of the present invention, methods, apparatuses, a system, a related computer program product and a data structure for UL scheduling are provided.

[0006] According to an example of the present invention, in a first aspect, this object is for example achieved by **a method** comprising:

transmitting, in an unused portion of a data unit, at least a first information element indicating a difference between a nominal maximum transmit power and an estimated transmit power if

- i) a size of the unused portion is equal to or greater than a size of the first information element and
- ii) a second information element indicating an amount of available transmission data has not been triggered.

[0007] According to further refinements of the example of the present invention as defined under the above first aspect,

- the transmitting is performed based on a parameter for controlling management of the unused portion;

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- if the second information element has been triggered, the second information element is transmitted in the unused portion if the size of the unused portion is equal to or greater than a size of the second information element alone;
- the transmitting is performed based on a parameter for prioritizing the first and second information elements with respect to each other;
- only the information element having the higher priority is transmitted if the size of the unused portion is less than a combined size of the first information element and the second information element;
- both the first and second information elements are transmitted if the size of the unused portion is equal to or greater than a combined size of the first information element and the second information element;
- the transmitting is performed over a plurality of subsequent data units each having an unused portion, such that one of the first and second information elements is transmitted in the unused portion of every even data unit while the other of the first and second information elements is transmitted in the unused portion of every odd data unit;
- the first information element is transmitted if no data to be sent in a used portion of the next data unit is present;
- the data is constituted by buffered data across logical channel groups;
- no data is indicated by the second information element reporting empty transmission buffers;
- the second information element is transmitted if data to be sent in a used portion of the next data unit is present.

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[0008] According to an example of the present invention, in a second aspect, this object is for example achieved by a method comprising:

configuring data transmission, in an unused portion of a data unit, of at least a first information element indicating a difference between a nominal maximum transmit power and an estimated transmit power if

i) a size of the unused portion is equal to or greater than a size of the first information element and

ii) a second information element indicating an amount of available transmission data has not been triggered.

[0009] According to further refinements of the example of the present invention as defined under the above second aspect,

- the configuring comprises a parameter for controlling management of the unused portion;

- the configuring comprises a parameter for prioritizing the first and second information elements with respect to each other.

[0010] According to further refinements of the example of the present invention as defined under the above first and second aspects,

- the data unit is constituted by a medium access control protocol data unit in an uplink shared channel;

- the unused portion is constituted by a padding portion;

- the unused portion has a size of at least 2 bytes;

- the first information element is constituted by a padding power headroom report;

- the second information element is constituted by a padding buffer status report;

- the data unit as well as the first and second

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information elements are part of a configuration for a voice over internet protocol;

- the data to be sent in the used portion of a next data unit is constituted by buffered data of a logical channel group.

[0011] According to an example of the present invention, in a third aspect, this object is for example achieved by **an apparatus** comprising:

- means for transmitting, in an unused portion of a data unit, at least a first information element indicating a difference between a nominal maximum transmit power and an estimated transmit power if

- i) a size of the unused portion is equal to or greater than a size of the first information element and

- ii) a second information element indicating an amount of available transmission data has not been triggered.

[0012] According to further refinements of the example of the present invention as defined under the above third aspect,

- the means for transmitting is configured to transmit based on a parameter for controlling management of the unused portion;

- the means for transmitting is configured to transmit, if the second information element has been triggered, the second information element in the unused portion if the size of the unused portion is equal to or greater than a size of the second information element alone;

- the means for transmitting is configured to transmit based on a parameter for prioritizing the first and second information elements with respect to each other;

- the means for transmitting is configured to transmit only the information element having the higher priority

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if the size of the unused portion is less than a combined size of the first information element and the second information element;

- the means for transmitting is configured to transmit both the first and second information elements if the size of the unused portion is equal to or greater than a combined size of the first information element and the second information element;

- the means for transmitting is configured to transmit over a plurality of subsequent data units each having an unused portion, such that one of the first and second information elements is transmitted in the unused portion of every even data unit while the other of the first and second information elements is transmitted in the unused portion of every odd data unit;

- the means for transmitting is configured to transmit the first information element if no data to be sent in a used portion of the data unit is present;

- the data is constituted by buffered data across logical channel groups;

- no data is indicated by the second information element reporting empty transmission buffers;

- the means for transmitting is configured to transmit the second information element if data to be sent in a used portion of the next data unit is present;

- the apparatus is constituted by a user equipment.

[0013] According to an example of the present invention, in a fourth aspect, this object is for example achieved by **an apparatus** comprising:

means for configuring data transmission, in an unused portion of a data unit, of at least a first information element indicating a difference between a nominal maximum transmit power and an estimated transmit power if

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- i) a size of the unused portion is equal to or greater than a size of the first information element and
- ii) a second information element indicating an amount of available transmission data has not been triggered.

[0014] According to further refinements of the example of the present invention as defined under the above fourth aspect,

- the means for configuring is configured to comprise a parameter for controlling management of the unused portion;
- the means for configuring is configured to comprise a parameter for prioritizing the first and second information elements with respect to each other;
- the apparatus is constituted by an evolved node B.

[0015] According to further refinements of the example of the present invention as defined under the above third and fourth aspects,

- the data unit is constituted by a medium access control protocol data unit in an uplink shared channel;
- the unused portion is constituted by a padding portion;
- the unused portion has a size of at least 2 bytes;
- the first information element is constituted by a padding power headroom report;
- the second information element is constituted by a padding buffer status report;
- the data unit as well as the first and second information elements are part of a configuration for a voice over internet protocol;
- the data to be sent in the used portion of the next data unit is constituted by buffered data of a logical channel group;

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- at least one, or more of means for transmitting, means for configuring and the apparatus is implemented as a chipset or module.

[0016] According to an example of the present invention, in a fifth aspect, this object is for example achieved by **an apparatus** comprising:

a transmitter configured to transmit, in an unused portion of a data unit, at least a first information element indicating a difference between a nominal maximum transmit power and an estimated transmit power if

- i) a size of the unused portion is equal to or greater than a size of the first information element and
- ii) a second information element indicating an amount of available transmission data has not been triggered.

[0017] According to further refinements of the example of the present invention as defined under the above fifth aspect,

- the transmitter is configured to transmit based on a parameter for controlling management of the unused portion;
- the transmitter is configured to transmit, if the second information element has been triggered, the second information element in the unused portion if the size of the unused portion is equal to or greater than a size of the second information element alone;
- the transmitter is configured to transmit based on a parameter for prioritizing the first and second information elements with respect to each other;
- the transmitter is configured to transmit only the information element having the higher priority if the size of the unused portion is less than a combined size of the first information element and the second

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information element;

- the transmitter is configured to transmit both the first and second information elements if the size of the unused portion is equal to or greater than a combined size of the first information element and the second information element;

- the transmitter is configured to transmit over a plurality of subsequent data units each having an unused portion, such that one of the first and second information elements is transmitted in the unused portion of every even data unit while the other of the first and second information elements is transmitted in the unused portion of every odd data unit;

- the transmitter is configured to transmit the first information element if no data to be sent in a used portion of the data unit is present;

- the data is constituted by buffered data across logical channel groups;

- no data is indicated by the second information element reporting empty transmission buffers;

- the transmitter is configured to transmit the second information element if data to be sent in a used portion of the next data unit is present;

- the apparatus is constituted by a user equipment.

[0018] According to an example of the present invention, in a sixth aspect, this object is for example achieved by **an apparatus** comprising:

- a configurator configured to configure data transmission, in an unused portion of a data unit, of at least a first information element indicating a difference between a nominal maximum transmit power and an estimated transmit power if

- i) a size of the unused portion is equal to or greater than a size of the first information element and

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ii) a second information element indicating an amount of available transmission data has not been triggered.

[0019] According to further refinements of the example of the present invention as defined under the above sixth aspect,

- the configurator is configured to comprise a parameter for controlling management of the unused portion;
- the configurator is configured to comprise a parameter for prioritizing the first and second information elements with respect to each other;
- the apparatus is constituted by an evolved node B.

[0020] According to further refinements of the example of the present invention as defined under the above fifth and sixth aspects,

- the data unit is constituted by a medium access control protocol data unit in an uplink shared channel;
- the unused portion is constituted by a padding portion;
- the unused portion has a size of at least 2 bytes;
- the first information element is constituted by a padding power headroom report;
- the second information element is constituted by a padding buffer status report;
- the data unit as well as the first and second information elements are part of a configuration for a voice over internet protocol;
- the data to be sent in the used portion of the next data unit is constituted by buffered data of a logical channel group;
- at least one, or more of a transmitter, a configurator and the apparatus is implemented as a chipset or module.

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[0021] According to an example of the present invention, in a seventh aspect, this object is for example achieved by a system comprising:

an apparatus according to the above third or fifth aspects; and

an apparatus according to the above fourth or sixth aspects.

[0022] According to an example of the present invention, in an eighth aspect, this object is for example achieved by a computer program product comprising code or code means for performing a method according to the above first or second aspects.

[0023] According to an example of the present invention, in a ninth aspect, this object is for example achieved by a data structure comprising:

an unused portion for transmitting at least a first information element indicating a difference between a nominal maximum transmit power and an estimated transmit power if

i) a size of the unused portion is equal to or greater than a size of the first information element and  
ii) a second information element indicating an amount of available transmission data has not been triggered.

[0024] According to further refinements of the example of the present invention as defined under the above ninth aspect,

- the data structure is constituted by a medium access control protocol data unit in an uplink shared channel;

- the unused portion is constituted by a padding portion;

- the unused portion has a size of at least 2 bytes;

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- the first information element is constituted by a padding power headroom report;
- the second information element is constituted by a padding buffer status report;
- the data structure as well as the first and second information elements are part of a configuration for a voice over internet protocol;
- data to be sent in a used portion of a next data unit is constituted by buffered data of a logical channel group.

[0025] In this connection, the example of the present invention enables one or more of the following:

- Coping with the fact that in VoIP, a BSR is of less relevance than a PHR, since VoIP comprises a packet size that does not vary much and a frequent absence of parallel services;
- Coping with the problem of a small padding for sending the PHR (with the agreed transport block size, the padding may, in case of VoIP, be around 2 bytes);
- Improving the scheduler efficiency e.g. for VoIP services;
- No impact on the signalling from higher layers and self-containance e.g. in the medium access control (MAC).

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The example of the present invention is described herein below with reference to the accompanying drawings, in which:

[0027] Fig. 1A shows methods for UL scheduling according to a first example of the present invention;

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[0028] Fig. 1B shows methods for UL scheduling according to a second example of the present invention;

[0029] Fig. 1C shows methods for UL scheduling according to a third example of the present invention;

[0030] Fig. 1D shows methods for UL scheduling according to a fourth example of the present invention;

[0031] Fig. 2A shows apparatuses for UL scheduling according to the first example of the present invention;

[0032] Fig. 2B shows apparatuses for UL scheduling according to the second example of the present invention;

[0033] Fig. 2C shows apparatuses for UL scheduling according to the third example of the present invention;

[0034] Fig. 2D shows apparatuses for UL scheduling according to the fourth example of the present invention; and

[0035] Fig. 3 shows a data structure for UL scheduling according to the first to fourth examples of the present invention.

#### DETAILED DESCRIPTION OF THE EXAMPLES OF THE PRESENT INVENTION

[0036] The examples of the present invention are described herein below by way of example with reference to the accompanying drawings.

[0037] It is to be noted that for this description, the terms "medium access control protocol data unit in an

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uplink shared channel; padding; padding power headroom report; padding buffer status report; and transmitted data of a logical channel group." are examples for "data unit; unused portion; first information element; second information element; and data in a used portion", respectively, without restricting the latter-named terms to the special technical or implementation details imposed to the first-named terms.

[0038] Figs. 1A to 1D show methods for UL scheduling according to the first to fourth examples of the present invention. Signaling between elements is indicated in horizontal direction, while time aspects between signaling may be reflected in the vertical arrangement of the signaling sequence as well as in the sequence numbers. It is to be noted that the time aspects indicated in Figs. 1A to 1D do not necessarily restrict any one of the method steps shown to the step sequence outlined. This applies in particular to method steps that are functionally disjunctive with each other. Within Figs. 1A to 1D, for ease of description, means or portions which may provide main functionalities are depicted with solid functional blocks or arrows and/or a normal font, while means or portions which may provide optional functions are depicted with dashed functional blocks or arrows and/or an italic font.

[0039] As shown in Figs. 1A to 1D, a communication system 200 may comprise a UE 201 and a network 203. In turn, the network 202 may comprise an eNB 202.

[0040] In step S2-1, e.g. the eNB 202 may perform configuring a data transmission, in an unused portion (e.g. padding) of a data unit (e.g. MAC PDU in UL-SCH), of at least a first information element (e.g. padding

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PHR) indicating a difference between a nominal maximum transmit power and an estimated transmit power if i) a size of the unused portion is equal to or greater than a size of the first information element and ii) a second information element (e.g. padding BSR) indicating an amount of available transmission data has not been triggered. The configuration may be received by the UE 201 in optional step S1-1.

[0041] Then, in step S1-2, e.g. the UE 201 may perform transmitting, in the unused portion (e.g. padding) of the data unit (e.g. MAC PDU in UL-SCH), at least the first information element (e.g. padding PHR) if i) the size of the unused portion is equal to or greater than the size of the first information element and ii) the second information element (e.g. padding BSR) has not been triggered.

[0042] In the first example, as shown in Fig. 1A, the configuring performed e.g. by the eNB 202 may comprise a parameter for controlling management of the unused portion. Accordingly, the transmitting performed e.g. by the UE 201 may be performed based on the parameter for controlling management of the unused portion.

[0043] In this case, the second information element may, if the second information element has been triggered, be transmitted in the unused portion if the size of the unused portion is equal to or greater than a size of the second information element alone.

[0044] In the second example, as shown in Fig. 1B, the configuring performed e.g. by the eNB 202 may comprise a parameter for prioritizing the first and second information elements with respect to each other.

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Accordingly, the transmitting performed e.g. by the UE 201 may be performed based on the parameter for prioritizing the first and second information elements with respect to each other.

[0045] In this case, only the information element having the higher priority may be transmitted if the size of the unused portion is less than a combined size of the first and second information elements. Alternatively, both the first and second information elements may be transmitted if the size of the unused portion is equal to or greater than the combined size.

[0046] In the third example, as shown in Fig. 1C, the transmitting performed e.g. by the UE 201 may be performed over a plurality of subsequent data units each having an unused portion, such that one of the first and second information elements may be transmitted in the unused portion of every even data unit while the other of the first and second information elements may be transmitted in the unused portion of every odd data unit.

[0047] In the fourth example, as shown in Fig. 1D, the first information element may be transmitted if no data to be sent in a used portion of the next data unit is present. In this case, "no data" may be indicated by the second information element reporting empty transmission buffers. Further, the data may be constituted by buffered data across logical channel groups. Accordingly, the second information element may be transmitted if data to be sent in a used portion of next the data unit is present.

[0048] As for developments of the methods according to the first to fourth examples of the present invention,

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the data unit may be constituted by a medium access control protocol data unit in an uplink shared channel. Further, the unused portion may be constituted by a padding portion, which may have a size of at least 2 bytes. Moreover, the first information element may be constituted by a padding power headroom report and/or the second information element may be constituted by a padding buffer status report. In addition, the data unit as well as the first and second information elements may be part of a configuration for a voice over internet protocol. Finally, the data to be sent in the used portion of the next data unit may be constituted by buffered data of a logical channel group.

[0049] Figs. 2A to 2D show apparatuses (e.g. UE 201 and eNB 202) for UL scheduling according to the first to fourth examples of the present invention. Within Figs. 2A to 2D, for ease of description, means or portions which may provide main functionalities are depicted with solid functional blocks or arrows and a normal font, while means or portions which may provide optional functions are depicted with dashed functional blocks or arrows and an italic font.

[0050] The UE 201 may comprise a CPU (or core functionality CF) 2011, a memory 2012, a transmitter (or means for transmitting) 2013, and an optional receiver (or means for receiving) 2014.

[0051] Further, the eNB 202 may comprise a CPU (or core functionality CF) 2021, a memory 2022, an optional transmitter (or means for transmitting) 2023, an optional receiver (or means for receiving) 2024 and a configurator (or means for configuring) 2025.

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[0052] As indicated by the dashed extensions of the functional blocks of the CPUs 2011 and 2021, the means for configuring 20215 of the eNB 202 may be a functionality running on the CPUs 20211 and 20221 of the MME 2021 or the MSS 2022, respectively, or may alternatively be a separate functional entity or means.

[0053] The CPUs 20x1 (wherein  $x = 1$  and  $2$ ) may respectively be configured to process various data inputs and to control the functions of the memories 20x2, the means for transmitting 20x3 and the means for receiving 20x4 (and the means for configuring 2025 of the eNB 202). The memories 20x2 may serve e.g. for storing code means for carrying out e.g. the methods according to the example of the present invention, when run e.g. on the CPUs 20x1. It is to be noted that the means for transmitting 20x3 and the means for receiving 20x4 may alternatively be provided as respective integral transceivers. It is further to be noted that the transmitters/receivers may be implemented i) as physical transmitters/receivers for transceiving e.g. via the air interface (e.g. between the UE 201 and the eNB 202), ii) as routing entities e.g. for transmitting/receiving data packets e.g. in a PS (packet switching) network (e.g. between the eNB 202 and another entity of the network 203 when disposed as separate network entities), iii) as functionalities for writing/reading information into/from a given memory area (e.g. in case of shared/common CPUs or memories e.g. of the eNB 202 and the other entity when disposed as an integral network entity), or iv) as any suitable combination of i) to iii).

[0054] For example, the means for configuring 2025 of the eNB 202 may perform configuring a data transmission, in an unused portion (e.g. padding) of a data unit (e.g. MAC

PDU in UL-SCH), of at least a first information element (e.g. padding PHR) indicating a difference between a nominal maximum transmit power and an estimated transmit power if i) a size of the unused portion is equal to or greater than a size of the first information element and ii) a second information element (e.g. padding BSR) indicating an amount of available transmission data has not been triggered. The configuration may be received e.g. by the means for receiving 2014 of the UE 201.

[0055] Then, e.g. the means for transmitting 2013 of the UE 201 may perform transmitting, in the unused portion (e.g. padding) of the data unit (e.g. MAC PDU in UL-SCH), at least the first information element (e.g. padding PHR) if i) the size of the unused portion is equal to or greater than the size of the first information element and ii) and the second information element (e.g. padding BSR) has not been triggered.

[0056] In the first example, as shown in Fig. 2A, the means for configuring 2025 of the eNB 202 may be configured to comprise a parameter for controlling management of the unused portion. Accordingly, the means for transmitting 2013 of the UE 201 may be configured to transmit based on the parameter for controlling management of the unused portion.

[0057] In this case, the means for transmitting 2013 may be configured to transmit, if the second information element has been triggered, the second information element in the unused portion if the size of the unused portion is equal to or greater than a size of the second information element alone.

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[0058] In the second example, as shown in Fig. 2B, the means for configuring 2025 may be configured to comprise a parameter for prioritizing the first and second information elements with respect to each other. Accordingly, the means for transmitting 2013 may be configured to transmit based on the parameter for prioritizing the first and second information elements with respect to each other.

[0059] In this case, the means for transmitting 2013 may be configured to transmit only the information element having the higher priority if the size of the unused portion is less than a combined size of the first and second information elements. Alternatively, the means for transmitting 2013 may be configured to transmit both the first and second information elements if the size of the unused portion is equal to or greater than the combined size.

[0060] In the third example, as shown in Fig. 2C, the means for transmitting 2013 may be configured to transmit over a plurality of subsequent data units each having an unused portion, such that one of the first and second information elements may be transmitted in the unused portion of every even data unit while the other of the first and second information elements may be transmitted in the unused portion of every odd data unit.

[0061] In the fourth example, as shown in Fig. 2D, the means for transmitting 2013 may be configured to transmit the first information element if no data to be sent in a used portion of the data unit is present. In this case, "no data" may be indicated by the second information element reporting empty transmission buffers. Further, the data may be constituted by buffered data across

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logical channel groups. Accordingly, the means for transmitting 2013 may be configured to transmit the second information element if data to be sent in a used portion of the next data unit is present.

[0062] As for developments of the apparatuses according to the first to fourth examples of the present invention, the data unit may be constituted by a medium access control protocol data unit in an uplink shared channel. Further, the unused portion may be constituted by a padding portion, which may have a size of at least 2 bytes. Moreover, the first information element may be constituted by a padding power headroom report and/or the second information element may be constituted by a padding buffer status report. In addition, the data unit as well as the first and second information elements may be part of a configuration for a voice over internet protocol. Finally, the data to be sent in the used portion of the next data unit may be constituted by buffered data of a logical channel group.

[0063] Furthermore, at least one of, or more of the above-described means for transmitting 2013, the means for configuring 2025 as well as the UE 201 and the eNB 202, or the respective functionalities carried out, may be implemented as a chipset or module.

[0064] Finally, the present invention also relates to a system which may comprise the UE 201 and the eNB 202 according to the above-described first to fourth examples of the present invention.

[0065] Further, Fig. 3 shows a data structure 301 according to the first to fourth examples of the present invention. As shown in Fig. 3, the data structure 301 may

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comprise a payload portion 3011 and an unused portion 3012 (e.g. padding) for transmitting at least the first information element 3013 (e.g. padding PHR) if i) the size of the unused portion 3012 is equal to or greater than the size of the first information element 3013 and ii) the second information element 3014 (e.g. padding BSR) has not been triggered.

[0066] As for further developments of the data structure according to the first to fourth examples of the present invention, the data structure 301 may be constituted by a medium access control protocol data unit in an uplink shared channel. Further, the unused portion 3012 may be constituted by a padding portion, which may have a size of at least 2 bytes. Still further, the first information element 3013 may be constituted by a padding power headroom report and/or the second information element 3014 may be constituted by a padding buffer status report. Moreover, the data structure as well as the first and second information elements may be part of a configuration for a voice over internet protocol. Finally, data to be sent in the used portion or payload portion 3011 of a next data unit 301 may be constituted by buffered data of a logical channel group.

[0067] Without being restricted to the details following in this section, the examples of the present invention may be summarized as follows:

In order to allow for a PHR to be sent instead of padding in case of VoIP, three solutions are proposed:

- 1) configure the UE to send either a padding PHR or padding BSR when padding is present;
- 2) always send both if possible but have the priority configurable (first padding PHR or padding BSR);
- 3) alternate the PHR/BSR; and

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4) send padding BSR only when non-empty buffer are reported, send a padding PHR otherwise.

More details on the four alternatives proposed above are given:

1) E.g. the radio resource controller (RRC) may configure a new parameter which controls how the MAC layer handles padding at the UE for uplink transmissions: send either a padding BSR or a padding PHR when the number of padding bits is equal to or larger than the size of the padding BSR or padding PHR, respectively;

2) E.g. the RRC may configure a new parameter which controls the priority of the padding PHR vs. padding BSR. If the padding PHR is configured with a higher priority than the padding BSR, when the number of padding bits is equal to or larger than the size of the padding PHR, a padding PHR is triggered first and only if there is enough padding left after that a padding BSR can be sent. Conversely if the padding PHR is configured with a lower priority than the padding BSR, when the number of padding bits is equal to or larger than the size of the padding BSR, a padding BSR is triggered first and only if there is enough padding left after that a padding PHR can be sent;

3) Padding BSR and PHR are sent in alternance (this can easily be done since they both require 2 bytes to be sent); and

4) If at least one logical channel group (LCG) has buffered data and if the number of padding bits is equal to or larger than the size of the padding BSR, send a padding BSR. Otherwise, if no LCG has buffered data and if the number of padding bits is equal to or larger than the size of the padding PHR, send a padding PHR.

Moreover, relating in particular to solution 4, for the

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logical channel Prioritization procedure, the UE may take into account the following relative priority in decreasing order:

- MAC control element for C-RNTI or data from UL-CCCH;
- MAC control element for BSR, with exception of BSR included for padding;
- MAC control element for PHR, with exception of PHR included for padding;
- data from any Logical Channel, except data from UL-CCCH;
- MAC control element for BSR or PHR included for padding.

A Buffer Status Report (BSR) may be triggered, for example, if the following event occurs:

- UL resources are allocated, at least one LCG has data available for transmission and number of padding bits is equal to or larger than the size of the Buffer Status Report MAC control element plus its subheader, in which case the BSR is referred below to as "Padding BSR";

A Power Headroom Report (PHR) may be triggered, for example, if the following event occurs:

- if the number of padding bits is equal to or larger than the size of the PHR plus its subheader and no padding BSR has been triggered.

[0068] [Further examples]

[0069] For the purpose of the present invention as described herein above, it should be noted that

- an access technology may be any technology by means of which a user equipment can access an access network (or base station, respectively). Any present or future technology, such as WiMAX (Worldwide Interoperability for

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Microwave Access) or WLAN (Wireless Local Access Network), Bluetooth, Infrared, and the like may be used; although the above technologies are mostly wireless access technologies, e.g. in different radio spectra, access technology in the sense of the present invention may also imply wirebound technologies, e.g. IP based access technologies like cable networks or fixed line.

- a network may be any device, unit or means by which a station entity or other user equipment may connect to and/or utilize services offered by the access network; such services include, among others, data and/or (audio-) visual communication, data download etc.;

- generally, the present invention may be applicable in those network/user equipment environments relying on a data packet based transmission scheme according to which data are transmitted in data packets and which are, for example, based on the Internet Protocol IP. The present invention is, however, not limited thereto, and any other present or future IP or mobile IP (MIP) version, or, more generally, a protocol following similar principles as (M)IPv4/6, is also applicable;

- a user equipment may be any device, unit or means by which a system user may experience services from an access network;

- method steps likely to be implemented as software code portions and being run using a processor at a network element or terminal (as examples of devices, apparatuses and/or modules thereof, or as examples of entities including apparatuses and/or modules therefore), are software code independent and can be specified using any known or future developed programming language as long as the functionality defined by the method steps is preserved;

- generally, any method step is suitable to be implemented as software or by hardware without changing

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the idea of the invention in terms of the functionality implemented;

- method steps and/or devices, units or means likely to be implemented as hardware components at the above-defined apparatuses, or any module(s) thereof, are hardware independent and can be implemented using any known or future developed hardware technology or any hybrids of these, such as MOS (Metal Oxide Semiconductor), CMOS (Complementary MOS), BiMOS (Bipolar MOS), BiCMOS (Bipolar CMOS), ECL (Emitter Coupled Logic), TTL (Transistor-Transistor Logic), etc., using for example ASIC (Application Specific IC (Integrated Circuit)) components, FPGA (Field-programmable Gate Arrays) components, CPLD (Complex Programmable Logic Device) components or DSP (Digital Signal Processor) components; in addition, any method steps and/or devices, units or means likely to be implemented as software components may alternatively be based on any security architecture capable e.g. of authentication, authorization, keying and/or traffic protection;

- devices, units or means (e.g. the above-defined apparatuses, or any one of their respective means) can be implemented as individual devices, units or means, but this does not exclude that they are implemented in a distributed fashion throughout the system, as long as the functionality of the device, unit or means is preserved;

- an apparatus may be represented by a semiconductor chip, a chipset, or a (hardware) module comprising such chip or chipset; this, however, does not exclude the possibility that a functionality of an apparatus or module, instead of being hardware implemented, be implemented as software in a (software) module such as a computer program or a computer program product comprising executable software code portions for execution/being run on a processor;

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- a device may be regarded as an apparatus or as an assembly of more than one apparatus, whether functionally in cooperation with each other or functionally independently of each other but in a same device housing, for example.

[0070] Although the present invention has been described herein before with reference to particular embodiments thereof, the present invention is not limited thereto and various modification can be made thereto.

## CLAIMS:

1. A method, comprising:

transmitting, in an unused portion of a data unit, at least a first information element indicating a difference between a nominal maximum transmit power and an estimated transmit power if

- i) a size of the unused portion is equal to or greater than a size of the first information element and
- ii) a second information element indicating an amount of available transmission data has not been triggered.

2. The method according to claim 1, wherein the transmitting is performed based on a parameter for controlling management of the unused portion.

3. The method according to claim 2, wherein, if the second information element has been triggered, the second information element is transmitted in the unused portion if the size of the unused portion is equal to or greater than a size of the second information element alone.

4. The method according to claim 1, wherein the transmitting is performed based on a parameter for prioritizing the first and second information elements with respect to each other.

5. The method according to claim 4, wherein only the information element having the higher priority is transmitted if the size of the unused portion is less than a combined size of the first information element and the second information element.

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6. The method according to claim 4, wherein both the first and second information elements are transmitted if the size of the unused portion is equal to or greater than a combined size of the first information element and the second information element.

7. The method according to claim 1, wherein the transmitting is performed over a plurality of subsequent data units each having an unused portion, such that one of the first and second information elements is transmitted in the unused portion of every even data unit while the other of the first and second information elements is transmitted in the unused portion of every odd data unit.

8. The method according to claim 1, wherein the first information element is transmitted if no data to be sent in a used portion of the next data unit is present.

9. The method according to claim 8, wherein the data is constituted by buffered data across logical channel groups.

10. The method according to claim 9, wherein no data is indicated by the second information element reporting empty transmission buffers.

11. The method according to claim 1, wherein the second information element is transmitted if data to be sent in a used portion of the next data unit is present.

12. A method, comprising:

    configuring data transmission, in an unused portion of a data unit, of at least a first information

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element indicating a difference between a nominal maximum transmit power and an estimated transmit power if

- i) a size of the unused portion is equal to or greater than a size of the first information element and
- ii) a second information element indicating an amount of available transmission data has not been triggered.

13. The method according to claim 12, wherein the configuring comprises a parameter for controlling management of the unused portion.

14. The method according to claim 12, wherein the configuring comprises a parameter for prioritizing the first and second information elements with respect to each other.

15. The method according to any one of claims 1 to 14, wherein at least one of the following applies:

- the data unit is constituted by a medium access control protocol data unit in an uplink shared channel;

- the unused portion is constituted by a padding portion;

- the unused portion has a size of at least 2 bytes;

- the first information element is constituted by a padding power headroom report;

- the second information element is constituted by a padding buffer status report;

- the data unit as well as the first and second information elements are part of a configuration for a voice over internet protocol; and

- the data to be sent in the used portion of a next data unit is constituted by buffered data of a logical channel group.

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16. An apparatus, comprising:

means for transmitting, in an unused portion of a data unit, at least a first information element indicating a difference between a nominal maximum transmit power and an estimated transmit power if

i) a size of the unused portion is equal to or greater than a size of the first information element and

ii) a second information element indicating an amount of available transmission data has not been triggered.

17. The apparatus according to claim 16, wherein the means for transmitting is configured to transmit based on a parameter for controlling management of the unused portion.

18. The apparatus according to claim 17, wherein the means for transmitting is configured to transmit, if the second information element has been triggered, the second information element in the unused portion if the size of the unused portion is equal to or greater than a size of the second information element alone.

19. The apparatus according to claim 16, wherein the means for transmitting is configured to transmit based on a parameter for prioritizing the first and second information elements with respect to each other.

20. The apparatus according to claim 19, wherein the means for transmitting is configured to transmit only the information element having the higher priority if the size of the unused portion is less than a combined size of the first information element and the second information element.

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21. The apparatus according to claim 19, wherein the means for transmitting is configured to transmit both the first and second information elements if the size of the unused portion is equal to or greater than a combined size of the first information element and the second information element.

22. The apparatus according to claim 16, wherein the means for transmitting is configured to transmit over a plurality of subsequent data units each having an unused portion, such that one of the first and second information elements is transmitted in the unused portion of every even data unit while the other of the first and second information elements is transmitted in the unused portion of every odd data unit.

23. The apparatus according to claim 16, wherein the means for transmitting is configured to transmit the first information element if no data to be sent in a used portion of the data unit is present.

24. The apparatus according to claim 23, wherein the data is constituted by buffered data across logical channel groups.

25. The apparatus according to claim 24, wherein no data is indicated by the second information element reporting empty transmission buffers.

26. The apparatus according to claim 16, wherein the means for transmitting is configured to transmit the second information element if data to be sent in a used portion of the next data unit is present.

27. An apparatus, comprising:

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means for configuring data transmission, in an unused portion of a data unit, of at least a first information element indicating a difference between a nominal maximum transmit power and an estimated transmit power if

- i) a size of the unused portion is equal to or greater than a size of the first information element and
- ii) a second information element indicating an amount of available transmission data has not been triggered.

28. The apparatus according to claim 27, wherein the means for configuring is configured to comprise a parameter for controlling management of the unused portion.

29. The apparatus according to claim 27, wherein the means for configuring is configured to comprise a parameter for prioritizing the first and second information elements with respect to each other.

30. The apparatus according to any one of claims 16 to 29, wherein at least one of the following applies:

- the data unit is constituted by a medium access control protocol data unit in an uplink shared channel;

- the unused portion is constituted by a padding portion;

- the unused portion has a size of at least 2 bytes;

- the first information element is constituted by a padding power headroom report;

- the second information element is constituted by a padding buffer status report;

- the data unit as well as the first and second information elements are part of a configuration for a voice over internet protocol; and

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the data to be sent in the used portion of the next data unit is constituted by buffered data of a logical channel group.

31. The apparatus according to any one of claims 16 to 26 and claim 30 depending on claim 16, wherein the apparatus is constituted by a user equipment.

32. The apparatus according to any one of claims 27 to 29 and claim 30 depending on claim 27, wherein the apparatus is constituted by an evolved node B.

33. The apparatus according to any one of claims 16 to 32, wherein at least one, or more of means for transmitting, means for configuring and the apparatus is implemented as a chipset or module.

34. A system, comprising:

an apparatus according to any one of claims 16 to 26 and claim 30 depending on claim 16; and

an apparatus according to any one of claims 27 to 29 and claim 30 depending on claim 27.

35. A computer program product comprising code means for performing a method according to any one of claims 1 to 15 when run on a processing means or module.

36. A data structure, comprising:

an unused portion for transmitting at least a first information element indicating a difference between a nominal maximum transmit power and an estimated transmit power if

i) a size of the unused portion is equal to or greater than a size of the first information element and

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ii) a second information element indicating an amount of available transmission data has not been triggered.

37. The data structure according to claim 36, wherein at least one of the following applies:

the data structure is constituted by a medium access control protocol data unit in an uplink shared channel;

the unused portion is constituted by a padding portion;

the unused portion has a size of at least 2 bytes;

the first information element is constituted by a padding power headroom report;

the second information element is constituted by a padding buffer status report;

the data structure as well as the first and second information elements are part of a configuration for a voice over internet protocol; and

data to be sent in a used portion of a next data unit is constituted by buffered data of a logical channel group.

**Fig. 1A**

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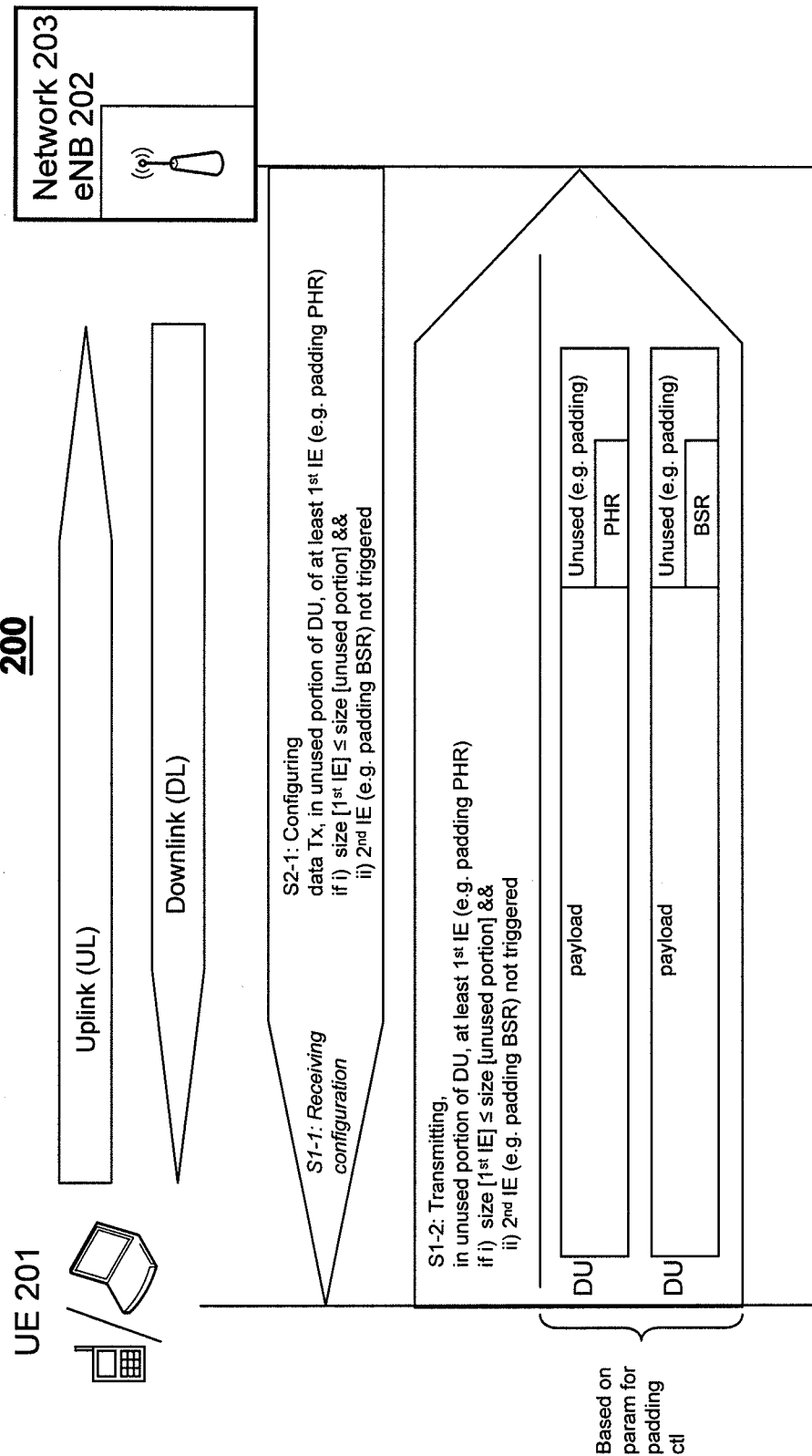


Fig. 1B

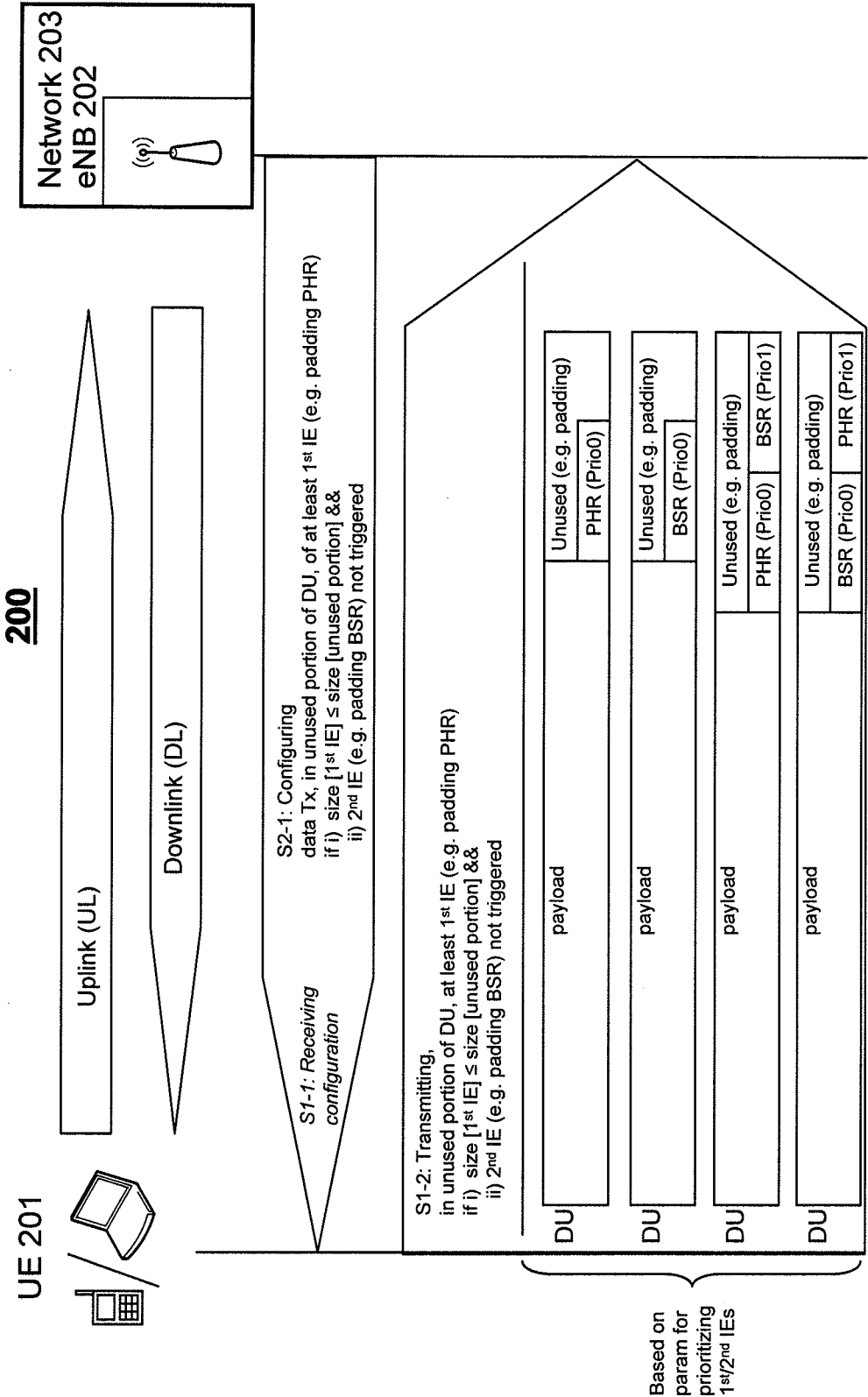


Fig. 1C

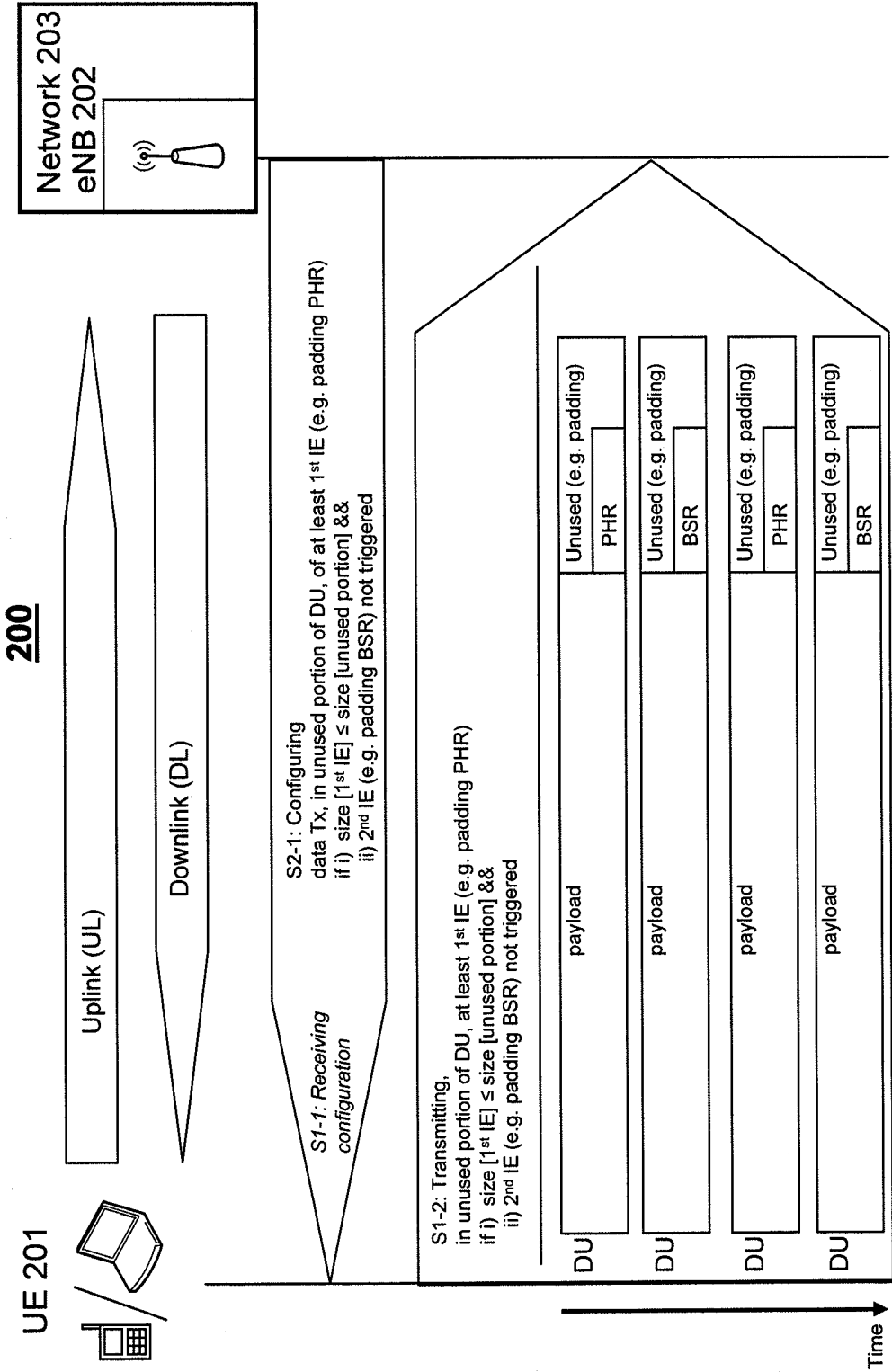


Fig. 1D

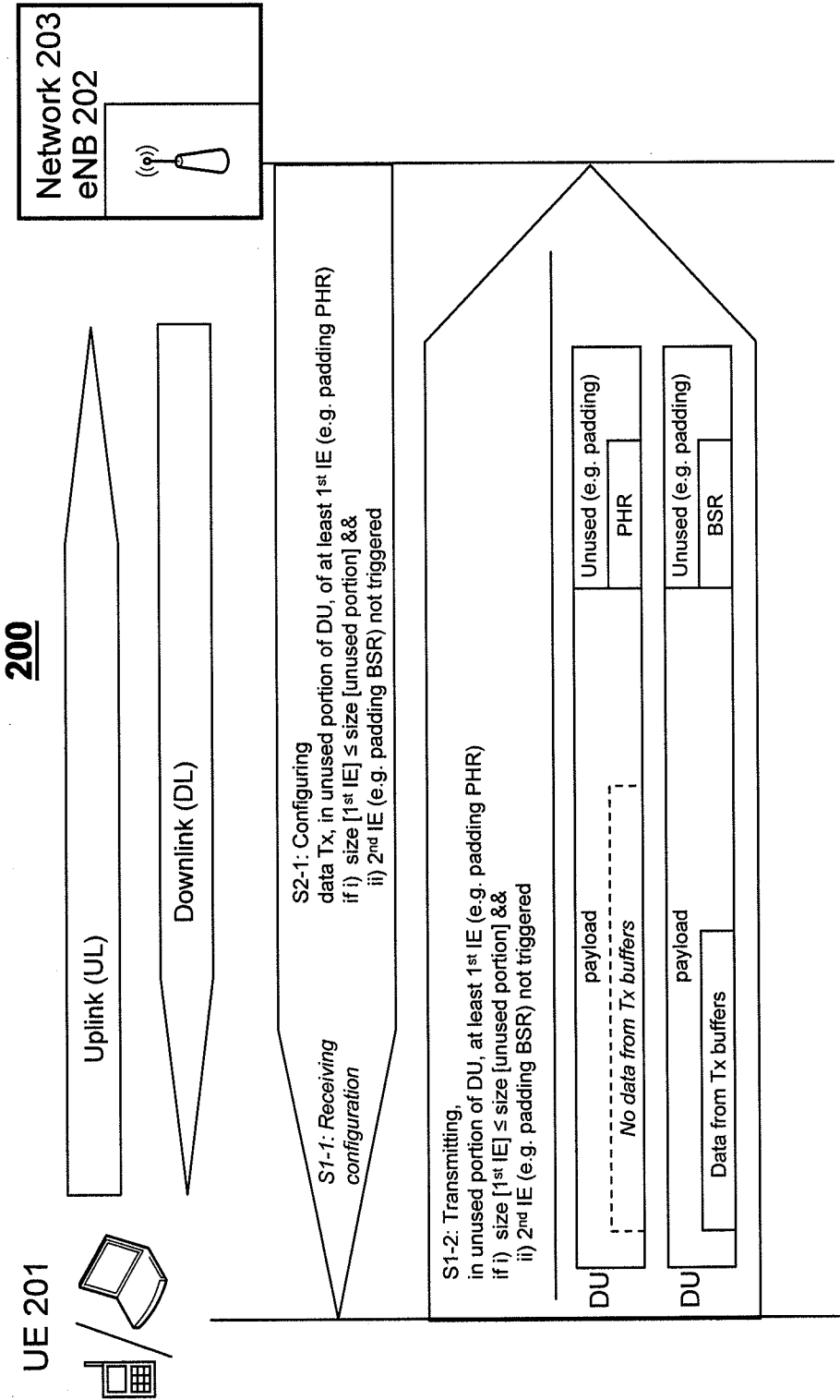


Fig. 2A

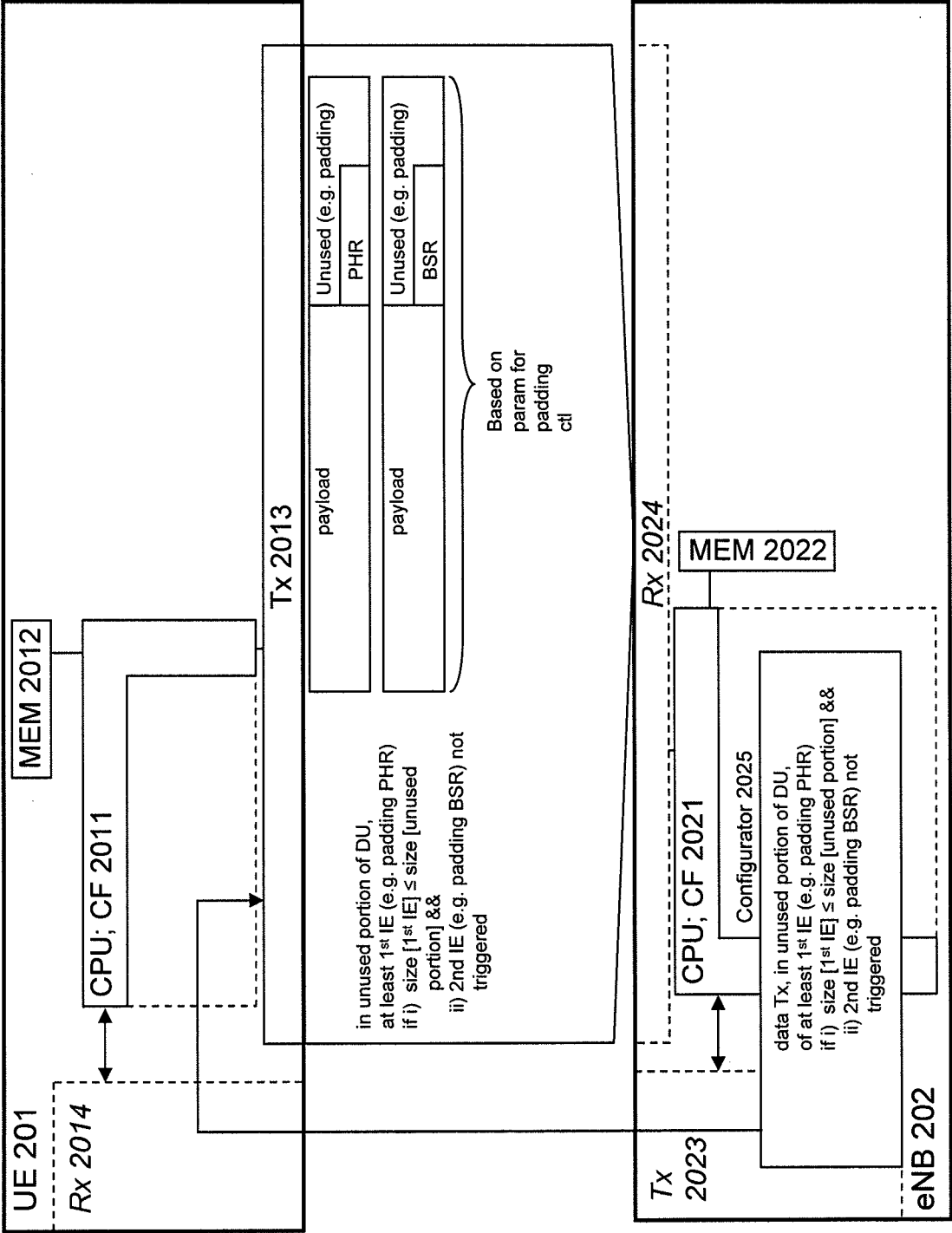


Fig. 2B

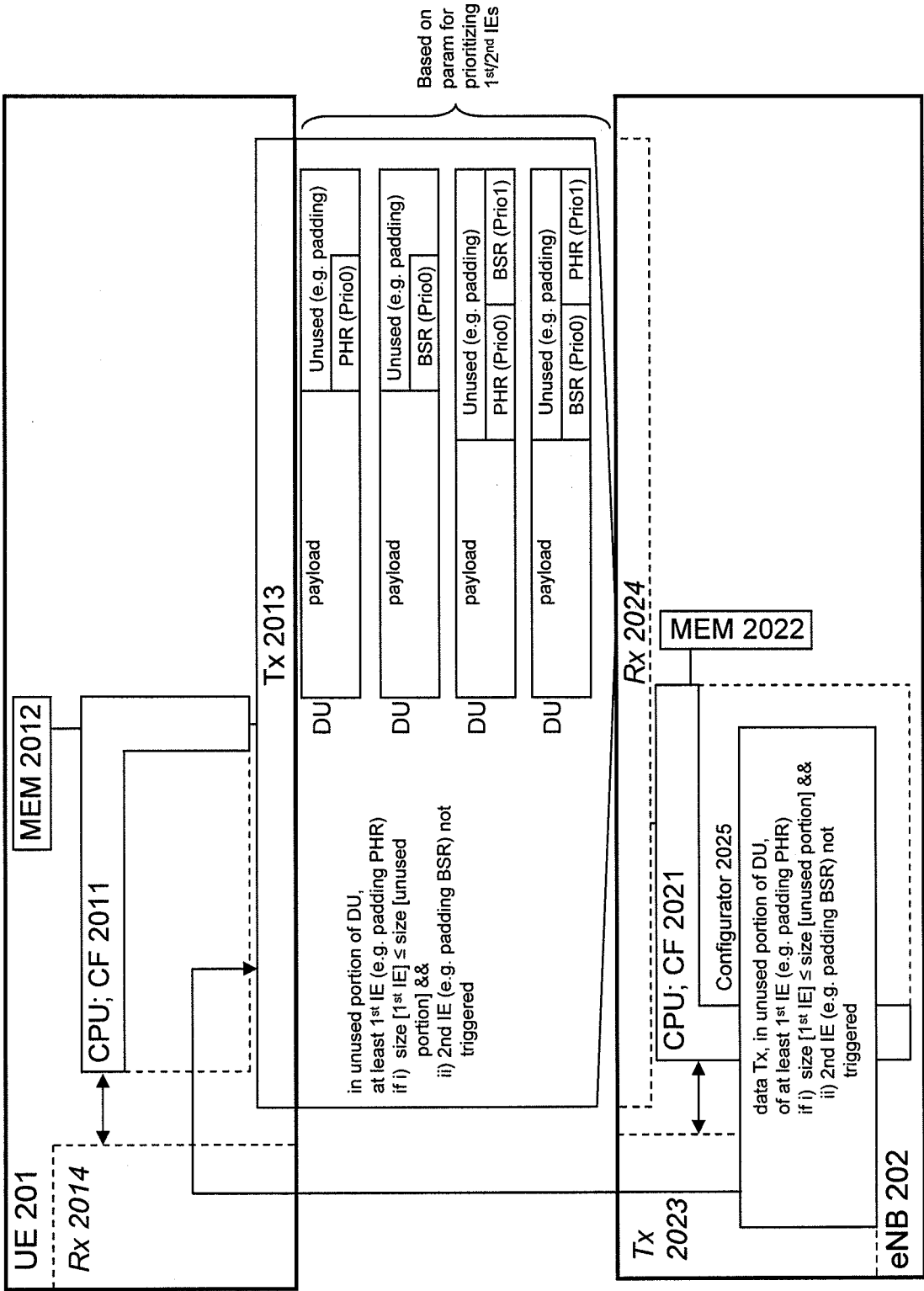


Fig. 2C

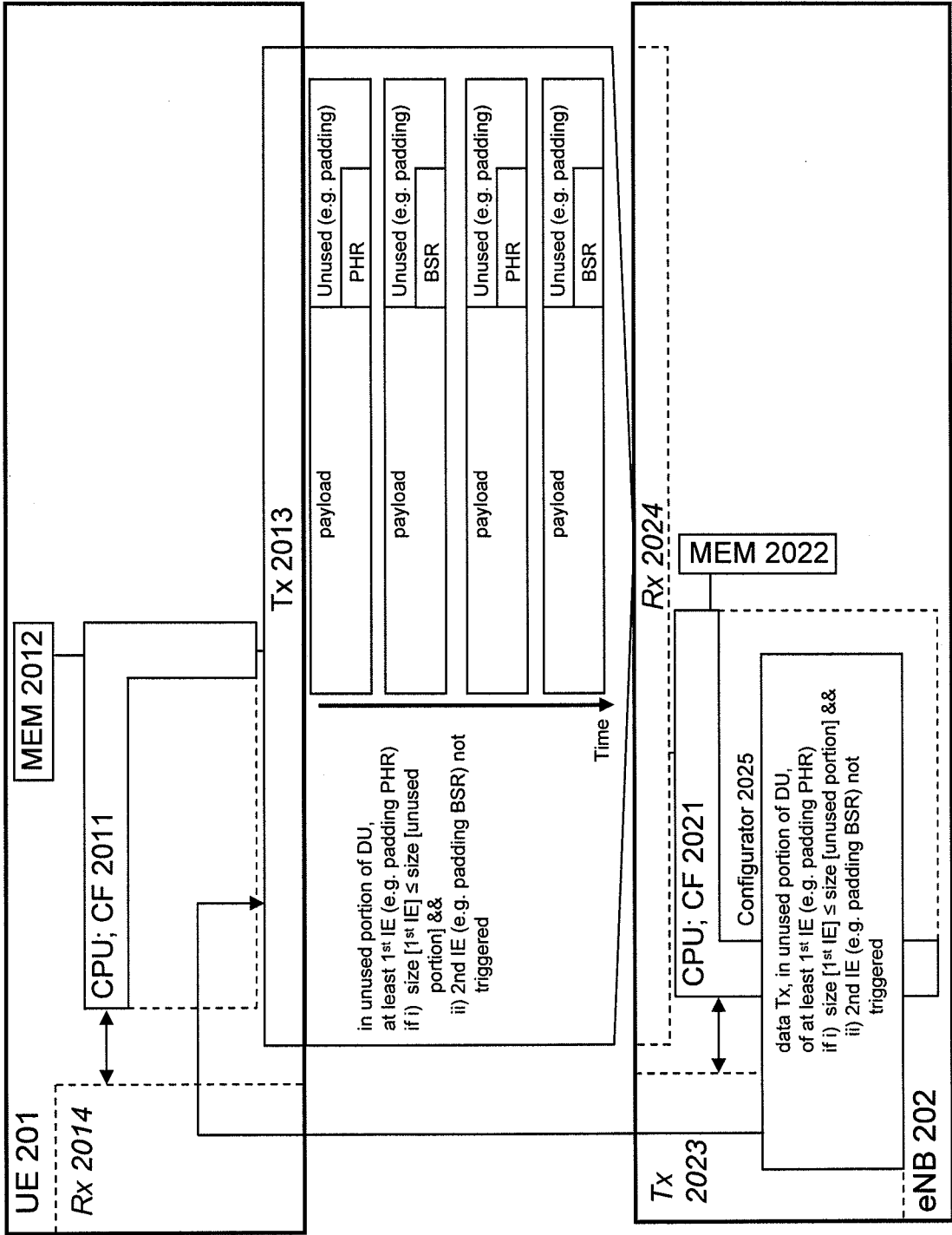


Fig. 2D

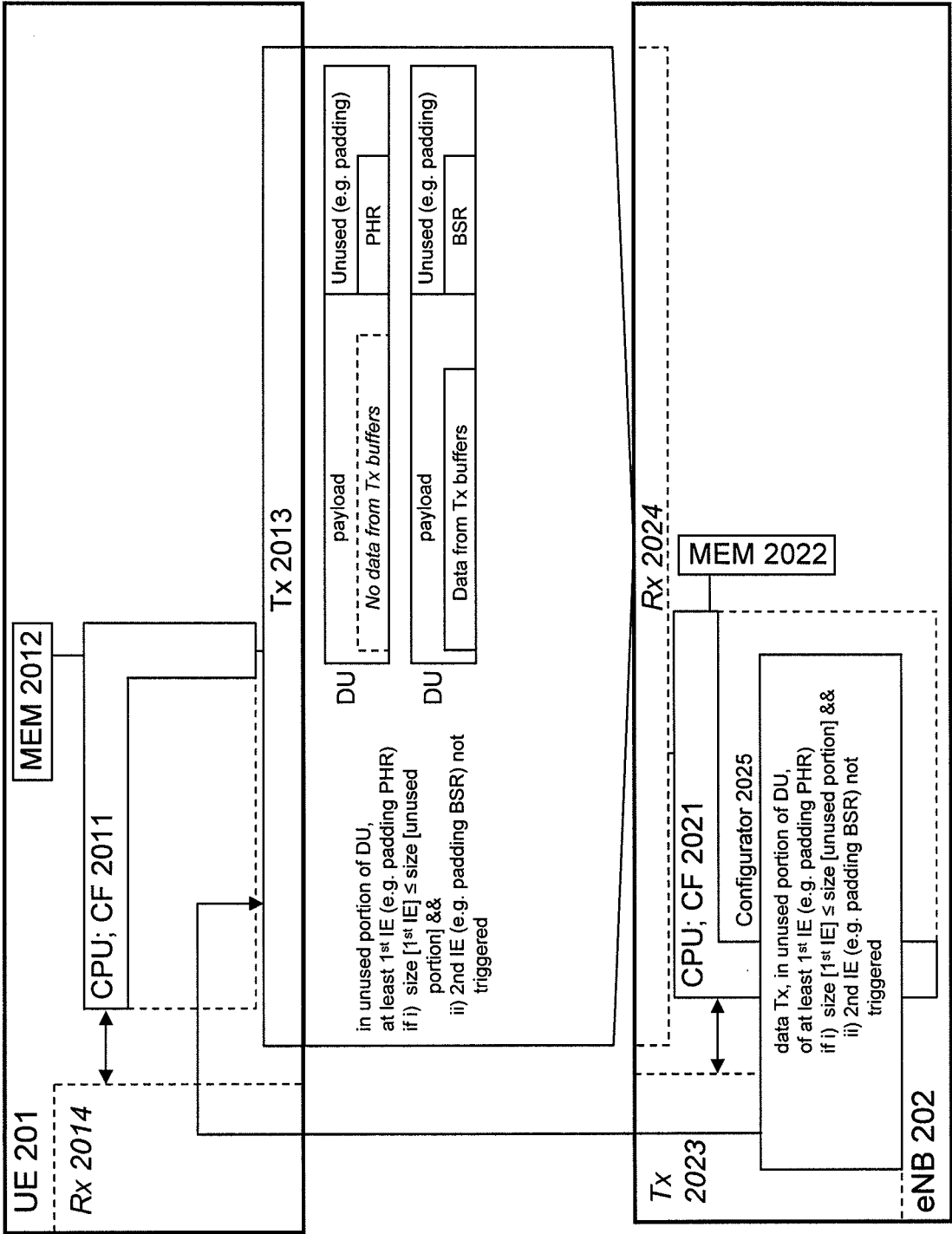
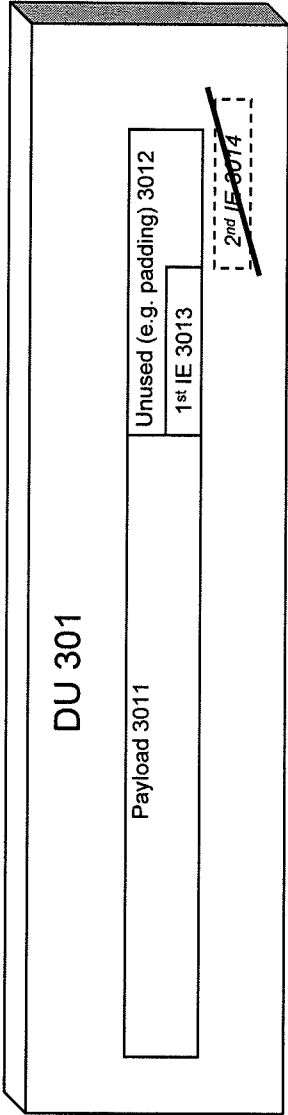


Fig. 3



# INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2009/053146

## A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W72/12

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

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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. |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | <p>3GPP: "MEDIUM ACCESS CONTROL (MAC) PROTOCOL SPECIFICATION (RELEASE 8)" TECHNICAL SPECIFICATION GROUP RADIO ACCESS NETWORK; EVOLVED UNIVERSAL TERRESTRIAL RADIO ACCESS (E-UTRA), [Online]<br/>vol. 3GPP, no. TS36.321,<br/>December 2008 (2008-12), pages 1,20-27,<br/>XP002564902<br/>France<br/>Retrieved from the Internet:<br/>URL:www.3gpp.org&gt;<br/>[retrieved on 2010-01-19]<br/>chapter 5.4.5, pages 25-26<br/>chapter 5.4.6, pages 26-27<br/>-----<br/>-/--</p> | 1-37                  |

☒ 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
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- "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

25 January 2010

Date of mailing of the international search report

05/02/2010

Name and mailing address of the ISA/

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# INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2009/053146

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>NOKIA SIEMENS NETWORKS: "Power Headroom Reporting"<br/> , [Online]<br/> vol. R2-082917, no. 62,<br/> 5 May 2008 (2008-05-05), pages 1-4,<br/> XP002537452<br/> Retrieved from the Internet:<br/> URL:ftp://ftp.3gpp.org/TSG_RAN/WG2_RL2/TSG<br/> R2_62/Docs/R2-082197.zip&gt;<br/> [retrieved on 2009-07-16]<br/> chapter 4 on page 2 (Conclusion)</p> <p>-----</p>                                                            | 1-37                  |
| T         | <p>NOKIA SIEMENS NETWORKS ET AL: "Padding PHR"<br/> 3GPP DRAFT; 36321_CRONNN-(REL-9)_R2-092051<br/> ON PADDING PHR, 3RD GENERATION PARTNERSHIP<br/> PROJECT (3GPP), MOBILE COMPETENCE CENTRE ;<br/> 650, ROUTE DES LUCIOLES ; F-06921<br/> SOPHIA-ANTIPOLIS CEDEX ; FRANCE, no.<br/> Seoul, Korea; 20090317,<br/> 17 March 2009 (2009-03-17), XP050339796<br/> [retrieved on 2009-03-17]<br/> the whole document</p> <p>-----</p> | 1-37                  |