



(51) International Patent Classification:
H04L 1/18 (2006.01)

(21) International Application Number:
PCT/CN2019/075260

(22) International Filing Date:
15 February 2019 (15.02.2019)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicants (*for CN only*): **NOKIA SHANGHAI BELL CO., LTD.** [CN/CN]; No. 388, Ningqiao Road, Pudong Jinqiao, Shanghai 201206 (CN). **NOKIA SOLUTIONS AND NETWORKS OY** [FI/FI]; Karaportti 3, FI-02610 Espoo (FI).

(71) Applicant (*for all designated States except CN*): **NOKIA TECHNOLOGIES OY** [FI/FI]; Karaportti 3, FI-02610 Espoo (FI).

(72) Inventors: **TAO, Tao**; No. 388 Ningqiao Road, Pudong Jinqiao, Shanghai 201206 (CN). **LIU, Jianguo**; No. 388 Ningqiao Road, Pudong Jinqiao, Shanghai 201206 (CN). **MENG, Yan**; No. 388 Ningqiao Road, Pudong Jinqiao, Shanghai 201206 (CN). **HOOLI, Kari**; Nokia Oyj, Kaapeliteie 4, FI-90620 Oulu (FI).

(74) Agent: **KING & WOOD MALLESONS**; 20th Floor, East Tower, World Financial Centre, No. 1 Dongsanhuan Zhonglu, Chaoyang District, Beijing 100020 (CN).

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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

Published:

— with international search report (Art. 21(3))

(54) Title: RETRANSMISSION FEEDBACK CONTROL

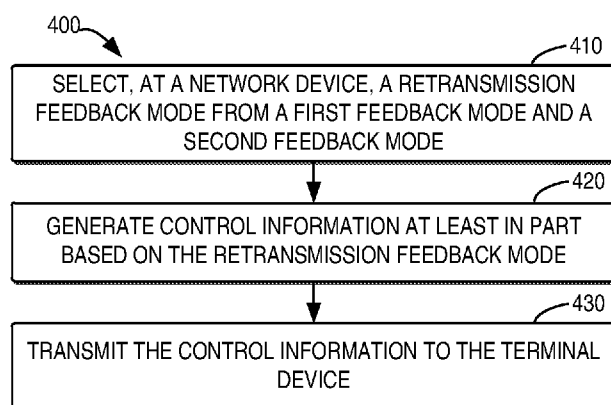


Fig. 4

(57) Abstract: Embodiments of the present disclosure relate to Hybrid Automatic Repeat Request (HARQ) feedback. In example embodiments, the method comprises selecting, at a network device, a retransmission feedback mode from a first feedback mode and a second feedback mode, the first feedback mode being used for a transmission block (TB) -level feedback for a terminal device, and the second feedback mode being used for a combination of TB-level and code block group (CBG) -level feedback for the terminal device; generating control information at least in part based on the retransmission feedback mode; and transmitting the control information to the terminal device. In this way, overhead of retransmission feedback will be reduced and flexibility of the retransmission feedback can be improved.



RETRANSMISSION FEEDBACK CONTROL

FIELD

5 [0001] Embodiments of the present disclosure generally relate to the field of telecommunication and, in particular, to devices, methods, apparatuses and computer readable storage media for controlling retransmission feedback.

BACKGROUND

10 [0002] Wireless communications networks are widely deployed to provide various communication services. These wireless telecommunication networks may include one or more user equipments (UEs) and one or more base stations (BSs). In a new radio (NR) network, the UE can transmit one or more data subframes to the BS over an unlicensed spectrum. The UE may autonomously initiate retransmission for a HARQ process that
15 was initially transmitted via a configured grant (CG) mechanism for NR-unlicensed spectrum when it receives NACK feedback via downlink control information, for example Downlink Feedback Information (DFI), for the corresponding HARQ process.

[0003] In CG mechanism, UE is configured with a persistent or semi-persistent (PUSCH) resource allocation as well as other necessary transmission parameters. The resource
20 allocation may be periodic. The UE may transmit on the configured grant PUSCH resource only when it has data to transmit and, in some cases, only if UE does not have any scheduled physical uplink control channel PUSCH resource available. The gNB blindly detect the presence of configured grant PUSCH transmission on the configured resources. One of the benefits of configured grant mechanism is reduced latency. There are also
25 other similar mechanisms, e.g. autonomous uplink transmission in LTE.

[0004] In order to improve efficiency and reduce latency in the NR network, a concept called Code Block Groups (CBGs) based transmission is introduced which will essentially divide the large transport block (TB) into smaller groups. As each group contains at least one code block (CB), the group is referred as code block group (CBG). Currently, the DFI
30 could provide CBG level feedback indication while UE can retransmit the failed CBGs based on received DFI. However, such a feedback mechanism may introduce unnecessary overhead and is not flexible enough.

SUMMARY

[0005] Generally, embodiments of the present disclosure relate to a method for controlling retransmission feedback and the corresponding communication devices.

5 [0006] In a first aspect, there is provided a method for communication. The method comprises selecting, at a network device, a retransmission feedback mode from a first feedback mode and a second feedback mode, the first feedback mode being used for a TB-level feedback for a terminal device, and the second feedback mode being used for a combination of TB-level and CBG-level feedback for the terminal device. The method
10 also comprises generating control information at least in part based on the retransmission feedback mode. The method further comprises transmitting the control information to the terminal device.

[0007] In a second aspect, embodiments of the disclosure provide a method for communication. The method comprises receiving, at a terminal device, control
15 information from a network device, a control information indicating a retransmission feedback mode selected from a first feedback mode and a second feedback mode, the first feedback mode being used for a TB-level feedback from the terminal device, and the second feedback mode being used for a combination of TB-level and CBG-level feedback from the terminal device. The method also comprises performing retransmission based on
20 the control information.

[0008] In a third aspect, embodiments of the disclosure provide a device. The device comprises at least one processor; and at least one memory including computer program codes; the at least one memory and the computer program codes are configured to, with the at least one processor, cause the device to select, at a network device, a retransmission
25 feedback mode from a first feedback mode and a second feedback mode, the first feedback mode being used for a TB-level feedback for a terminal device, and the second feedback mode being used for a combination of TB-level and CBG-level feedback for the terminal device. The device is also caused to generate control information at least in part based on the retransmission feedback mode. The device is further caused to transmit the control
30 information to the terminal device.

[0009] In a fourth aspect, embodiments of the disclosure provide a device. The device comprises at least one processor; and at least one memory including computer program

codes; the at least one memory and the computer program codes are configured to, with the at least one processor, cause the device to receive, at a terminal device, control information from a network device, a control information indicating a retransmission feedback mode selected from a first feedback mode and a second feedback mode, the first feedback mode being used for a TB-level feedback for the terminal device, and the second feedback mode being used for a combination of TB-level and CBG-level feedback for the terminal device. The device is also caused to perform retransmission based on the control information.

[0010] In a fifth aspect, embodiments of the disclosure provide an apparatus for communication. The apparatus comprises means for selecting, at a network device, a retransmission feedback mode from a first feedback mode and a second feedback mode, the first feedback mode being used for a TB-level feedback for a terminal device, and the second feedback mode being used for a combination of TB-level and CBG-level feedback for the terminal device. The apparatus further comprises means for generating control information at least in part based on the retransmission feedback mode. The apparatus also comprises means for transmitting the control information to the terminal device.

[0011] In a sixth aspect, embodiments of the disclosure provide an apparatus for communication. The apparatus comprises means for receiving, at a terminal device, control information from a network device, a control information indicating a retransmission feedback mode selected from a first feedback mode and a second feedback mode, the first feedback mode being used for a TB-level feedback from the terminal device, and the second feedback mode being used for a combination of TB-level and CBG-level feedback from the terminal device. The apparatus also comprises means for performing retransmission based on the control information.

[0012] In a seventh aspect, embodiments of the disclosure provide a computer readable storage medium. The computer readable storage medium comprises program instructions stored thereon, the instructions, when executed by a processor of a device, causing the device to perform the method according to the first aspect or the second aspect.

[0013] Other features and advantages of the embodiments of the present disclosure will also be apparent from the following description of specific embodiments when read in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of embodiments of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Embodiments of the disclosure are presented in the sense of examples and their advantages are explained in greater detail below, with reference to the accompanying drawings, where

5 [0015] Fig. 1 illustrates a schematic diagram of a communication system according to embodiments of the present disclosure;

[0016] Fig. 2 illustrates a block diagram of a codebook for HARQ feedback;

[0017] Fig. 3 illustrates a schematic diagram of interactions among devices according to embodiments of the present disclosure;

10 [0018] Fig. 4 illustrates a flowchart of a method implemented at a device according to embodiments of the present disclosure;

[0019] Fig. 5 illustrates a block diagram of an example bitmap for HARQ feedback according to embodiments of the present disclosure;

15 [0020] Fig. 6 illustrates a block diagram of an example bitmap for HARQ feedback according to embodiments of the present disclosure;

[0021] Fig. 7 illustrates a block diagram of an example codebook for HARQ feedback according to embodiments of the present disclosure;

[0022] Fig. 8 illustrates a block diagram of an example bitmap for HARQ feedback according to embodiments of the present disclosure;

20 [0023] Fig. 9 illustrates a block diagram of an example codebook for HARQ feedback according to embodiments of the present disclosure;

[0024] Fig. 10 illustrates a flowchart of a method implemented at a device according to embodiments of the present disclosure;

25 [0025] Fig. 11 illustrates a schematic diagram of a device according to embodiments of the present disclosure; and

[0026] Fig. 12 shows a block diagram of an example computer readable medium in accordance with some embodiments of the present disclosure.

[0027] Throughout the figures, same or similar reference numbers indicate same or similar elements.

DETAILED DESCRIPTION

[0028] The subject matter described herein will now be discussed with reference to several example embodiments. It should be understood these embodiments are discussed only for the purpose of enabling those skilled persons in the art to better understand and thus implement the subject matter described herein, rather than suggesting any limitations on the scope of the subject matter.

[0029] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of example embodiments. As used herein, the singular forms “a,” “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises,” “comprising,” “includes” and/or “including,” when used herein, specify the presence of stated features, integers, steps, operations, elements and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components and/or groups thereof.

[0030] It should also be noted that in some alternative implementations, the functions/acts noted may occur out of the order noted in the figures. For example, two functions or acts shown in succession may in fact be executed concurrently or may sometimes be executed in the reverse order, depending upon the functionality/acts involved.

[0031] As used herein, the term “communication network” refers to a network following any suitable communication standards, such as Long Term Evolution (LTE), LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), High-Speed Packet Access (HSPA), and so on. Furthermore, the communications between a terminal device and a network device in the communication network may be performed according to any suitable generation communication protocols, including, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the future fifth generation (5G) communication protocols, and/or any other protocols either currently known or to be developed in the future.

[0032] Embodiments of the present disclosure may be applied in various communication systems. Given the rapid development in communications, there will of course also be future type communication technologies and systems with which the present disclosure may be embodied. It should not be seen as limiting the scope of the present disclosure to

only the aforementioned system. For the purpose of illustrations, embodiments of the present disclosure will be described with reference to 5G communication system.

[0033] The term “network device” used herein includes, but not limited to, a base station (BS), a gateway, a registration management entity, and other suitable device in a communication system. The term “base station” or “BS” represents a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a NR NB (also referred to as a gNB), a Remote Radio Unit (RRU), a radio header (RH), a remote radio head (RRH), a relay, a low power node such as a femto, a pico, and so forth.

[0034] The term “terminal device” used herein includes, but not limited to, “user equipment (UE)” and other suitable end device capable of communicating with the network device. By way of example, the “terminal device” may refer to a terminal, a Mobile Terminal (MT), a Subscriber Station (SS), a Portable Subscriber Station, a Mobile Station (MS), or an Access Terminal (AT).

[0035] The term “circuitry” used herein may refer to one or more or all of the following:

[0036] (a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and

[0037] (b) combinations of hardware circuits and software, such as (as applicable):

[0038] (i) a combination of analog and/or digital hardware circuit(s) with

[0039] software/firmware and

[0040] (ii) any portions of hardware processor(s) with software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as a mobile phone or server, to perform various functions) and

[0041] (c) hardware circuit(s) and or processor(s), such as a microprocessor(s) or a portion of a microprocessor(s), that requires software (e.g., firmware) for operation, but the software may not be present when it is not needed for operation.”

[0042] This definition of circuitry applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term circuitry also covers an implementation of merely a hardware circuit or processor (or multiple processors) or portion of a hardware circuit or processor and its (or their) accompanying software and/or firmware. The term circuitry also covers, for example and if applicable to the particular claim element, a baseband integrated circuit or processor integrated circuit for

a mobile device or a similar integrated circuit in server, a cellular network device, or other computing or network device.

[0043] Fig. 1 shows an example communication network 100 in which embodiments of the present disclosure can be implemented. The network 100 includes a network device 110 and terminal devices 120-1 and 120-2 (hereinafter collectively referred to as terminal devices 120 or individually referred to as a terminal device 120) served by the network device 110. The serving area of the network device 110 is called as a cell 102. It is to be understood that the number of network devices and terminal devices is only for the purpose of illustration without suggesting any limitations. The network 100 may include any suitable number of network devices and terminal devices adapted for implementing embodiments of the present disclosure. Although not shown, it would be appreciated that one or more terminal devices may be in the cell 102 and served by the network device 110.

[0044] The communications in the network 100 may conform to any suitable standards including, but not limited to, Long Term Evolution (LTE), LTE-Evolution, LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), Code Division Multiple Access (CDMA) and Global System for Mobile Communications (GSM) and the like. Furthermore, the communications may be performed according to any generation communication protocols either currently known or to be developed in the future. Examples of the communication protocols include, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G) communication protocols.

[0045] Typically, in order to bring in more efficiency and reduce latency in NR network, the terminal device may transmit data via uplink channel, such as PUSCH, in form of CBGs to the network device over unlicensed spectrum. These CBGs will be decoded by the network device and the network device will send HARQ feedback for each of the individual groups.

[0046] The advantage of this approach is that since NR will be supporting huge Transport Block Sizes (TBS) and the scheduler usually works with a 10% BLER target, so this means that if the terminal device transmits a huge TBS data, around 10% of this data will be retransmitted. Unlike LTE, the entire TB does not need be retransmitted if the transmission gets NACK. Instead only those CBGs which the network device 110 failed to successfully decode are retransmitted.

[0047] To enable CBG based retransmissions in configured grant resources, the HARQ feedback in the configured grant-Downlink feedback information (CG-DFI) will need to be updated to include the CBG feedback information. In further enhanced Licensed Assisted Access (feLAA), a codebook in DFI is adopted for indicating TB-level ACK/NACK (A/N) for all HARQ processes, where the codebook size is scaled with the number of HARQ processes. Due to unreliable LBT, making a codebook design based on the deterministic timing relation between the CG-PUSCH and HARQ feedback challenging, it can be expected the same codebook design principle will also be used in NR-U. That means HARQ feedback for all HARQ processes can be expected in NR CG-DFI. However, including CBG-level feedback for all HARQ processes may make the expected control information payload size very large in some cases making it difficult to include all feedback in one DCI. For example, when a terminal device is configured with 8 HARQ processes and 8 CBGs per TB for configured grant, it would lead to a codebook with 64 bits in CG-DFI. Therefore, in current NR DCI format 0_0 and format 0_1, there are not sufficiently large payload to accommodate CBG-level HARQ feedback for all HARQ processes.

[0048] Conventionally, in a HARQ feedback procedure, one possible solution for CBG-level HARQ feedback is splitting the information across multiple DCIs. That means, the CBG-based feedback payload for all HARQ processes is divided into multiple parts and then encased into multiple DCIs. However, such solution does not solve the issue of high feedback overhead in CG-DFI or try to compress the CG-DFI overhead.

[0049] Another possible solution for HARQ feedback is using a hybrid codebook. In this solution, the network device 110 can provide a combination of TB-level feedback and CBG-level feedback in a codebook. Fig.2 illustrates a block diagram of codebook 200 for HARQ feedback. In order to indicate whether TB-level A/N or CBG-level A/N is adopted for each HARQ process, a bitmap can be included in CG-DFI. Further, to simplify DFI blind decoding on terminal device side, the DFI payload should have a predetermined, semi-static size. In this possible solution, the DFI may contain bits for CBG feedback for a predetermined number of HARQ processes, e.g. for 3 HARQ processes, as shown in Fig. 2. However, as the actually needed number of HARQ feedback bits varies dynamically, this potential solution may cause useless extra overhead in case that only some HARQ processes have pending HARQ feedback and those processes are correctly decoded at the network device. On other hand, occasionally there may be need to provide CBG based

HARQ feedback for more than (the exemplary) 3 HARQ processes. In these situations, this possible solution suffers from the limited capability to provide CBG feedback.

[0050] In order to address at least some of the above problems and other potential problems, according to embodiments of the present disclosure, there is proposed a solution for retransmission feedback. In this solution, the network device 110 can select a retransmission feedback mode from a first feedback mode and a second feedback mode. In the first feedback mode, the network device 110 only needs to perform TB-level feedback and in the second feedback mode, the network device 110 can perform a combination of TB-level and CBG-level feedback. As such, the network device 110 can transmit CBG-level HARQ feedback on-demand. As all code blocks (CBs) are decoded correctly is the most common scenario, the HARQ feedback overhead can be reduced dramatically by avoiding always using a large payload size DFI to carry both TB-level and CBG-level feedback.

[0051] Principle and implementations of the present disclosure will be described in detail below with reference to Fig. 3, which illustrates a schematic diagram of interactions 300 in accordance with embodiments of the present disclosure. The interactions 300 may be implemented at any suitable devices. Only for the purpose of illustrations, the interactions 300 are described to be implemented at the terminal device 120 and the network device 110.

[0052] The network device 110 selects a retransmission feedback mode by considering the requirement for the CBG-level HARQ feedback. The network device 110 can select a first feedback mode which is used for a TB-level feedback. In the first feedback mode, the network device 110 can transmit the retransmission feedback mode in one transmission of control information, for example, with one DCI. In some embodiments, the control information may be CG-DFI or other suitable type of downlink information.

[0053] The network device 110 can also select a second feedback mode which is used for a combination of a TB-level and CBG-level feedback. In the second mode, the network device 110 can transmit the feedback information with two DCIs, such as, a first CG-DFI and a second CG-DFI, a third CG-DFI and a fourth CG-DFI. The first CG-DFI/ third CG-DFI can be used to indicate the HARQ feedback codebook structure in the second CG-DFI/fourth DCI.

[0054] After selecting the retransmission feedback mode, the network device 110

generates 320 control information. If there is no CBG-level HARQ feedback, the network device 110 generates a bitmap in one CG-DFI to indicate the TB-level HARQ feedback. Otherwise, the network device 110 generates a bitmap in the first CG-DFI/third CG-DFI and a codebook in the second CG-DFI/fourth CG-DFI.

5 [0055] The network device 110 transmits 330 the generated control information to the terminal device 120. In some embodiments, the control information can be transmitted on Physical Downlink Control Channel (PDCCH.)

[0056] The terminal device 120 receives 330 the control information. In some embodiments, the terminal device 120 performs a blind-decode procedure. The terminal
10 device 120 extracts the control information and obtains retransmission feedback mode. The terminal device 120 may perform 340 retransmission based on the control information.

[0057] In some embodiments, if the network device 110 receives a PUSCH transmission from the terminal device 120, the network device 110 may inform the terminal device 120 of the retransmission feedback mode. As such the terminal device 120 may perform
15 retransmission based on the retransmission feedback mode.

[0058] Operations at the network device 110 will be discussed by referring Fig. 4 to Fig. 9 as below.

[0059] Fig. 4 illustrates a flow chart of a method 400 in accordance with embodiments of the present disclosure. The method 400 may be implemented at any suitable devices.
20 Only for the purpose of illustrations, the method 400 is described to be implemented at the network device 110.

[0060] At block 410, the network device 110 selects a retransmission feedback mode from a first feedback mode and a second feedback mode. The first feedback mode can be used for a TB-level feedback for the terminal device 120, and the second feedback mode can be
25 used for a combination of TB-level and CBG-level feedback from the terminal device 120.

[0061] In some embodiments, the network device 110 selects a retransmission feedback mode based on a status of the network, a predefined rule between network device 110 and the terminal device 120, or the results of decoding, and so on.

[0062] At block 420, the network device 110 generates control information based on the
30 selected retransmission feedback mode. The control information may be generated in a variety of ways.

[0063] In some embodiments, the network device 110 may select the first feedback mode to perform TB-level feedback only. In this case, the network device 110 generates the control information comprising a first bitmap for HARQ processes between the network

device 110 and the terminal device 120. In some embodiments, the first bitmap comprises an indication of a TB-level ACK or a TB-level NACK for the HARQ process. That is, the network device 110 only needs to transmit one DCI. The first bitmap for HARQ processes may be comprised in this DCI. An example of a structure of such DCI will be discussed with respect to Fig. 5.

[0064] It should be noted that, in some embodiments, the first bitmap may comprise indications of a TB-level ACK or a TB-level NACK for part of the HARQ processes or all HARQ processes.

[0065] By this way, the first DCI could reuse NR DCI format 0_0, which has small payload size. As the first DCI is more important, the network device 110 could use a high aggregation level to transmit the first DCI. Due to small payload size, it will not increase the PDCCH capacity too much. Therefore, overhead of retransmission feedback will be reduced.

[0066] Alternatively, in some embodiments, the network device 110 may select the second feedback mode to perform a combination of TB-level and CBG-level feedback. In this case, the network device may use two DCIs for the second feedback mode.

[0067] In some embodiments, if the network device 110 selects the second feedback mode as the retransmission feedback mode, the network device 110 generates the control information comprising a second bitmap and a first feedback codebook. The second bitmap indicates feedback levels for the HARQ processes and the first feedback codebook comprises a plurality of portions corresponding to the HARQ processes, and a size of each portion is associated to the respective feedback level for the HARQ process.

[0068] In some embodiments, the second bitmap can be transmitted in the first DCI and the first feedback codebook can be transmitted in the second DCI. In some embodiments, the first DCI can comprise a first indication for presence of the first feedback codebook. Upon receipt of the first indication, the terminal device 120 may detect the first feedback codebook based on the first indication.

[0069] Alternatively or in addition, in some embodiments, the network device 110 may not transmit the first indication. In this case, the terminal device 120 performs the blind-decode procedure by detecting search space on the control information comprising one or more DCIs. Based on the number of the detected DCI(s), and other optional assistant information (such as, format of the DCI(s), search space of the DCI(s) or one or more indications, e.g., an indication for the first feedback mode, an indication for the presence of a first feedback codebook, an indication for the presence of a second feedback

codebook, or indication that a third DCI comprises a third bitmap), the terminal device 120 may determine the retransmission feedback mode.

[0070] By this way, when CBG-level feedback is needed, it can be transmitted with a DCI format supporting sufficiently large payload (e.g., NR DCI format 0_1). There is no need to overly compress CBG-level feedback as it is not regularly transmitted, but only when actually needed.

[0071] Detailed structures of the first DCI and the second DCI will be discussed with reference to Figs. 6 and 7.

[0072] Alternatively, in some embodiments, if the network device 110 selects the second feedback mode as the retransmission feedback mode, the network device 110 generates a third bitmap and a second feedback codebook. The third bitmap may comprise an indication of a TB-level ACK or an indication for retransmission for a corresponding HARQ process. The second feedback codebook comprises a fourth bitmap indicating a feedback level of a first HARQ process corresponding to the indication for retransmission.

[0073] In some embodiments, if the feedback level of said first HARQ process indicated by the fourth bitmap is the CBG-level, the second feedback codebook may further comprise a fifth bitmap corresponding to the first HARQ process. The fifth bitmap comprises an indication of a CBG-level ACK or a CBG-level NACK for the first HARQ process.

[0074] In some embodiments, the third bitmap is transmitted in third DCI and the second feedback codebook is transmitted in fourth DCI.

[0075] By this way, when CBG-level feedback is needed, it can be transmitted with a DCI format supporting sufficiently large payload (e.g., NR DCI format 0_1). There is no need to over-compress CBG-level feedback as it is not regularly transmitted, but only when actually needed.

[0076] Detailed structures of the third DCI and the fourth DCI will be discussed with reference to Figs. 8 and 9.

[0077] At block 430, the network device 110 transmits the control information to the terminal device 120.

[0078] In some embodiments, the network device 110 transmits the second bitmap in first DCI and transmits the first feedback codebook in second DCI.

[0079] In some embodiments, the network device 110 transmits the third bitmap in third DCI and transmits the second feedback codebook in fourth DCI.

[0080] In some embodiments, third DCI further comprises at least one of: a second indication for presence of the second feedback codebook, and a third indication that the

third DCI comprises the third bitmap.

[0081] In this way, by avoiding always using large size payload, the overhead for the retransmission feedback will be reduced. Further, the current DCI format can be reused.

[0082] As mentioned above, the network device 110 may select the first feedback mode to perform retransmission feedback and generate one DCI comprising a first bitmap. Referring to Fig.5, the structure of the DCI for the first retransmission feedback mode will be discussed as below.

[0083] Fig. 5 illustrates a block diagram of a bitmap 500 for HARQ feedback. If only TB-level A/N feedback is needed for all HARQ processes, the network device 110 shall only transmit one DCI, such as, CG-DFI, as shown in Fig. 5. In addition, except the first bitmap, the DCI can also comprise other control information for configured grant PUSCH operation, e.g., CIF; transmit power control command, etc. This DCI could re-use NR DCI format 0_0, which has small payload size. As the first CG-DFI is more important, the network device 110 could use a high aggregation level to transmit the first DFI. Due to low payload size, it will not increase the PDCCH capacity too much.

[0084] Bitmap 500 illustrates a bitmap of "00011111" and each bit in the bitmap indicates the ACK ('1') or NACK ('0') information for corresponding HARQ process. It should be noted that the number of the HARQ processes and the values of the HARQ FEEDBACK (TB-LEVEL) shown with respect to Fig. 5 are only for purpose of illustrations, rather than limitations. The number of the HARQ processes can be any suitable number and the values of the HARQ FEEDBACK can be any suitable value. It should also be noted that although one HARQ process corresponds to one bit as shown in Fig. 5, in other implements, one HARQ process can correspond to a plurality of bits. It should be noted that the HARQ processes can be ordered in the bitmap in various ways, e.g. according to the increasing or decreasing order of HARQ process number. However, the ordering is predefined to ensure correct interpretation of bitmap both at network device and terminal device.

[0085] As mentioned above, the network device 110 can perform retransmission feedback in the second feedback mode. The network device 110 generates first DCI comprising a second bitmap and a second DCI comprising a first feedback codebook. Referring to Fig.6 and Fig. 7, detailed structures of the first DCI and the second DCI are discussed as below. Fig. 6 illustrates a block diagram of a bitmap 600 for HARQ feedback. Fig. 7 illustrates a block diagram of a codebook 700 for HARQ feedback. It should be noted that the number of the HARQ processes, the values of the HARQ FEEDBACK and the values of ACK/RE-TX shown with respect to Fig. 6 and Fig. 7 are only for purpose of illustrations,

rather than limitations. The number of the HARQ processes can be any suitable number and the values of the HARQ FEEDBACK and the values of TB/CBG can be any suitable value.

[0086] If the network device 110 contains both TB-level and CBG-level feedback for the terminal device 120 with configured UL grant transmission, a first DCI and a second DCI (e.g., the first and the second CG-DFI) will be used to indicate HARQ A/N feedback to the terminal device 120. As shown in Fig. 6 and Fig. 7, the terminal device 120 has 8 HARQ processes for UL transmission. Bitmap 600 illustrates a bitmap of “11010111” and each bit in the bitmap indicates the TB-level (‘1’) or CBG-level (‘0’) information for corresponding HARQ process. 8-bit bitmap in the first CG-DFI is used to indicate TB-level A/N or CBG-level A/N is adopted for each HARQ process. Here, ‘1’ means TB-level A/N will be provided to the HARQ process and ‘0’ means CBG-level A/N will be provided to the HARQ process. Bitmap 600 illustrates that HARQ process #3 and HARQ process #5 will provide CBG-level A/N feedback.

[0087] The first CG-DFI could re-use NR DCI format 0_0, which has small payload size. In addition, the first CG-DFI can comprise an optional one-bit information to indicate the presence of the second CG-DFI.

[0088] Codebook 700 is an example of the first feedback codebook comprised in the second CG-DFI. The first feedback codebook of HARQ ACK feedback is determined by the followings: the information of TB-level A/N or CBG-level A/N used for each HARQ process, which is indicated in the first CG-DFI, and the number of CBGs for each HARQ process. This information is indicated by the network device 110 via RRC signalling or indicated by the terminal device 120 via CG-UCI. As shown in Fig. 7, 14-bit codebook of “00011101110111” in the second CG-DFI is used to indicate HARQ A/N feedback for different HARQ processes. As HARQ process #3 and #5 have four CBGs in their TB, 4-bit information is used to indicate CBG-level A/N feedback for these two HARQ processes.

[0089] The second CG-DFI could re-use NR DCI format 0_1, which has relative larger payload size. In addition, the second CG-DFI can comprise an indication (such as, one-bit flag) to indicate it is the second CG-DFI.

[0090] Alternatively, when the network device 110 can perform retransmission feedback in the second feedback mode, the network device 110 can generate a third DCI comprising a third bitmap and a fourth DCI comprising a second feedback codebook. Referring to Fig.8 and Fig. 9, detailed structures of the third DCI and the fourth DCI are discussed as

below. Fig. 8 illustrates a block diagram of a bitmap 800 for HARQ feedback. Fig. 9 illustrates a block diagram of a codebook 900 for HARQ feedback. It should be noted that the number of the HARQ processes, the values of ACK/RE-TX and the values of PRESENCE OF CBG BASED FEEDBACK and values of HARQ FEEDBACK shown with respect to Fig. 8 and Fig. 9 are only for purpose of illustrations, rather than limitations. The number of the HARQ processes can be any suitable number and the values of ACK/RE-TX and the values of PRESENCE OF CBG BASED FEEDBACK and values of HARQ FEEDBACK can be any suitable value.

[0091] The network device 110 contains both TB-level and CBG-level feedback for the terminal device 120 with configured UL grant transmission and both the third DCI and the fourth DCI (such as, the third and the fourth CG-DFI) are used to indicate HARQ A/N feedback to the terminal device 120. As shown in Fig. 8 and Fig. 9, the terminal device 120 has 8 HARQ processes for UL transmission. Bitmap 800 illustrating a bitmap of "10010111" is used to indicate TB-level ACK or a need for retransmission for each HARQ process. Here, '1' means TB-level ACK and '0' means need for retransmission. In addition, the third CG-DFI may comprise a second indication, for example, one bit, to indicate the presence of the second DFI and an optional indication (e.g., one-bit flag) to indicate that the third DCI comprise the third bitmap. Upon receipt of the second indication, the terminal device 120 may detect the second feedback codebook based on the second indication.

[0092] Alternatively or in addition, in some embodiments, the network device 110 may not transmit the second indication. In this case, the terminal device 120 performs the blind-decode procedure by detecting search space on the control information comprising one or more DCIs. This procedure is similar to the blind-decode procedure in absence of the first indication, and thus details are omitted herein.

[0093] As shown in Fig. 9, the fourth CG-DFI contains first an 8-bit bitmap whether CBG based feedback is contained in the DFI. The size of the bitmap may correspond to the number of HARQ processes configured for CG-PUSCH operation or, alternatively, to the number of HARQ processes for which the bitmap 800 indicated need for a retransmission. As the third DFI indicated retransmissions for HARQ processes #2, #3 and #5, and the fourth DFI contains CBG based feedback only for HARQ processes #3 and #5, the terminal device 120 determines that TB based NACK is indicated for HARQ process #2. The terminal device 120 determines the CBG based feedback for HARQ processes #3 and #5. In this example, HARQ processes #3 and #5 have four CBGs. As a result, 16 bits are used

to indicate CGB based feedback for HARQ process #3 and #5. The remaining bits of the DFI (aligned e.g. with DCI 0-1 size) are padded with dummy bits.

[0094] In addition, the fourth CG-DFI can comprise an indication (such as, one-bit flag) to indicate it is the fourth CG-DFI.

5 [0095] The third CG-DFI can reuse NR DCI format 0_0 and the fourth CG-DFI can reuse NR DCI format 0_1.

[0096] In this way, the terminal device 120 can perform at least some of the retransmissions even if it detects only one DFI. In case that the terminal device 120 detects only the third DFI, the terminal device 120 will interpret its content as TB-based
10 A/N. Further, in case that the terminal device 120 detects only the fourth DFI, the terminal device 120 can perform retransmissions for HARQ processes for which it contained the CBG based HARQ feedback.

[0097] Now details of operations of the terminal device 120 will be discussed with reference to Fig. 10. Fig. 10 illustrates a flow chart of a method 1000 in accordance with
15 embodiments of the present disclosure. The method 1000 may be implemented at any suitable devices. Only for the purpose of illustrations, the method 1000 is described to be implemented at the terminal device 120.

[0098] At block 1010, the terminal device 120 receives control information from a network device 110. The control information can indicate a retransmission feedback
20 mode selected from a first feedback mode and a second feedback mode. The first feedback mode can be used for a TB-level feedback for the terminal device 120, and the second feedback mode can be used for a combination of TB-level and CBG-level feedback from the terminal device 120.

[0099] In some embodiments, the terminal device 120 determines whether the control
25 information comprises a first indication for presence of a first feedback codebook or a second indication for presence of a second feedback codebook. If the terminal device 120 determines that the control information comprises neither the first indication nor the second indication, the terminal device 120 extracts the first bitmap from the control information. The first bitmap comprises an indication of a TB-level ACK or a TB-level NACK for the
30 HARQ process.

[00100] In some embodiments, if the terminal device 120 determines that the control information comprises the first indication, the terminal device 120 extracts the second bitmap and the first feedback codebook. The second bitmap indicates feedback levels the

HARQ processes and the first feedback codebook comprises a plurality of portions corresponding to the HARQ processes. The size of the portion is associated to the respective feedback level for the HARQ process.

[00101] In some embodiments, the terminal device 120 receives the second bitmap in first DCI and the first feedback codebook in second DCI on a downlink control channel. In an example, the first DCI may comprise the first indication. Upon detection of the first indication from the first DCI, the terminal device 120 may know that there is a first feedback codebook in the second DCI.

[00102] In some embodiments, if the terminal device 120 determines that the control information comprises the second indication, the terminal device 120 extracts the third bitmap and the second feedback codebook. The third bitmap comprises an indication of a TB-level ACK or an indication for retransmission for the HARQ process and the second feedback codebook comprises the fourth bitmap indicating a feedback level of a first HARQ process corresponding to the indication for retransmission.

[00103] In some embodiments, if the feedback level of the first HARQ process indicated by the fourth bitmap is the CBG-level, the second feedback codebook further comprises the fifth bitmap corresponding to the first HARQ process. The fifth bitmap may comprise an indication of a CBG-level ACK or a CBG-level NACK for the first HARQ process.

[00104] In some embodiments, the terminal device 120 receives the third bitmap in third DCI and the second feedback codebook in fourth DCI on a downlink control channel.

[00105] In some embodiments, the third DCI comprises at least one of: the second indication for presence of the second feedback codebook, and the third indication that the third DCI comprises the third bitmap.

[00106] At block 1020, the terminal device 120 performs retransmission based on the control information.

[00107] In some embodiments, the terminal device 120 determines whether the fourth DCI is successfully received. If the fourth DCI is successfully received, the terminal device 120 performs retransmission at least in part based on the third bitmap and the fourth DCI. If the fourth DCI is unsuccessfully received, the terminal device 120 performs retransmission based on the third bitmap.

[00108] In some embodiments, if the terminal device 120 determines that the third DCI is

unsuccessfully received and at least in part the fourth DCI is successfully received, the terminal device 120 performs retransmission based on the fourth bitmap and fifth bitmap in the fourth DCI.

[00109] In some embodiments, an apparatus for performing the method 400 (for example, the network device 110) may comprise respective means for performing the corresponding steps in the method 400. These means may be implemented in any suitable manners. For example, it can be implemented by circuitry or software modules.

[00110] In some embodiments, the apparatus comprises means for selecting, at a network device, a retransmission feedback mode from a first feedback mode and a second feedback mode, the first feedback mode being used for a TB-level feedback for a terminal device, and the second feedback mode being used for a combination of TB-level and CBG-level feedback for the terminal device; means for generating control information at least in part based on the retransmission feedback mode; and means for transmitting the control information to the terminal device.

[00111] In some embodiments, the means for generating the control information comprises: means for in response to the first feedback mode being selected as the retransmission feedback mode, generating the control information comprising a first bitmap for HARQ processes between the network device and the terminal device, the first bitmap comprising an indication of a TB-level ACK or a TB-level NACK for the HARQ process.

[00112] In some embodiments, the means for generating the control information comprises: means for in response to the second feedback mode being selected as the retransmission feedback mode, generating the control information comprising: a second bitmap for HARQ processes between the network device and the terminal device, the second bitmap indicating feedback levels for the HARQ processes, and a first feedback codebook comprising a plurality of portions corresponding to the HARQ processes, wherein a size of each portion is associated to the respective feedback level for the HARQ process.

[00113] In some embodiments, the means for transmitting the control information to the terminal device comprises: means for transmitting the second bitmap in first DCI and the first feedback codebook in second DCI on a downlink control channel.

[00114] In some embodiments, the first DCI further comprises a first indication for presence of the first feedback codebook.

[00115] In some embodiments, the means for generating control information comprises:

means for in response to the second feedback mode being selected as the retransmission feedback mode, generating the control information comprising: a third bitmap for HARQ processes between the network device and the terminal device, the third bitmap comprising an indication of a TB-level ACK or an indication for retransmission for the HARQ process, and a second feedback codebook comprising a fourth bitmap indicating a feedback level of a first HARQ process corresponding to the indication for retransmission.

[00116] In some embodiments, if the feedback level of the first HARQ process indicated by the fourth bitmap is the CBG-level, the second feedback codebook further comprises: a fifth bitmap corresponding to the first HARQ process, the fifth bitmap comprising an indication of a CBG-level ACK or a CBG-level NACK for the first HARQ process.

[00117] In some embodiments, the means for transmitting the control information to the terminal device comprises: means for transmitting the third bitmap in third DCI and the second feedback codebook in fourth DCI on a downlink control channel.

[00118] In some embodiments, the third DCI further comprises at least one of: a second indication for presence of the second feedback codebook, and a third indication that the third DCI comprises the third bitmap.

[00119] In some embodiments, an apparatus for performing the method 1000 (for example, the terminal device 120) may comprise respective means for performing the corresponding steps in the method 1000. These means may be implemented in any suitable manners. For example, it can be implemented by circuitry or software modules.

[00120] In some embodiments, the apparatus comprises means for receiving, at a terminal device, control information from a network device, a control information indicating a retransmission feedback mode selected from a first feedback mode and a second feedback mode, the first feedback mode being used for a TB-level feedback from the terminal device, and the second feedback mode being used for a combination of TB-level and CBG-level feedback from the terminal device; and means for performing retransmission based on the control information.

[00121] In some embodiments, the means for receiving the control information comprises means for determining whether the control information comprises a first indication for presence of a first feedback codebook or a second indication for presence of a second feedback codebook; and means for in response to determining that the control information comprises neither the first indication nor the second indication, extracting, from the control

information, a first bitmap for HARQ processes between the network device and the terminal device, the first bitmap comprising an indication of a TB-level ACK or a TB-level NACK for the HARQ process.

[00122] In some embodiments, the apparatus further comprises means for in response to determining that the control information comprises the first indication, extracting, from the control information, a second bitmap for HARQ processes between the network device and the terminal device, the second bitmap indicating feedback levels the HARQ processes, and a first feedback codebook comprising a plurality of portions corresponding to the HARQ processes, wherein a size of each portion is associated to the respective feedback level for the HARQ process.

[00123] In some embodiments, the means for receiving the control information from the network device comprises: means for receiving the second bitmap in first DCI and the first feedback codebook in second DCI on a downlink control channel.

[00124] In some embodiments, the first DCI comprises the first indication.

[00125] In some embodiments, the apparatus further comprises means for in response to determining that the control information comprises the second indication, extracting, from the control information, a third bitmap for HARQ processes between the network device and the terminal device, the third bitmap comprising an indication of a TB-level ACK or an indication for retransmission for the HARQ process, and a second feedback codebook comprising a fourth bitmap indicating a feedback level of a first HARQ process corresponding to the indication for retransmission.

[00126] In some embodiments, if the feedback level of the first HARQ process indicated by the fourth bitmap is the CBG-level, the second feedback codebook further comprises: a fifth bitmap corresponding to the first HARQ process, the fifth bitmap comprising an indication of a CBG-level ACK or a CBG-level NACK for the first HARQ process.

[00127] In some embodiments, the means for receiving the control information from the network device comprises: means for receiving the third bitmap in third DCI and the second feedback codebook in fourth DCI on a downlink control channel.

[00128] In some embodiments, the third DCI comprises at least one of: the second indication for presence of the second feedback codebook, and a third indication that the third DCI comprises the third bitmap.

[00129] In some embodiments, the means for performing retransmission based on the control information comprises: means for determining whether the fourth DCI is successfully received; means for in response to determining that the fourth DCI is successfully received, performing retransmission at least in part based on the third bit map and the fourth DCI; and means for in response to determining that the fourth DCI is unsuccessfully received, performing retransmission based on the third bitmap.

[00130] In some embodiments, the means for performing retransmission based on the control information comprises: in response to determining that the third DCI is unsuccessfully received and the fourth DCI is successfully received, performing retransmission at least in part based on the fourth bitmap and fifth bitmap in the fourth DCI.

[00131] Fig. 11 is a simplified block diagram of a device 1100 that is suitable for implementing embodiments of the present disclosure. The device 1100 may be implemented at the network device 110. The device 1100 may also be implemented at the terminal device 120.

[00132] As shown, the device 1100 includes one or more processors 1110, one or more memories 1120 coupled to the processor(s) 1110, one or more transmitters and/or receivers (TX/RX) 1140 coupled to the processor 1110.

[00133] The processor 1110 may be of any type suitable to the local technical network, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multicore processor architecture, as non-limiting examples. The device 1100 may have multiple processors, such as an application specific integrated circuit chip that is slaved in time to a clock which synchronizes the main processor.

[00134] The memory 1120 may be of any type suitable to the local technical network and may be implemented using any suitable data storage technology, such as a non-transitory computer readable storage medium, semiconductor based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory, as non-limiting examples.

[00135] The memory 1120 stores at least a part of a program 1130. The device 1100 may load the program 1130 from the computer readable medium to the RAM for execution. The computer readable medium may include any types of tangible non-volatile storage, such as ROM, EPROM, a flash memory, a hard disk, CD, DVD, and the like. Fig. 12

shows an example of the computer readable medium 1200 in form of CD or DVD. The computer readable medium has the program 1130 stored thereon.

[00136] The TX/RX 1140 is for bidirectional communications. The TX/RX 1140 has at least one antenna to facilitate communication, though in practice an Access Node mentioned in this application may have several ones. The communication interface may represent any interface that is necessary for communication with other network elements.

[00137] The program 1130 is assumed to include program instructions that, when executed by the associated processor 1110, enable the device 1100 to operate in accordance with the embodiments of the present disclosure, as discussed herein with reference to Figs. 5 and 7.

That is, embodiments of the present disclosure can be implemented by computer software executable by the processor 1110 of the device 1100, or by hardware, or by a combination of software and hardware.

[00138] While this specification contains many specific implementation details, these should not be construed as limitations on the scope of any disclosure or of what may be claimed, but rather as descriptions of features that may be specific to particular embodiments of particular disclosures. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable sub-combination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a sub-combination or variation of a sub-combination.

[00139] Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Moreover, the separation of various system components in the embodiments described above should not be understood as requiring such separation in all embodiments, and it should be understood that the described program components and systems can generally be integrated together in a single software product or packaged into

multiple software products.

[00140] Various modifications, adaptations to the foregoing exemplary embodiments of this disclosure may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings. Any
5 and all modifications will still fall within the scope of the non-limiting and exemplary embodiments of this disclosure. Furthermore, other embodiments of the disclosures set forth herein will come to mind to one skilled in the art to which these embodiments of the disclosure pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings.

10 [00141] Therefore, it is to be understood that the embodiments of the disclosure are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are used herein, they are used in a generic and descriptive sense only and not for purpose of limitation.

WHAT IS CLAIMED IS:

1. A method comprising:

selecting, at a network device, a retransmission feedback mode from a first feedback mode and a second feedback mode, the first feedback mode being used for a transmission block (TB)-level feedback for a terminal device, and the second feedback mode being used for a combination of TB-level and code block group (CBG)-level feedback for the terminal device;

generating control information at least in part based on the retransmission feedback mode; and

transmitting the control information to the terminal device.

2. The method of claim 1, wherein generating the control information comprises:

in response to the first feedback mode being selected as the retransmission feedback mode, generating the control information comprising a first bitmap for Hybrid Automatic Repeat Request (HARQ) processes between the network device and the terminal device, the first bitmap comprising an indication of a TB-level ACK or a TB-level NACK for the HARQ process.

3. The method of claim 1, wherein generating control information comprises:

in response to the second feedback mode being selected as the retransmission feedback mode, generating the control information comprising:

a second bitmap for HARQ processes between the network device and the terminal device, the second bitmap indicating feedback levels for the HARQ processes, and

a first feedback codebook comprising a plurality of portions corresponding to the HARQ processes, wherein a size of each portion is associated to the respective feedback level for the HARQ process.

4. The method of claim 3, wherein transmitting the control information to the terminal device comprises:

transmitting the second bitmap in first downlink control information (DCI) and the first feedback codebook in second DCI on a downlink control channel.

5. The method of claim 4, wherein the first DCI further comprises a first indication for presence of the first feedback codebook.

5 6. The method of claim 1, wherein generating control information comprises:
in response to the second feedback mode being selected as the retransmission feedback mode, generating the control information comprising:

a third bitmap for HARQ processes between the network device and the terminal device, the third bitmap comprising an indication of a TB-level ACK or an indication for retransmission for the HARQ process, and

a second feedback codebook comprising a fourth bitmap indicating a feedback level of a first HARQ process corresponding to the indication for retransmission.

15 7. The method of claim 6, wherein if the feedback level of the first HARQ process indicated by the fourth bitmap is the CBG-level, the second feedback codebook further comprises:

a fifth bitmap corresponding to the first HARQ process, the fifth bitmap comprising an indication of a CBG-level ACK or a CBG-level NACK for the first HARQ process.

20 8. The method of claim 6, wherein transmitting the control information to the terminal device comprises:

transmitting the third bitmap in third DCI and the second feedback codebook in fourth DCI on a downlink control channel.

25 9. The method of claim 8, wherein the third DCI further comprises at least one of:

a second indication for presence of the second feedback codebook, and

a third indication that the third DCI comprises the third bitmap.

30 10. A method comprising:
receiving, at a terminal device, control information from a network device, a control information indicating a retransmission feedback mode selected from a first feedback mode and a second feedback mode, the first feedback mode being used for a TB-level feedback

for the terminal device, and the second feedback mode being used for a combination of TB-level and CBG-level feedback for the terminal device; and
performing retransmission based on the control information.

5 11. The method of claim 10, wherein receiving the control information comprising:

 determining whether the control information comprises a first indication for presence of a first feedback codebook or a second indication for presence of a second feedback codebook; and

10 in response to determining that the control information comprises neither the first indication nor the second indication, extracting, from the control information, a first bitmap for HARQ processes between the network device and the terminal device, the first bitmap comprising an indication of a TB-level ACK or a TB-level NACK for the HARQ process.

15 12. The method of claim 11, further comprising:

 in response to determining that the control information comprises the first indication, extracting, from the control information,

 a second bitmap for HARQ processes between the network device and the terminal device, the second bitmap indicating feedback levels the HARQ processes,
20 and

 a first feedback codebook comprising a plurality of portions corresponding to the HARQ processes, wherein a size of each portion is associated to the respective feedback level for the HARQ process.

25 13. The method of claim 12, wherein receiving the control information from the network device comprises:

 receiving the second bitmap in first DCI and the first feedback codebook in second DCI on a downlink control channel.

30 14. The method of claim 13, wherein the first DCI comprises the first indication.

 15. The method of claim 11, further comprising:

 in response to determining that the control information comprises the second indication, extracting, from the control information,

a third bitmap for HARQ processes between the network device and the terminal device, the third bitmap comprising an indication of a TB-level ACK or an indication for retransmission for the HARQ process, and

a second feedback codebook comprising a fourth bitmap indicating a feedback level of a first HARQ process corresponding to the indication for retransmission.

16. The method of claim 15, wherein if the feedback level of the first HARQ process indicated by the fourth bitmap is the CBG-level, the second feedback codebook further comprises:

a fifth bitmap corresponding to the first HARQ process, the fifth bitmap comprising an indication of a CBG-level ACK or a CBG-level NACK for the first HARQ process.

17. The method of claim 15, wherein receiving the control information from the network device comprises:

receiving the third bitmap in third DCI and the second feedback codebook in fourth DCI on a downlink control channel.

18. The method of claim 17, wherein the third DCI comprises at least one of:
the second indication for presence of the second feedback codebook, and
a third indication that the third DCI comprises the third bitmap.

19. The method of claim 18, wherein the performing retransmission based on the control information comprises:

determining whether the fourth DCI is successfully received;
in response to determining that the fourth DCI is successfully received, performing retransmission at least in part based on the third bit map and the fourth DCI; and
in response to determining that the fourth DCI is unsuccessfully received, performing retransmission based on the third bitmap.

20. The method of claim 17, wherein performing retransmission based on the control information comprises:

in response to determining that the third DCI is unsuccessfully received and the fourth DCI is successfully received, performing retransmission at least in part based on the

fourth bitmap and the fifth bitmap in the fourth DCI.

21. A device, comprising:

at least one processor; and

at least one memory including computer program codes;

the at least one memory and the computer program codes are configured to, with the at least one processor, cause the device to perform the method of any of claims 1-9.

22. A device, comprising:

at least one processor; and

at least one memory including computer program codes;

the at least one memory and the computer program codes are configured to, with the at least one processor, cause the device to perform the method of any of claims 10-20.

23. A computer readable storage medium comprising program instructions stored thereon, the instructions, when executed by a processor of a device, causing the device to perform the method of any of claims 1-9.

24. A computer readable storage medium comprising program instructions stored thereon, the instructions, when executed by a processor of a device, causing the device to perform the method of any of claims 10-20.

25. An apparatus, comprising:

means for selecting, at a network device, a retransmission feedback mode from a first feedback mode and a second feedback mode, the first feedback mode being used for a transmission block (TB)-level feedback for a terminal device, and the second feedback mode being used for a combination of TB-level and code block group (CBG)-level feedback for the terminal device;

means for generating control information at least in part based on the retransmission feedback mode; and

means for transmitting the control information to the terminal device.

26. An apparatus, comprising:

means for receiving, at a terminal device, control information from a network device,

a control information indicating a retransmission feedback mode selected from a first feedback mode and a second feedback mode, the first feedback mode being used for a TB-level feedback for the terminal device, and the second feedback mode being used for a combination of TB-level and CBG-level feedback for the terminal device; and

5 means for performing retransmission based on the control information.

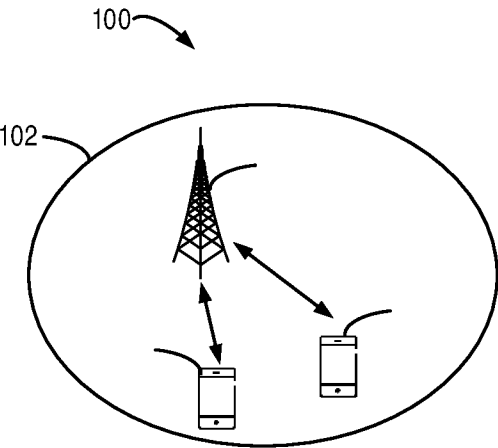


Fig. 1

200

MAX PAYLOAD SIZE=37 BITS

TB/CBG INDICATOR	0	0	0	1	0	1	1	0
	HARQ ID=1	HARQ ID=2	HARQ ID=3	HARQ ID=4	HARQ ID=5	HARQ ID=6	HARQ ID=7	HARQ ID=8
HARQ A/N CODEBOOK	1 BIT TB-LEVEL HARQ A/N	1 BIT TB-LEVEL HARQ A/N	1 BIT TB-LEVEL HARQ A/N	1 BIT TB-LEVEL HARQ A/N	1 BIT TB-LEVEL HARQ A/N	8 BITS CBG-LEVEL HARQ A/N	8 BITS CBG-LEVEL HARQ A/N	1 BIT TB-LEVEL HARQ A/N

Fig. 2

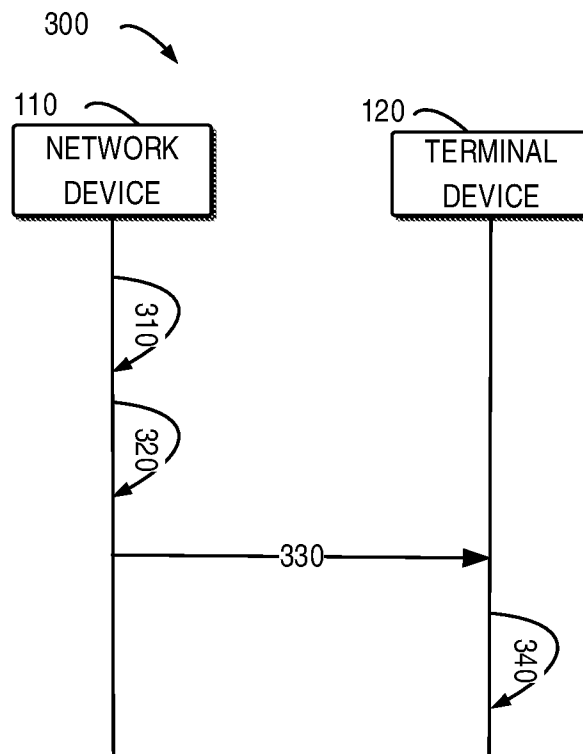


Fig. 3

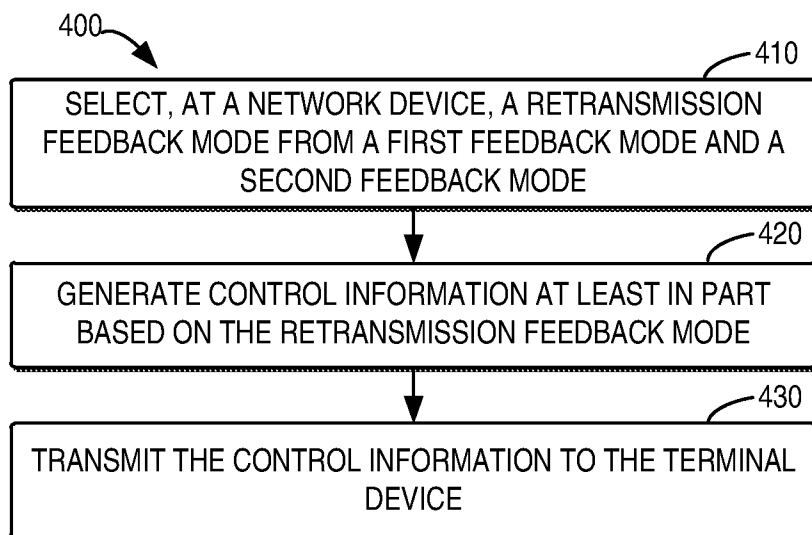


Fig. 4

500

	HARQ ID#1	HARQ ID#2	HARQ ID#3	HARQ ID#4	HARQ ID#5	HARQ ID#6	HARQ ID#7	HARQ ID#8
HARQ FEEDBACK (TB-LEVEL)	0	0	0	1	1	1	1	1

Fig. 5

600

	HARQ ID#1	HARQ ID#2	HARQ ID#3	HARQ ID#4	HARQ ID#5	HARQ ID#6	HARQ ID#7	HARQ ID#8
TB/CBG	1	1	0	1	0	1	1	1

Fig. 6

700

	HARQ ID#1	HARQ ID#2	HARQ ID#3			HARQ ID#4	HARQ ID#5			HARQ ID#6	HARQ ID#7	HARQ ID#8		
HARQ FEEDBACK	0	0	0	1	1	1	0	1	1	1	0	1	1	1

Fig. 7

800

	HARQ ID#1	HARQ ID#2	HARQ ID#3	HARQ ID#4	HARQ ID#5	HARQ ID#6	HARQ ID#7	HARQ ID#8
ACK/RE-TX	1	0	0	1	0	1	1	1

Fig. 8

900										910										920															
		HARQ ID#1		HARQ ID#2		HARQ ID#3		HARQ ID#4		HARQ ID#5		HARQ ID#6		HARQ ID#7		HARQ ID#8						HARQ ID#3				HARQ ID#5									
PRESENCE OF CBG BASED FEEDBACK		1		1		0		1		0		1		1		1		1		HARQ FEEDBACK				0		1		1		1		1		0	

Fig. 9

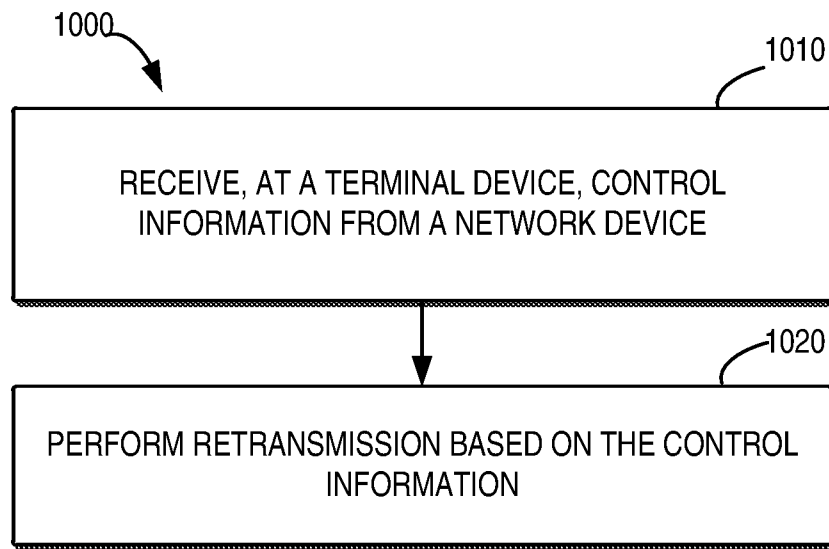


Fig. 10

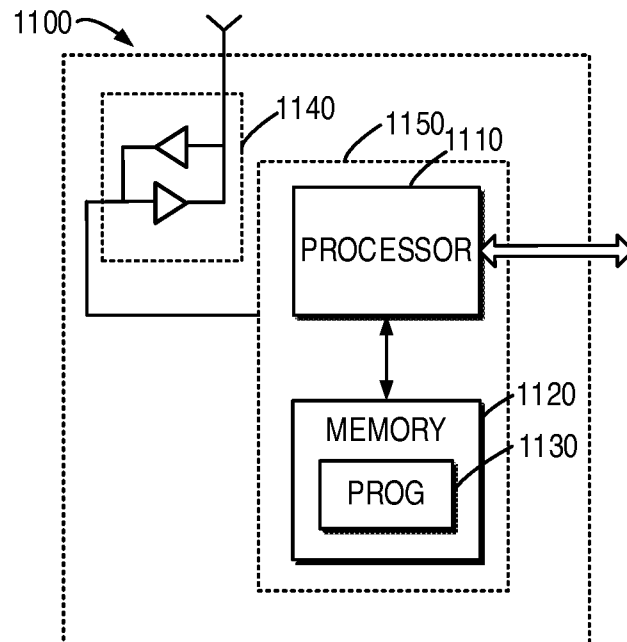


Fig. 11

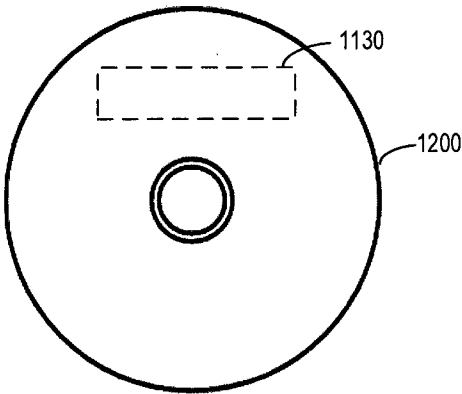


Fig. 12

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/075260

A. CLASSIFICATION OF SUBJECT MATTER

H04L 1/18(2006.01)i

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)

H04L; 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 practicable, search terms used)

CNPAT, WPI, EPODOC, CNKI, 3GPP: retransmission, feedback, control, mode, DCI, information, transmitting, receiving, CBG, TB, block, code, group, reduced, ACK, bitmap, HARQ, flexibility

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016218835 A1 (ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE) 28 July 2016 (2016-07-28) description paragraphs [0028]-[0058]	1-26
A	US 2010111107 A1 (SAMSUNG ELECTRONICS CO., LTD.) 06 May 2010 (2010-05-06) the whole document	1-26
A	US 2012002657 A1 (FUJITSU LIMITED) 05 January 2012 (2012-01-05) the whole document	1-26
A	CN 103718493 A (HUAWEI TECHNOLOGIES CO., LTD.) 09 April 2014 (2014-04-09) the whole document	1-26

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“E” earlier application or patent but published on or after the international filing date

“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

11 October 2019

Date of mailing of the international search report

28 October 2019

Name and mailing address of the ISA/CN

National Intellectual Property Administration, PRC
6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing
100088
China

Authorized officer

YANG, Yingxiao

Facsimile No. (86-10)62019451

Telephone No. 86-(10)-53961572

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2019/075260

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2016218835	A1	28 July 2016	None			
US	2010111107	A1	06 May 2010	EP	2770656	A1	27 August 2014
				CN	102273098	A	07 December 2011
				WO	2010050784	A2	06 May 2010
				KR	20100048496	A	11 May 2010
				EP	2182689	A2	05 May 2010
				US	2017019227	A1	19 January 2017
				CN	104065459	A	24 September 2014
US	2012002657	A1	05 January 2012	WO	2010109521	A1	30 September 2010
				JP	WO2010109521	A1	20 September 2012
				EP	2413627	A1	01 February 2012
CN	103718493	A	09 April 2014	AU	2012387032	A1	05 March 2015
				RU	2015106910	A	27 September 2016
				US	2015155976	A1	04 June 2015
				WO	2014019209	A1	06 February 2014
				EP	2869490	A1	06 May 2015
				BR	112015002353	A2	07 November 2017
				JP	2015530012	A	08 October 2015