HARQ PROCESS–BASED DATA TRANSMISSION METHOD AND TERMINAL

[0001]

TECHNICAL FIELD

[0002] This application relates to the field of communication technologies, and in particular, to a hybrid automatic repeat request (Hybrid Automatic Repeat request, HARQ) process–based data transmission method and a terminal.

BACKGROUND

[0003] In a new radio (new radio, NR)–based access to unlicensed spectrum (NR-based access to unlicensed spectrum, NR-U) technology, a terminal supports a plurality of configured grant configurations (configured grant configurations, CG configurations) on one activated bandwidth part (bandwidth part, BWP). The CG configuration represents a resource required for uplink transmission (that is, uplink data transmission) preconfigured by a network device for the terminal, and the plurality of CG configurations may share a HARQ process (namely, a HARQ process).

[0004] The terminal starts to send uplink data by using a HARQ process that is associated with a CG configuration, and starts a configured grant timer (configured grant timer, CGT) and a configured grant retransmission timer (configured grant retransmission timer, CGRT) when the uplink data is successfully sent by using a listen before talk (Listen Before Talk, LBT) mechanism. The CGT is used to limit total duration of a process of transmitting one piece of uplink data, and the CGRT is used to limit a transmission interval between retransmissions in the process of transmitting one piece of uplink data. The process of transmitting one piece of uplink data includes new transmission and retransmission for the same piece of uplink data. The new transmission

[0083] The memory 22 may be a read-only memory (Read-Only Memory, ROM) or another type of static storage device that can store static information and instructions, a random access memory (Random Access Memory, RAM) or another type of dynamic storage device that can store information and instructions, or may be an electrically erasable programmable read-only memory (Electrically Erasable Programmable Read-Only Memory, EEPROM), a compact disc read-only memory (Compact Disc Read-Only Memory, CD-ROM) or another compact disc storage, an optical disc storage (including compact optical disc, a laser disc, an optical disc, a digital versatile disc, a Blu-ray disc, or the like), a magnetic disk storage medium or another magnetic storage device, or any other medium that can be used to carry or store expected program code in a form of instructions or a data structure and that can be accessed by a computer. However, the memory 22 is not limited thereto. The memory 22 may exist independently and be connected to the processor 21 through the bus 24. Alternatively, the memory 22 may be integrated with the processor 21. The memory 22 is configured to store a software program that executes the solutions of this application, and the processor 21 controls execution.

[0084] The communication interface 23 is configured to communicate with another device or a communication network, for example, is configured to communicate with a communication network such as an ethernet, a radio access network (radio access network, RAN) a wireless local area network (Wireless Local Area Network, WLAN). The communication interface 23 may include a receiving unit for implementing a receiving function and a sending unit for implementing a sending function.

[0085] The bus 24 may be an industry standard architecture (Industry Standard Architecture, ISA) bus, a peripheral component interconnect (Peripheral Component Interconnect, PCI) bus, an extended industry standard architecture (Extended Industry Standard Architecture, EISA) bus, or the like. The bus may be classified into an address bus, a data bus, a control bus, and the like. For ease of representation, in FIG. 2, only one thick line is used for representation, but it does not mean that there is only one bus or only one type of bus.

[0086] The structure of the device shown in FIG. 2 imposes no limitation on the terminal. The terminal may include components more or fewer than those shown in the figure, combine a part of components, or have different component arrangements. Although not shown, the terminal may further include a battery, a camera, a Bluetooth module, a global positioning system (Global Positioning System, GPS) module, a display, and the like. Details are not described herein.

[0087] The following describes terms used in embodiments of this application.

[0088] (1) LBT channel contention access technology: Before data transmission, a channel occupation status of an unlicensed spectrum may be monitored, and a channel can be used only when a condition for an idle channel is met. Because the unlicensed spectrum is a shared spectrum, many air interface technologies use the unlicensed spectrum, for example, Wi-Fi, a licensed Assisted access (Licensed Assisted Access, LAA) based on long term evolution (Long Term Evolution, LTE), and a MulteFire technology. To ensure that a plurality of air interface technologies coexist on the unlicensed spectrum, an LBT mechanism is used to avoid mutual interference between the plurality of air interface technologies.

[0089] An LBT failure means that a channel fails to be occupied because the channel is busy, and a signal (for example, data or an instruction) cannot be transmitted. An LBT success means that a channel is successfully occupied and data is transmitted. For different signal transmission directions, transmission signals are classified into uplink transmission and downlink transmission. The uplink transmission means that a terminal transmits a signal to a network device through a channel. The channel used for the uplink transmission is referred to as an uplink channel. The signal in the uplink transmission is referred to as an uplink signal (for example, uplink data or an uplink instruction). The downlink transmission means that a network device transmits a signal to a terminal through a channel. The channel used for the downlink transmission is referred to as a downlink channel. The signal in the downlink transmission is referred to as a downlink signal (for example, downlink data or a downlink instruction). Correspondingly, LBT is classified into uplink LBT and downlink LBT. The uplink LBT means that a terminal monitors a channel occupation status of an unlicensed spectrum before uplink transmission, and the downlink LBT means that a network device monitors a channel occupation status of an unlicensed spectrum before downlink transmission.

[0090] Channel access processes in which the LBT is used are classified into two types. A first type is energy detection based on fixed duration. A transmitting end (a terminal or a network device) detects a signal strength of a channel in an unlicensed spectrum. If the signal strength is greater than a preset threshold, it is considered that the channel is busy; if the signal strength is not greater than a preset threshold, it is considered that the channel is idle. A second type is energy detection based on a backoff mechanism. The transmitting end (the terminal or the network device) randomly selects a value A from a value range (for example, a window [min, max], where min is

Correction, FEC) technology and an automatic repeat request (Automatic Repeat Request, ARQ) technology. The FEC technology may be used to improve communication trustworthiness. However, in a unidirectional communication channel (for example, an LTE FDD system), when a receiving end receives a data packet (for example, uplink data) sent by a transmitting end, if the receiving end detects an uncorrectable error, the receiving end cannot request the transmitting end to retransmit the data packet. In the HARQ technology, however, the receiving end may request, by using an ARQ mechanism, the transmitting end to retransmit the data packet. Specifically, the receiving end may check, by using a cyclic redundancy check (Cyclic Redundancy Check, CRC), whether the received data packet is incorrect. If the data packet is correct, the receiving end returns an ACK feedback of the data packet to the transmitting end; or if the data packet is incorrect, the receiving end sends a NACK feedback of the data packet to the transmitting end, and the receiving end retransmits the data packet to the receiving end after receiving the NACK feedback of the data packet.

[0098] Uplink data transmission is used as an example. The network device (namely, the receiving end) receives uplink data sent by the terminal (namely, the transmitting end) by using the HARQ process on a resource indicated by an uplink grant (uplink grant, UL grant). If the network device correctly receives the uplink data, a status of HARQ feedback performed by the network device on a downlink is an ACK (namely, the network device feeds back an ACK feedback of the uplink data to the terminal). If the network device does not correctly receive the uplink data, the status of the HARQ feedback performed by the network device on the downlink is a NACK (namely, the network device feeds back a NACK feedback of the uplink data to the terminal). In other words, the HARQ feedback being the ACK indicates that the network device correctly receives the uplink data, and the HARQ feedback being the NACK indicates that the network device does not correctly receive the uplink data. Then, if receiving the NACK fed back by the network device, the terminal retransmits the uplink data to the network device, so that the network device can perform HARQ combination on the retransmitted uplink data and the uplink data that is not correctly received.

[0099] Generally, the terminal may perform, by using the HARQ process, uplink transmission on the resource indicated by the UL grant. For example, an uplink grant that is associated with the HARQ process is delivered to a HARQ entity of the terminal, so that the uplink data is sent on a resource indicated by the uplink grant that is associated with the HARQ process. The uplink grant

may be a dynamic grant (dynamic grant, DG) dynamically scheduled by the network terminal, or may be a configured grant CG of the network terminal. One HARQ entity of the terminal may maintain a plurality of parallel HARQ processes. Each HARQ process has one HARQ identifier (identifier, ID), and different HARQ processes may be distinguished by using HARQ IDs.

[00100] (4) CG configuration: The CG configuration refers to a resource that is required for uplink transmission and that is preconfigured by a network device in an NR-U for a terminal. The preconfigured resource required for the uplink transmission may be referred to as the CG configuration or a preconfigured uplink grant configuration. The terminal can perform the uplink transmission on the CG configuration without dynamic scheduling of the network device. The CG configuration includes but is not limited to two preconfigured grant resources used in a 5th generation (5th Generation, 5G) mobile communication technology. The two preconfigured grant resources used in the 5G are respectively obtained in two grant types. The two grant types include a configured grant type 1 (configured grant type 1) and a configured grant type 2 (configured grant type 2).

[00101] The configured grant type 1 means that the network device preconfigures, for the terminal in a semi-static configuration manner, the resource (the CG configuration) required for the uplink transmission, that is, periodically configures an activated CG configuration, and the terminal does not need to obtain an uplink grant of the CG configuration from the network device each time before sending uplink data. For example, the network device may configure, for the terminal by using RRC signaling, the CG configuration that is used for the uplink transmission, where the RRC signaling may further include a period of the CG configuration.

[00102] The configured grant type 2 means that the network device may configure, for the terminal by using the RRC signaling, some information that is used for the uplink transmission, for example, the period of the CG configuration that is used for the uplink transmission. Then, the network device activates the CG configuration by using physical layer signaling that carries the CG configuration used for the uplink transmission, so that the terminal can perform the uplink transmission in the CG configuration. The physical layer signaling includes DCI.

[00103] It should be noted that names of the foregoing two grant types are not limited to the configured grant type 1 and the configured grant type 2, and may further have other names. Names of the two grant types are not limited in this embodiment of this application. In addition to a 5G communication system, a communication system to which the foregoing two grant types are

consecutive uplink LBT failures occur on the first BWP, indicating that the HARQ process being used on the first BWP may be in the pending status. In this case, the terminal sets all the HARQ processes that are associated with the second CG configuration on the first BWP to be in the not pending status. The terminal may set all the HARQ processes that are associated with the second CG configuration on the first BWP to be in the not pending status by clearing the buffers of all the HARQ processes that are associated with the second CG configuration on the first BWP or setting all the HARQ processes that are associated with the second CG configuration to be in the not pending status. It may be understood that all the HARQ processes that are associated with the second CG configuration may include a HARQ process that is in the pending status on the first BWP. Therefore, all the HARQ processes that are associated with the second CG configuration on the first BWP may be set to be in the not pending status by clearing the buffers of all the HARQ processes that are associated with the second CG configuration on the first BWP or setting all the HARQ processes that are associated with the second CG configuration to be in the not pending status.

[00165] In this way, a problem that a status of a HARQ process in the pending status on the first BWP (namely, the BWP that is not switched) is not processed when the terminal performs BWP switching is resolved. Further, a CG configuration of the terminal on a second BWP (namely, a BWP that is switched to) may be associated with the HARQ process in the pending status on the first BWP. Because the HARQ process in the pending status on the first BWP has been set to be in the not pending status, the HARQ process can be used for new transmission on the BWP that is switched to.

[00166] In some embodiments, if determining that the N consecutive uplink LBT failures occur on the first BWP, when sending a MAC CE to the network device, the terminal clears the buffers of all the HARQ processes that are associated with the second CG configuration on the first BWP, or sets all the HARQ processes that are associated with the second CG configuration on the first BWP to be in the not pending status. The MAC CE includes an LBT failure status indicator bit of a serving cell in which the terminal is located.

[00167] The sending of the media access control control element MAC CE to the network device may mean that the terminal successfully sends the MAC CE. Specifically, if the terminal receives an LBT success indication that is from a physical layer (physical layer, PHY) and that is related to the MAC CE, it indicates that the MAC CE can be successfully sent, and it is considered

CLAIMS

1. A hybrid automatic repeat request, HARQ process–based data transmission method, wherein the method is applied to a terminal, and the method comprises:

if receiving a downlink control information, DCI activation command from a network device, determining that one or more HARQ processes that are associated with a first configured grant, CG configuration are in a not pending status, wherein the DCI activation command indicates the terminal to activate the first CG configuration, wherein the first CG configuration comprises one or more CG configurations configured by a network device for the terminal on the first bandwidth part, BWP, and the first BWP is a currently activated BWP of the terminal; and

sending uplink data to the network device by using a HARQ process that is associated with the first CG configuration and that is in the not pending status.

2. A hybrid automatic repeat request, HARQ process–based data transmission method, wherein the method is applied to a terminal, and the method comprises:

if receiving radio resource control, RRC signaling from a network device, determining that one or more HARQ processes that are associated with a first configured grant, CG configuration are in a not pending status, wherein the RRC signaling is used to configure and activate the first CG configuration for the terminal, wherein the first CG configuration comprises one or more CG configurations configured by the network device for the terminal on the first bandwidth part, BWP, and the first BWP is a currently activated BWP of the terminal; and

sending uplink data to the network device by using a HARQ process that is associated with the first CG configuration and that is in the not pending status.

3. The method according to claim 1 or 2, wherein the one or more HARQ processes that are associated with the first CG configuration comprise:

all HARQ processes that are associated with the first CG configuration;

a HARQ process that is one of the HARQ processes that are associated with the first CG configuration and that is in a pending status;

a first HARQ process that is one of the HARQ processes that are associated with the first CG configuration, wherein no uplink grant that is associated with the first HARQ process exists in uplink grant currently delivered to a HARQ entity, and that no uplink grant that is associated with the first HARQ process exists in uplink grant currently delivered to a HARQ entity indicates that

the first HARQ process is not used by the terminal;

a HARQ process that is one of the HARQ processes that are associated with the first CG configuration and that is not being used; or

a corresponding HARQ process that is one of the HARQ processes that are associated with the first CG configuration, wherein the corresponding HARQ process is a HARQ process randomly selected by the terminal.

4. The method according to any one of claims 1 to 3, wherein the method further comprises:

if it is determined that N consecutive uplink listen before talk, LBT failures occur on the first BWP, clearing buffers of all HARQ processes that are associated with a second CG configuration on the first BWP, or determining that all HARQ processes that are associated with a second CG configuration on the first BWP are in the not pending status, wherein

$N \geq 2$, and N is an integer; the second CG configuration comprises all CG configurations configured by the network device for the terminal on the first BWP or an activated CG configuration for the terminal on the first BWP; and after the buffers of all the HARQ processes that are associated with the second CG configuration are cleared, all the HARQ processes that are associated with the second CG configuration are in the not pending status.

5. The method according to claim 4, wherein the clearing buffers of all HARQ processes that are associated with a second CG configuration on the first BWP, or determining that all HARQ processes that are associated with a second CG configuration on the first BWP are in the not pending status comprises:

when sending a media access control control element, MAC CE to the network device, clearing the buffers of all the HARQ processes that are associated with the second CG configuration, or determining that all the HARQ processes that are associated with the second CG configuration are in the not pending status, wherein

the MAC CE comprises an LBT failure status indicator bit of a serving cell in which the terminal is located.

6. The method according to claim 4, wherein the clearing buffers of all HARQ processes that are associated with a second CG configuration on the first BWP, or determining that all HARQ processes that are associated with a second CG configuration on the first BWP are in the not pending status comprises:

when the terminal is located in a primary cell or a primary secondary cell, and the terminal

actively switches from the first BWP to a second BWP, clearing the buffers of all the HARQ processes that are associated with the second CG configuration, or determining that all the HARQ processes that are associated with the second CG configuration are in the not pending status, wherein

the second BWP is a BWP that is configured with a physical random access channel, PRACH resource and on which the N consecutive uplink LBT failures do not occur, and the second BWP and the first BWP belong to a same serving cell.

7. The method according to claim 4, wherein the clearing buffers of all HARQ processes that are associated with a second CG configuration on the first BWP, or determining that all HARQ processes that are associated with a second CG configuration on the first BWP are in the not pending status comprises:

receiving a BWP switching instruction from the network device; and

in response to the BWP switching instruction, clearing the buffers of all the HARQ processes that are associated with the second CG configuration, or determining that all the HARQ processes that are associated with the second CG configuration are in the not pending status.

8. The method according to any one of claims 1 to 7, wherein the method further comprises:

determining, each time by the terminal that the HARQ process that is used to send the uplink data is used for new transmission or retransmission, and determining whether the HARQ process that is used to send the uplink data is in the pending status;

if the HARQ process that is used to send the uplink data is in the pending status, increasing a quantity of pending times recorded by a pending counter by 1, wherein an initial value of the quantity of pending times recorded by the pending counter is zero; and

if the quantity of pending times recorded by the pending counter is equal to a preset quantity-of-times threshold, clearing, by the terminal, a buffer of the HARQ process that is used to send the uplink data, or determining that the HARQ process that is used to send the uplink data is in the not pending status, wherein after the buffer of the HARQ process that is used to send the uplink data is cleared, the HARQ process that is used to send the uplink data is in the not pending status.

9. The method according to any one of claims 1 to 9, wherein the method further comprises:

determining, each time by the terminal that the HARQ process that is used to send the uplink data is used for new transmission or retransmission, and determining whether the HARQ process that is used to send the uplink data is in the pending status or the not pending status;

determining that the HARQ process that is used to send the uplink data is in the pending status and a pending timer is not started, and starting the pending timer, wherein the pending timer is used to count total duration during which the HARQ process that is used to send the uplink data is in the pending status in a process of transmitting the uplink data;

determining that the HARQ process that is used to send the uplink data is in the not pending status and the pending timer is running, and stopping the pending timer; and

if timing duration of the pending timer is equal to a preset duration threshold, clearing, by the terminal, a buffer of the HARQ process that is used to send the uplink data, or determining that the HARQ process that is used to send the uplink data is in the not pending status, wherein after the buffer of the HARQ process that is used to send the uplink data is cleared, the HARQ process that is used to send the uplink data is in the not pending status.

10. A communication apparatus, comprising a processor and a memory, wherein the processor is coupled to the memory, and the processor is configured to control the apparatus to implement the method according to any one of claims 1 to 9.

11. A computer readable medium, wherein the medium comprises computer readable instructions, and when the computer readable instructions are run on a terminal, the terminal is enabled to perform the method according to any one of claims 1 to 10.

12. A computer program product, wherein the computer program product comprises instructions, and when the instructions are run by a computer, the method according to any one of claims 1 to 10 is implemented.

13. A communication system, wherein the communication system comprises the apparatus to implement the method according to any one of claims 1 to 9 and a network device.