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(71) Demandeur/Applicant:
HUAWEI TECHNOLOGIES CO., LTD., CN
(72) Inventeurs/Inventors:
SUN, HAO, CN;
HUANG, WENWEN, CN;
CHENG, YAN, CN
(74) Agent: GOWLING WLG (CANADA) LLP

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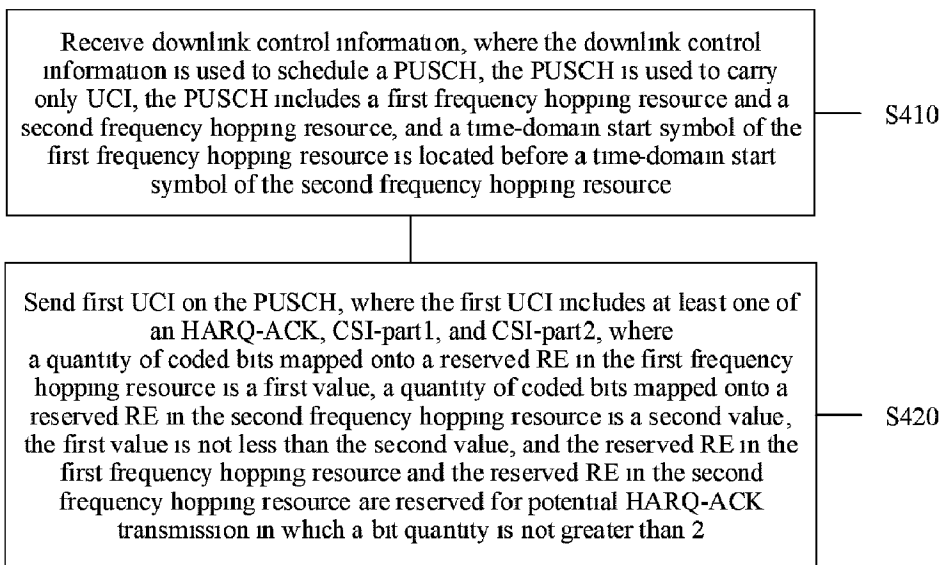


FIG. 4

(57) **Abrégé/Abstract:**

Provided is a method for performing communication in a UCI-only scenario, comprising: receiving downlink control information for scheduling a PUSCH, the PUSCH comprising a first frequency hopping resource and a second frequency hopping resource, and

(57) **Abrégé(suite)/Abstract(continued):**

a time-domain start symbol of the first frequency hopping resource being positioned before a time-domain start symbol of the second frequency hopping resource; and transmitting first UCI on the PUSCH, the first UCI comprising at least one of an HARQ-ACK, a CSI-part1 and a CSI-part2, wherein a quantity of coded bits mapped to reserved REs in the first frequency hopping resource is greater than or equal to a quantity of coded bits mapped to reserved REs in the second frequency hopping resource. In the above solution, a quantity of coded bits to be mapped to reserved REs in the second frequency hopping resource is reduced, such that a quantity of REs in the second frequency hopping resource to which a CSI-part1 can be mapped is increased, thereby solving the problem of an incomplete transmission of a CSI-part1 as a result of a frequency hopping transmission of UCI.

ABSTRACT

This application provides a communication method in a UCI-only scenario. The method includes: receiving downlink control information used to schedule a PUSCH, where the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and sending first UCI on the PUSCH, where the first UCI includes at least one of an HARQ-ACK, CSI-part1, and CSI-part2, where a quantity of coded bits that can be mapped onto reserved REs in the first frequency hopping resource is greater than or equal to a quantity of coded bits that can be mapped onto reserved REs in the second frequency hopping resource. In the foregoing solution, the quantity of coded bits that can be mapped onto the RE in the second frequency hopping resource is reduced, and a quantity of REs that are in the second frequency hopping resource and that are used to map the CSI-part1 is increased, resolving a problem that due to UCI transmission through frequency hopping, the CSI-part1 is incompletely sent.

COMMUNICATION METHOD AND COMMUNICATIONS APPARATUS

[0001] This application claims priority to Chinese Patent Application No. 201810910306.9, filed with the Chinese Patent Office on August 10, 2018 and entitled "COMMUNICATION
5 METHOD AND COMMUNICATIONS APPARATUS", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] This application relates to the communications field, and in particular, to a communication method and a communications apparatus.

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BACKGROUND

[0003] In a 5th generation (the 5th generation, 5G) mobile communications system, transmission of uplink control information (uplink control information, UCI) is supported on a physical uplink shared channel (physical uplink shared channel, PUSCH), and there is a scenario in which only the UCI is sent and the uplink shared channel (uplink shared channel, UL-SCH) is
15 not sent, that is, there is a UCI-only scenario.

[0004] In the UCI-only scenario, the sent UCI includes a hybrid automatic repeat request-acknowledgement (hybrid automatic repeat request acknowledgement, HARQ-ACK), a channel state information part 1 (channel state information part 1, CSI-part1), and a channel state information part 2 (CSI-part2). Requirements of the three types of information for a protection
20 level are lowered in the foregoing order. Therefore, when mapping the foregoing three types of information to resources, the terminal device sequentially maps, based on channel estimation quality, the HARQ-ACK, the CSI-part1, and the CSI-part2 to resource elements (resource element, RE) that can carry data and that are of the PUSCH.

[0005] To obtain a frequency hopping gain, the PUSCH may be divided into two parts in time

domain, where the two parts are respectively referred to as a first hop (hop 1) and a second hop (hop 2). To obtain a maximum frequency hopping gain, frequency domain resources on the hop 1 and the hop 2 are generally far away from each other and at least do not exactly overlap. Correspondingly, the HARQ-ACK, the CSI-part1, and the CSI-part2 are also mapped to the hop 1 and the hop 2 according to a preset rule. However, information in the CSI-part1 mapped to the frequency hopping resources is incompletely sent, that is, a part of the CSI-part1 fails to be transmitted. This adversely affects application of UCI transmission through frequency hopping in the UCI-only scenario.

SUMMARY

10 [0006] This application provides a communication method and a communications apparatus. A CSI-part1 mapping rule is changed, to resolve a problem that due to UCI transmission through frequency hopping in a UCI-only scenario, information in CSI-part1 is incompletely sent.

[0007] According to a first aspect, a communication method is provided, and includes: receiving downlink control information, where the downlink control information is used to schedule a PUSCH, the PUSCH is used to carry only UCI, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and sending first UCI on the PUSCH, where the first UCI includes at least one of an HARQ-ACK, CSI-part1, and CSI-part2, where a quantity of coded bits that can be mapped onto reserved REs in the first frequency hopping resource is a first value, a quantity of coded bits that can be mapped onto reserved REs in the second frequency hopping resource is a second value, the first value is not less than the second value, and the reserved RE in the first frequency hopping resource and the reserved RE in the second frequency hopping resource are reserved for transmitting potential HARQ-ACK which has less than or equal to 2 bits. A peer device of the device that performs the foregoing method may correspondingly perform steps of sending the downlink control information and receiving the first UCI on the PUSCH. It should be noted herein that, that the PUSCH includes a first frequency hopping resource and a second frequency hopping resource means that when a frequency hopping identifier field in uplink grant (UL grant) DCI indicated by a network device enables frequency hopping for the PUSCH, a time-frequency

domain resource of the PUSCH in a first hop and a time-frequency domain resource of the PUSCH in a second hop are respectively referred to as the first frequency hopping resource and the second frequency hopping resource. To distinguish between the first frequency hopping resource and the second frequency hopping resource of the PUSCH in this application, there is a sequential relationship between a start time of the first frequency hopping resource and a start time of the second frequency hopping resource. In addition, a value of a quantity of coded bits mapped onto a specific quantity of REs of the PUSCH is equal to the quantity of REs multiplied by a quantity of transmission layers of the PUSCH and then multiplied by a modulation order of UCI potentially transmitted on the PUSCH.

10 [0008] A reason that information in the CSI-part1 is incompletely sent is that a quantity of coded bits that are of the CSI-part1 and that are mapped onto the second frequency hopping resource is relatively small. In other words, a quantity of REs on the second frequency hopping resource that are used to map the CSI-part1 is relatively small, and consequently, the CSI-part1 cannot be all mapped onto the second frequency hopping resource. Compared with the prior art, 15 this application reduces a quantity of coded bits that are capable of being mapped onto reserved REs in the second frequency hopping resource, thereby increasing a quantity of REs that are in the second frequency hopping resource and that are used to map the CSI-part1. This resolves a problem that due to UCI transmission through frequency hopping in a UCI-only scenario, information in the CSI-part1 is incompletely sent.

20 [0009] Optionally, the method further includes: determining a first quantity G_{rvd}^{ACK} of coded bits, where G_{rvd}^{ACK} is a sum of the quantities of coded bits mapped onto the reserved REs in the first frequency hopping resource and the second frequency hopping resource, and both the first value and the second value are determined based on G_{rvd}^{ACK} .

[0010] The "sum of the quantities of coded bits mapped onto the reserved REs in the first 25 frequency hopping resource and the second frequency hopping resource" refers to a sum of a quantity of coded bits that are capable of being mapped onto the reserved RE in the first frequency hopping resource and a quantity of coded bits that are capable of being mapped onto the reserved RE in the second frequency hopping resource, but should not be understood as a sum of a quantity of coded bits actually mapped onto the reserved RE in the first frequency hopping resource and a 30 quantity of coded bits actually mapped onto the reserved RE in the second frequency hopping

resource.

[0011] Optionally, the first value is $G_{\text{rvd}}^{\text{ACK}}(1)$, and $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$;

and/or the second value is $G_{\text{rvd}}^{\text{ACK}}(2)$, and $G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$, where N_L is

a quantity of transmission layers of the PUSCH, and Q_m is a modulation order of the first UCI,

5 namely, a modulation order of the UCI transmitted on the PUSCH.

[0012] Optionally, $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$, and $G_{\text{rvd}}^{\text{ACK}}(2) = G_{\text{rvd}}^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(1)$;

or

$$G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor, \text{ and } G_{\text{rvd}}^{\text{ACK}}(1) = G_{\text{rvd}}^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(2).$$

[0013] Optionally, the method further includes: determining a quantity G^{ACK} of coded bits

10 of the HARQ-ACK in the first UCI, where a quantity of coded bits that are of the HARQ-ACK in

the first UCI and that are mapped onto the first frequency hopping resource is $G^{\text{ACK}}(1)$, and a

value of $G^{\text{ACK}}(1)$ is a smaller one of the following two values:

a quantity of coded bits mapped onto an RE that is after a first group of consecutive demodulation reference signal (demodulation reference signal, DMRS) symbols on the first
15 frequency hopping resource and that are capable of being used to carry data, and a third value that is determined based on G^{ACK} .

[0014] If the quantity of coded bits that are of the HARQ-ACK in the first UCI and that are capable of being mapped onto the first frequency hopping resource exceeds a bearer capability of the first frequency hopping resource, a terminal device may determine, based on the bearer

20 capability of the first frequency hopping resource, the quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the first frequency hopping resource. Otherwise,

the terminal device may determine, based on the quantity (for example,

$N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$) of coded bits that are of the HARQ-ACK in the first UCI and that

are capable of being mapped onto the first frequency hopping resource, the quantity of coded bits

25 that are of the HARQ-ACK and that are mapped onto the first frequency hopping resource.

[0015] Optionally, a value of the quantity of coded bits mapped onto the RE that is after the first group of consecutive DMRS symbols on the first frequency hopping resource and that are

capable of being used to carry data is equal to $M_3 \cdot N_L \cdot Q_m$, where M_3 is a quantity of REs that are after the first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data, N_L is the quantity of transmission layers of the PUSCH, Q_m is the modulation order of the first UCI, and the third value is

5 $N_L \cdot Q_m \cdot \lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$.

[0016] The quantity of bits of the HARQ-ACK in the first UCI is not greater than 2.

[0017] The foregoing solution is content described in a formula

$$G^{\text{ACK}}(1) = \min\left(N_L \cdot Q_m \cdot \lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil, M_3 \cdot N_L \cdot Q_m\right).$$

[0018] Optionally, a quantity of coded bits that are of the HARQ-ACK in the first UCI and

10 that are mapped onto the second frequency hopping resource is $G^{\text{ACK}}(2)$, where

$$G^{\text{ACK}}(2) = G^{\text{ACK}} - G^{\text{ACK}}(1).$$

[0019] According to a second aspect, this application further provides a communication method, including: receiving downlink control information, where the downlink control information is used to schedule a PUSCH, the PUSCH is used to carry only UCI, the PUSCH

15 includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and sending first UCI on the PUSCH, where the first UCI includes at least one of an HARQ-ACK, CSI-part1, and CSI-part2. A peer device correspondingly performs steps of sending the downlink control information and receiving the first

20 UCI.

[0020] A quantity $G^{\text{CSI-part1}}(1)$ of coded bits that are of the CSI-part1 in the first UCI and that are mapped onto the first frequency hopping resource is a smaller one of a fourth value and a fifth value, the fourth value is determined based on a quantity $G^{\text{CSI-part1}}$ of coded bits of the CSI-part1 in the first UCI, and the fifth value is determined based on a larger value in $G^{\text{ACK}}(1)$ and

25 $G^{\text{ACK}}_{\text{rvd}}(1)$, or the fifth value is determined based on $G^{\text{ACK}}(1)$, where $G^{\text{ACK}}(1)$ is a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the first frequency hopping resource, and $G^{\text{ACK}}_{\text{rvd}}(1)$ is a quantity of coded bits that can be mapped onto reserved REs

in the first frequency hopping resource.

[0021] In the prior art, the fifth value is determined based only on $G^{\text{ACK}}(1)$. For example, the fifth value is $M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)$ in the prior art, and this parameter sets an upper limit (namely, a first upper limit) for a resource occupied by the CSI-part1 on the first frequency hopping resource. In addition, the CSI-part1 cannot occupy the reserved RE in the first frequency hopping resource. That is, $G^{\text{CSI-part1}}(1)$ should also not be greater than an upper limit $M_1 \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}}(1)$ (namely, a second upper limit). When the quantity of HARQ-ACK information bits is 0, 1, or 2, $G^{\text{ACK}}(1)$ is a quantity of coded bits that is calculated based on an actual quantity of HARQ-ACK information bits, and $G_{\text{rvd}}^{\text{ACK}}$ is a quantity that is of coded bits mapped onto the reserved RE and that is calculated based on the quantity of HARQ-ACK information bits being 2. Therefore, if the actual quantity of HARQ-ACK information bits is 0 or 1, $G^{\text{ACK}} < G_{\text{rvd}}^{\text{ACK}}$, and $G^{\text{ACK}}(1) < G_{\text{rvd}}^{\text{ACK}}(1)$. That is, on the first frequency hopping resource, $G^{\text{ACK}} < G_{\text{rvd}}^{\text{ACK}}$. In this case, the first upper limit is greater than the second upper limit. In the prior art, if the fifth value is determined based only on $G^{\text{ACK}}(1)$, a non-reserved RE in the first frequency hopping resource may be insufficient for carrying the quantity $G^{\text{CSI-part1}}(1)$ of coded bits of the CSI-part1 on the first frequency hopping resource.

[0022] In the solution provided in this application, the fifth value is determined based on the larger one of $G^{\text{ACK}}(1)$ and $G_{\text{rvd}}^{\text{ACK}}(1)$ (where when the quantity of HARQ-ACK bits is greater than 2, $G_{\text{rvd}}^{\text{ACK}}(1)$ is equal to 0), to ensure that $G^{\text{CSI-part1}}(1)$ is calculated by using an actual non-reserved RE in the first frequency hopping resource as a reference, thereby avoiding the foregoing problem that the CSI-part1 is incompletely sent.

[0023] Optionally, that the fifth value is determined based on a larger value in $G^{\text{ACK}}(1)$ and $G_{\text{rvd}}^{\text{ACK}}(1)$ includes that the fifth value is equal to $M_1 \cdot N_L \cdot Q_m - \max(G^{\text{ACK}}(1), G_{\text{rvd}}^{\text{ACK}}(1))$; or that the fifth value is determined based on $G^{\text{ACK}}(1)$ includes: the fifth value is equal to $M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)$ when the quantity of HARQ-ACK bits is greater than 2; or the fifth

value is equal to $M_1 \cdot N_L \cdot Q_m - \max(G^{\text{ACK}}(1), G_{\text{rvd}}^{\text{ACK}}(1))$ when the quantity of HARQ-ACK bits is less than or equal to 2.

[0024] M_1 is a quantity of REs that can carry data and that are in the first frequency hopping resource, N_L is a quantity of transmission layers of the PUSCH, and Q_m is a modulation order of the first UCI.

[0025] Optionally, that the fourth value is determined based on a quantity $G^{\text{CSI-part1}}$ of coded bits of the CSI-part1 in the first UCI includes: the fourth value is equal to $N_L \cdot Q_m \cdot \lfloor G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \rfloor$, where N_L is the quantity of transmission layers of the PUSCH, and Q_m is the modulation order of the first UCI.

[0026] The solution provided in the second aspect may be separately implemented, or may be jointly implemented with the solution provided in the first aspect.

[0027] According to a third aspect, a communication method is provided, and includes:

receiving indication information, where the indication information is used to schedule a physical uplink shared channel PUSCH, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and sending first UCI on the PUSCH, where the first UCI includes at least one of a transmission hybrid automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2, where a quantity of coded bits that can be mapped onto reserved resource elements REs in the first frequency hopping resource is a first value, a quantity of coded bits mapped onto reserved REs in the second frequency hopping resource is a second value, the first value is not less than the second value, and the reserved RE in the first frequency hopping resource and the reserved RE in the second frequency hopping resource are reserved for potential HARQ-ACK transmission in which a bit quantity is not greater than 2.

[0028] Optionally, the method may be performed by a terminal device, or may be performed by an apparatus or a chip that is integrated into a terminal device or that is independent from a terminal device.

[0029] Correspondingly, this application provides an apparatus, where the apparatus includes: a receiving unit, configured to receive indication information, where the indication

information is used to schedule a physical uplink shared channel PUSCH, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and a sending unit, for sending first UCI on the PUSCH, where the first UCI includes at least one of a transmission hybrid automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2, where a quantity of coded bits that can be mapped onto reserved resource elements REs in the first frequency hopping resource is a first value, a quantity of coded bits that can be mapped onto reserved REs in the second frequency hopping resource is a second value, the first value is not less than the second value, and the reserved RE in the first frequency hopping resource and the reserved RE in the second frequency hopping resource are reserved for potential HARQ-ARK transmission in which a bit quantity is not greater than 2.

[0030] In the third aspect, this application further provides another communication method, where the method includes:

15 sending indication information, where the indication information is used to schedule a physical uplink shared channel PUSCH, and the PUSCH includes a first frequency hopping resource and a second frequency hopping resource; and receiving first UCI on the PUSCH, where the first UCI includes at least one of a transmission hybrid automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2, where a quantity of coded bits that can be mapped onto reserved resource elements REs in the first frequency hopping resource is a first value, a quantity of coded bits that can be mapped onto reserved REs in the second frequency hopping resource is a second value, the first value is not less than the second value, and the reserved RE in the first frequency hopping resource and the reserved RE in the second frequency hopping resource are reserved for potential HARQ-ARK transmission in which a bit quantity is not greater than 2.

[0031] Optionally, the method may be performed by a network device, or may be performed by an apparatus or a chip that is integrated into a network device or that is independent from a network device.

[0032] Correspondingly, this application provides an apparatus, where the apparatus includes a sending unit and a receiving unit, to perform corresponding steps in the foregoing method.

[0033] In the third aspect, further:

[0034] In an optional design, the PUSCH includes an uplink shared channel UL-SCH, the first UCI includes the HARQ-ACK, a quantity of coded bits that are of the HARQ-ACK and that are mapped onto the first frequency hopping resource is a sixth value, and a quantity of coded bits that are of the HARQ-ACK and that are mapped onto the second frequency hopping resource is a seventh value, where the sixth value is not less than the seventh value.

[0035] In an optional design, a quantity of mapped coded bits of the HARQ-ACK included in the first UCI is $G^{\text{ACK,withUL-SCH}}$; and

the sixth value is $G^{\text{ACK,withUL-SCH}}(1)$, and

$$G^{\text{ACK,withUL-SCH}}(1) = N_L \cdot Q_m \cdot \left\lceil G^{\text{ACK,withUL-SCH}} / (2 \cdot N_L \cdot Q_m) \right\rceil; \text{ and/or}$$

the seventh value is $G^{\text{ACK,withUL-SCH}}(2)$, and

$$G^{\text{ACK,withUL-SCH}}(2) = N_L \cdot Q_m \cdot \left\lfloor G^{\text{ACK,withUL-SCH}} / (2 \cdot N_L \cdot Q_m) \right\rfloor, \text{ where}$$

N_L is a quantity of transmission layers of the PUSCH, and Q_m is a modulation order of the UL-SCH and the first UCI.

[0036] In an optional design, the sixth value is

$$G^{\text{ACK,withUL-SCH}}(1) = N_L \cdot Q_m \cdot \left\lceil G_{\text{rvd}}^{\text{ACK,withUL-SCH}} / (2 \cdot N_L \cdot Q_m) \right\rceil, \text{ and the seventh value is}$$

$$G^{\text{ACK,withUL-SCH}}(2) = G^{\text{ACK,withUL-SCH}} - G^{\text{ACK,withUL-SCH}}(1); \text{ or}$$

the seventh value is $G^{\text{ACK,withUL-SCH}}(2) = N_L \cdot Q_m \cdot \left\lfloor G^{\text{ACK,withUL-SCH}} / (2 \cdot N_L \cdot Q_m) \right\rfloor$, and the

sixth value is $G^{\text{ACK,withUL-SCH}}(1) = G^{\text{ACK,withUL-SCH}} - G^{\text{ACK,withUL-SCH}}(2)$.

[0037] According to the solutions provided in the third aspect, when a quantity of HARQ-ACK bits is 2, on the first frequency hopping resource, a quantity of coded bits of the HARQ-ACK is exactly equal to the quantity of coded bits mapped onto the reserved RE, and on the second frequency hopping resource, a quantity of coded bits of the HARQ-ACK is exactly equal to the quantity of coded bits mapped onto the reserved.

[0038] According to a fourth aspect, this application provides an apparatus. The apparatus may implement functions corresponding to the steps in the methods in the first aspect, the second aspect, and/or the third aspect. The functions may be implemented by hardware, or may be implemented by hardware executing corresponding software. The hardware or the software includes one or more

units or modules corresponding to the foregoing functions.

[0039] In a possible design, the apparatus includes a processor, where the processor is configured to support the apparatus in executing the corresponding functions in the method in the foregoing first aspect. The apparatus may further include a memory, where the memory is
5 configured to couple to the processor, and the memory stores program instructions and data that are necessary to the apparatus. Optionally, the apparatus further includes a transceiver, where the transceiver is configured to support communication between the apparatus and another network element. The transceiver may be an independent receiver, an independent transmitter, or a transceiver having transmission and receiving functions.

10 [0040] According to a fourth aspect, this application provides a computer-readable storage medium. The computer-readable storage medium stores computer program code, and when the computer program code is executed by a processing unit or a processor, the methods according to the first aspect, the second aspect, and/or the third aspect are implemented.

[0041] According to a fifth aspect, this application provides a computer program product. The
15 computer program product includes computer program code, and when the computer program code is executed by a processing unit or a processor, the methods according to the first aspect, the second aspect, and/or the third aspect are implemented.

[0042] According to a sixth aspect, a communication method is provided, and includes:
20 sending downlink control information, where the downlink control information is used to schedule a PUSCH, the PUSCH is used to carry only UCI, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and receiving first UCI on the PUSCH, where the first UCI includes at least one of an HARQ-ACK, CSI-part1, and CSI-part2, where a quantity of coded bits that can be mapped onto
25 reserved REs in the first frequency hopping resource is a first value, a quantity of coded bits that can be mapped onto reserved REs in the second frequency hopping resource is a second value, the first value is not less than the second value, and the reserved RE in the first frequency hopping resource and the reserved RE in the second frequency hopping resource are reserved for transmitting potential HARQ-ACK which has less than or equal to 2 bits.

30 [0043] A reason that information in the CSI-part1 is incompletely sent is that a quantity of coded bits that are of the CSI-part1 and that are mapped onto the second frequency hopping

resource is relatively small. In other words, a quantity of REs on the second frequency hopping resource that are used to map the CSI-part1 is relatively small, and consequently, the CSI-part1 cannot be all mapped onto the second frequency hopping resource. Compared with the prior art, this application reduces a quantity of coded bits that are capable of being mapped onto reserved
 5 REs in the second frequency hopping resource, thereby increasing a quantity of REs that are in the second frequency hopping resource and that are used to map the CSI-part1. This resolves a problem that due to UCI transmission through frequency hopping in a UCI-only scenario, information in the CSI-part1 is incompletely sent.

[0044] Optionally, the first value is $G_{\text{rvd}}^{\text{ACK}}(1)$, and $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$;
 10 and/or

the second value is $G_{\text{rvd}}^{\text{ACK}}(2)$, and $G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$, where

N_L is a quantity of transmission layers of the PUSCH, and Q_m is a modulation order of the first UCI.

[0045] Optionally, $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$, and $G_{\text{rvd}}^{\text{ACK}}(2) = G_{\text{rvd}}^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(1)$;
 15 or

$G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$, and $G_{\text{rvd}}^{\text{ACK}}(1) = G_{\text{rvd}}^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(2)$.

[0046] Optionally, a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the first frequency hopping resource is $G^{\text{ACK}}(1)$, and a value of $G^{\text{ACK}}(1)$ is a smaller one of the following two values:

20 a quantity of coded bits mapped onto an RE that is after a first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data, and a third value that is determined based on G^{ACK} , where G^{ACK} is a quantity of coded bits of the HARQ-ACK in the first UCI.

[0047] Optionally, a value of the quantity of coded bits mapped onto the RE that is after the
 25 first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data is equal to $M_3 \cdot N_L \cdot Q_m$, where M_3 is a quantity of REs that are after the first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data, N_L is the quantity of transmission layers of the

PUSCH, Q_m is the modulation order of the first UCI, and the third value is $N_L \cdot Q_m \cdot \lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$. The quantity of bits of the HARQ-ACK in the first UCI is not greater than 2.

[0048] The foregoing solution is content described in a formula

$$5 \quad G^{\text{ACK}}(1) = \min\left(N_L \cdot Q_m \cdot \lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil, M_3 \cdot N_L \cdot Q_m\right).$$

[0049] Optionally, a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the second frequency hopping resource is $G^{\text{ACK}}(2)$, where

$$G^{\text{ACK}}(2) = G^{\text{ACK}} - G^{\text{ACK}}(1).$$

[0050] According to a seventh aspect, this application further provides a communication
10 method, including: sending downlink control information, where the downlink control information is used to schedule a PUSCH, the PUSCH is used to carry only UCI, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and receiving first UCI on the PUSCH, where the first UCI includes
15 at least one of an HARQ-ACK, CSI-part1, and CSI-part2.

[0051] A quantity $G^{\text{CSI-part1}}(1)$ of coded bits that are of the CSI-part1 in the first UCI and that are mapped onto the first frequency hopping resource is a smaller one of a fourth value and a fifth value, the fourth value is determined based on a quantity $G^{\text{CSI-part1}}$ of coded bits of the CSI-part1 in the first UCI, and the fifth value is determined based on a larger value in $G^{\text{ACK}}(1)$ and
20 $G_{\text{rvd}}^{\text{ACK}}(1)$, or the fifth value is determined based on $G^{\text{ACK}}(1)$, where $G^{\text{ACK}}(1)$ is a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the first frequency hopping resource, and $G_{\text{rvd}}^{\text{ACK}}(1)$ is a quantity of coded bits that can be mapped onto reserved REs in the first frequency hopping resource.

[0052] In the prior art, the fifth value is determined based only on $G^{\text{ACK}}(1)$. For example, the
25 fifth value is $M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)$ in the prior art, and this parameter sets an upper limit (namely, a first upper limit) for a resource occupied by the CSI-part1 on the first frequency hopping resource. In addition, the CSI-part1 cannot occupy the reserved RE in the first frequency hopping resource.

That is, $G^{\text{CSI-part1}}(1)$ should also not be greater than an upper limit $M_1 \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}}(1)$ (namely, a second upper limit). When a quantity of HARQ-ACK information bits is 0, 1, or 2, $G^{\text{ACK}}(1)$ is a quantity of coded bits that is calculated based on an actual quantity of HARQ-ACK information bits, and $G_{\text{rvd}}^{\text{ACK}}$ is a quantity that is of coded bits mapped onto the reserved RE and
 5 that is calculated based on the quantity of HARQ-ACK information bits being 2. Therefore, if the actual quantity of HARQ-ACK information bits is 0 or 1, $G^{\text{ACK}} < G_{\text{rvd}}^{\text{ACK}}$, and $G^{\text{ACK}}(1) < G_{\text{rvd}}^{\text{ACK}}(1)$. That is, on the first frequency hopping resource, $G^{\text{ACK}} < G_{\text{rvd}}^{\text{ACK}}$. In this case, the first upper limit is greater than the second upper limit. In the prior art, if the fifth value is determined based only on $G^{\text{ACK}}(1)$, a non-reserved RE in the first frequency hopping resource may be insufficient for
 10 carrying the quantity $G^{\text{CSI-part1}}(1)$ of coded bits of the CSI-part1 on the first frequency hopping resource.

[0053] In the solution provided in this application, the fifth value is determined based on the larger one of $G^{\text{ACK}}(1)$ and $G_{\text{rvd}}^{\text{ACK}}(1)$ (where when the quantity of HARQ-ACK bits is greater than 2, $G_{\text{rvd}}^{\text{ACK}}(1)$ is equal to 0), to ensure that $G^{\text{CSI-part1}}(1)$ is calculated by using an actual non-
 15 reserved RE in the first frequency hopping resource as a reference, thereby avoiding the foregoing problem that the CSI-part1 is incompletely sent.

[0054] Optionally, that the fifth value is determined based on a larger value in $G^{\text{ACK}}(1)$ and $G_{\text{rvd}}^{\text{ACK}}(1)$ includes that the fourth value is equal to $M_1 \cdot N_L \cdot Q_m - \max(G^{\text{ACK}}(1), G_{\text{rvd}}^{\text{ACK}}(1))$; or
 that the fifth value is determined based on $G^{\text{ACK}}(1)$ includes that the fifth value is
 20 equal to $M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)$ when the quantity of HARQ-ACK bits is greater than 2.

[0055] M_1 is a quantity of REs that can carry data and that are in the first frequency hopping resource, N_L is a quantity of transmission layers of the PUSCH, and Q_m is a modulation order of the first UCI.

[0056] Optionally, that the fourth value is determined based on a quantity $G^{\text{CSI-part1}}$ of coded
 25 bits of the CSI-part1 in the first UCI includes: the fourth value is equal to

$N_L \cdot Q_m \cdot \left\lceil G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \right\rceil$, where N_L is the quantity of transmission layers of the PUSCH, and Q_m is the modulation order of the first UCI.

BRIEF DESCRIPTION OF DRAWINGS

- [0057] FIG. 1 is a schematic diagram of a communications system to which this application is applicable;
- [0058] FIG. 2 is a schematic diagram of a UCI mapping scheme in a UCI-only scenario according to this application;
- [0059] FIG. 3 is a schematic diagram of another UCI mapping scheme in a UCI-only scenario according to this application;
- [0060] FIG. 4 is a schematic diagram of a communication method according to this application;
- [0061] FIG. 5 is a schematic diagram of PUSCH resource allocation according to this application;
- [0062] FIG. 6 is a schematic diagram of another communication method according to this application;
- [0063] FIG. 7 is a schematic diagram of still another communication method according to this application;
- [0064] FIG. 8 is a schematic diagram of still another communication method according to this application;
- [0065] FIG. 9 is a schematic diagram of a communications apparatus according to this application;
- [0066] FIG. 10 is a schematic diagram of another communications apparatus according to this application;
- [0067] FIG. 11 is a schematic diagram of still another communications apparatus according to this application;
- [0068] FIG. 12 is a schematic diagram of still another communications apparatus according to this application;
- [0069] FIG. 13 is a schematic diagram of still another communications apparatus according to this application;

[0070] FIG. 14 is a schematic diagram of still another communications apparatus according to this application;

[0071] FIG. 15 is a schematic diagram of still another communications apparatus according to this application; and

5 [0072] FIG. 16 is a schematic diagram of still another communications apparatus according to this application.

DESCRIPTION OF EMBODIMENTS

[0073] The following describes technical solutions of this application with reference to accompanying drawings.

10 [0074] FIG. 1 shows a communications system to which this application is applicable. The communications system includes a network device and a terminal device. The network device communicates with the terminal device via a wireless network. When the terminal device sends information, a wireless communications module of the terminal device may obtain information bits that are to be sent to the network device over a channel. For example, the information bits are
15 generated by a processing module of the terminal device, received from another device, or stored in a storage module of the terminal device.

[0075] In this application, the terminal device may be referred to as an access terminal, user equipment (user equipment, UE), a subscriber unit, a subscriber station, a mobile station, a mobile console, a remote station, a remote terminal, a mobile device, a user terminal, a terminal, a wireless
20 communications device, a user agent, or a user apparatus. The access terminal may be a cellular phone, a handheld device having a wireless communication function, a computing device, another processing device connected to a wireless modem, a vehicle-mounted device, a wearable device, or user equipment in a 5G communications system.

[0076] The network device may be a base transceiver station (base transceiver station, BTS) in a code division multiple access (code division multiple access, CDMA) system, a NodeB (node B, NB) in a wideband code division multiple access (wideband code division multiple access, WCDMA) system, an evolved NodeB (evolutional node B, eNB) in a long term evolution (long term evolution, LTE) system, or a gNB (gNB) in a 5G communications system. The foregoing base stations are only used as examples for illustration. Alternatively, the network device may be
25

a relay node, an access point, a vehicle-mounted device, a wearable device, or another type of device.

[0077] The foregoing communications systems to which this application is applicable are merely examples for description, and a communications system to which this application is applicable is not limited thereto. For example, the communications system may include another
5 quantity of network devices and another quantity of terminal devices.

[0078] To facilitate understanding of the technical solutions in this application, concepts used in this application are first briefly described. A 5G system is used as an example for description.

[0079] In a scenario in which UE sends UCI to a gNB on a PUSCH, the UE may miss detecting
10 a downlink control channel (physical uplink control channel, PDCCH). Consequently, a cognitive error occurs on a quantity of HARQ-ACK bits that need to be fed back, that is, a quantity of HARQ-ACK bits actually fed back by the UE is less than a quantity of HARQ-ACK bits that the gNB schedules the UE to feed back. Further, all UCI sent by the UE on the PUSCH may not be correctly received by the gNB. To avoid impact, on CSI-part1, of a decrease in HARQ-ACKs sent
15 by the UE, in a communication protocol, reserved REs for an HARQ-ACK (reserved RE for HARQ-ACK), namely, a reserved RE, is defined for the scenario in which the UE sends the UCI to the gNB on the PUSCH. The specific definition is as follows:

[0080] (1) When a quantity of HARQ-ACK information bits is 0, 1, or 2, the reserved RE is generated based on the quantity of HARQ-ACK information bits being 2.

[0081] (2) Because CSI-part1 having a relatively high protection level requirement cannot be
20 sent on the reserved RE, when the quantity of HARQ-ACK information bits is not greater than 2, missing transmission of an HARQ-ACK does not affect the CSI-part1.

[0082] (3) CSI-part2 and a UL-SCH may be sent on the reserved RE (where in a UCI-only scenario, only the CSI-part2 may be sent).

[0083] (4) If there are HARQ-ACK information bits that need to be transmitted (that is, the
25 quantity of HARQ-ACK information bits is 1 or 2), an HARQ-ACK is transmitted on the reserved RE. In other words, the reserved RE onto which the CSI-part2 that has been mapped is punctured for the HARQ-ACK in this case.

[0084] To obtain a frequency hopping gain, the PUSCH may be divided into two parts in time
30 domain, where the two parts are respectively referred to as a first hop (hop 1) and a second hop (hop 2). Frequency domain resources on the hop 1 and the hop 2 are different. Correspondingly,

the HARQ-ACK, the CSI-part1, and the CSI-part2 are also mapped to the hop 1 and the hop 2 according to a preset rule.

[0085] The foregoing mapping rule may be intuitively represented in FIG. 2. As shown in FIG. 2, the CSI-part1 is mapped only onto a non-reserved RE, and the CSI-part2 has both a part mapped onto reserved REs and a part mapped onto a non-reserved RE. If there is an HARQ-ACK (that is, an information bit is 1 or 2), the HARQ-ACK is mapped onto reserved REs (in other words, a resource onto which a coded bit of the CSI-part2 has been mapped is punctured).

[0086] The following rules apply to PUSCH frequency hopping:

[0087] A frequency hopping rule for a quantity of PUSCH symbols includes intra-slot (slot) frequency hopping and inter-slot frequency hopping. Details are as follows:

[0088] For the intra-slot frequency hopping, a quantity of symbols on the hop 1 is rounding half of a total quantity of PUSCH symbols down to a nearest integer, namely, $\lfloor N_{\text{sym}}^{\text{PUSCH},s} / 2 \rfloor$; and a quantity of symbols on the hop 2 is equal to the total quantity of PUSCH symbols minus the quantity of symbols on the hop 1, namely, $N_{\text{sym}}^{\text{PUSCH},s} - \lfloor N_{\text{sym}}^{\text{PUSCH},s} / 2 \rfloor$. $N_{\text{sym}}^{\text{PUSCH},s}$ is a total quantity of PUSCH symbols in one slot.

[0089] For the inter-slot frequency hopping, the hop 1 and the hop 2 are obtained through division by slot in terms of time. For example, a hop with an even slot number is the hop 1, and a hop with an odd slot number is the hop 2.

[0090] Depending on a demodulation reference signal (demodulation reference signal, DMRS) pattern in a case of PUSCH frequency hopping specified in a current protocol, a possible case of the intra-slot frequency hopping includes: a quantity of symbols that can carry data on the hop 1 is equal to a quantity of symbols that can carry data on the hop 2; or a quantity of symbols that can carry data on the hop 1 is less than a quantity of symbols that can carry data on the hop 2 by 1; and in the case of the inter-slot frequency hopping, a quantity of symbols that can carry data on the hop 1 is equal to a quantity of symbols that can carry data on the hop 2.

[0091] A frequency hopping splitting rule for a quantity of coded bits mapped onto the reserved RE is as follows:

[0092] Assuming that the quantity of coded bits mapped onto the reserved RE is $G_{\text{rvd}}^{\text{ACK}}$, quantities of coded bits mapped onto reserved REs on the hop 1 and the hop 2 are respectively:

$$G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \left\lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \right\rfloor \quad (1)$$

$$G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \left\lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \right\rceil \quad (2)$$

where N_L is a quantity of transmission layers of the PUSCH, and Q_m is a modulation order of the PUSCH. It can be learned from the formula (1) and the formula (2) that,

$$G_{\text{rvd}}^{\text{ACK}}(1) \leq G_{\text{rvd}}^{\text{ACK}} / 2 \quad (3)$$

$$G_{\text{rvd}}^{\text{ACK}}(2) \geq G_{\text{rvd}}^{\text{ACK}} / 2 \quad (4)$$

[0093] The equals signs in the formula (3) and the formula (4) are valid only when $G_{\text{rvd}}^{\text{ACK}}$ can be exactly divided by $(2 \cdot N_L \cdot Q_m)$.

[0094] According to an existing specification, in the UCI-only scenario, quantities of coded bits of the parts (the HARQ-ACK, the CSI-part1, and the CSI-part2) of the UCI are also obtained through splitting according to a specific rule during frequency hopping. The following three parameters are defined before the splitting is described:

[0095] Quantity of REs that can carry data on the hop 1: $M_1 = \sum_{l=0}^{N_{\text{symb,hop}}^{\text{PUSCH}}(1)-1} M_{\text{SC}}^{\text{UCI}}(l)$.

$N_{\text{symb,hop}}^{\text{PUSCH}}(1)$ is a quantity of symbols on the hop 1, $M_{\text{SC}}^{\text{UCI}}(l)$ is a size of a set Φ_l^{UCI} , and the set Φ_l^{UCI} is a quantity of REs that can carry data on a symbol l .

[0096] Quantity of REs that can carry data on the hop 2: $M_2 = \sum_{l=N_{\text{symb,hop}}^{\text{PUSCH}}(1)}^{N_{\text{symb,hop}}^{\text{PUSCH}}(1)+N_{\text{symb,hop}}^{\text{PUSCH}}(2)-1} M_{\text{SC}}^{\text{UCI}}(l)$.

$N_{\text{symb,hop}}^{\text{PUSCH}}(2)$ is a quantity of symbols on the hop 2.

[0097] Quantity of REs that can carry data on a PUSCH symbol after a first consecutive DMRS symbol set on the hop 1 of the PUSCH: $M_3 = \sum_{l=l^{(1)}}^{N_{\text{symb,hop}}^{\text{PUSCH}}(1)-1} M_{\text{SC}}^{\text{UCI}}(l)$. $l^{(1)}$ is defined as an index of the first symbol that does not include a DMRS and that is after the first consecutive DMRS symbol set. A consecutive DMRS symbol set may include one DMRS symbol, or may include a plurality of consecutive DMRS symbols.

[0098] Frequency hopping splitting rules for the quantities of coded bits of the parts (the HARQ-ACK, the CSI-part1, and the CSI-part2) of the UCI are as follows:

[0099] Frequency hopping splitting rule for coded bits of the HARQ-ACK:

[0100] Assuming that the quantity of coded bits of the HARQ-ACK is G^{ACK} , quantities of coded bits of the HARQ-ACK that are sent on the hop 1 and the hop 2 are respectively:

$$G^{\text{ACK}}(1) = \min\left(N_L \cdot Q_m \cdot \left\lfloor G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \right\rfloor, M_3 \cdot N_L \cdot Q_m\right); \text{ and}$$

$$5 \quad G^{\text{ACK}}(2) = G^{\text{ACK}} - G^{\text{ACK}}(1) .$$

[0101] Frequency hopping splitting rule for coded bits of the CSI-part1:

[0102] Assuming that the quantity of coded bits of the CSI-part1 is $G^{\text{CSI-part1}}$, quantities of coded bits of the CSI-part1 that are sent on the hop 1 and the hop 2 are respectively:

$$G^{\text{CSI-part1}}(1) = \min\left(N_L \cdot Q_m \cdot \left\lfloor G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \right\rfloor, M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)\right) \quad (5)$$

$$10 \quad G^{\text{CSI-part1}}(2) = G^{\text{CSI-part1}} - G^{\text{CSI-part1}}(1) \quad (6)$$

[0103] When a minimum operation $\min(\cdot, \cdot)$ in the formula (4) is performed on the left of the comma, the following can be learned by combining the formulas (5) and (6):

$$G^{\text{CSI-part1}}(1) \leq G^{\text{CSI-part1}}(2) \quad (7)$$

[0104] The equals sign is valid only when $G^{\text{CSI-part1}}$ can be exactly divided by $(2 \cdot N_L \cdot Q_m)$.

15 [0105] Frequency hopping splitting rule for coded bits of the CSI-part2:

[0106] Assuming that the quantity of coded bits of the CSI-part2 is $G^{\text{CSI-part2}}$, quantities of coded bits of the CSI-part2 that are sent on the hop 1 and the hop 2 are respectively:

$$G^{\text{CSI-part2}}(1) = M_1 \cdot N_L \cdot Q_m - G^{\text{CSI-part1}}(1) \quad (8)$$

$$G^{\text{CSI-part2}}(2) = M_2 \cdot N_L \cdot Q_m - G^{\text{CSI-part1}}(2) \quad (9)$$

20 [0107] When the following three conditions exist in the UCI-only scenario, the CSI-part1 is incompletely sent.

[0108] Condition 1: The quantity of coded bits of the CSI-part1 is exactly equal to a quantity of coded bits mapped onto all REs that can carry data other than the reserved REs on the hop 1 and the hop 2 of the PUSCH, that is:

$$25 \quad G^{\text{CSI-part1}} = (M_1 + M_2) \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}} \quad (10)$$

[0109] Condition 2: $G^{\text{CSI-part1}}$ cannot be exactly divided by $(2 \cdot N_L \cdot Q_m)$. Therefore, the

equals sign is invalid in the formula (7), that is:

$$G^{\text{CSI-part1}}(1) < G^{\text{CSI-part1}}(2) \quad (11)$$

[0110] Condition 3: Quantities of REs that are capable of being used to carry data and that are of two frequency hopping resources are the same, that is, for the hop 1 and the hop 2 of the PUSCH,

$$M_1 = M_2 \quad (12).$$

[0111] The following can be learned from the formulas (8), (9), (11), and (12):

$$G^{\text{CSI-part2}}(1) > G^{\text{CSI-part2}}(2) \quad (13)$$

[0112] The following can be obtained by adding the formulas (8) and (9):

$$G^{\text{CSI-part2}}(1) + G^{\text{CSI-part2}}(2) = (M_1 + M_2) \cdot N_L \cdot Q_m - G^{\text{CSI-part1}} \quad (14)$$

10 [0113] The following can be obtained from the formulas (14) and (10):

$$G^{\text{CSI-part2}}(1) + G^{\text{CSI-part2}}(2) = G_{\text{rvd}}^{\text{ACK}} \quad (15)$$

[0114] The following can be obtained from the formulas (13) and (15):

$$G^{\text{CSI-part2}}(2) < G_{\text{rvd}}^{\text{ACK}} / 2 \quad (16)$$

[0115] The following can be obtained from the formulas (16) and (4):

$$15 \quad G^{\text{CSI-part2}}(2) < G_{\text{rvd}}^{\text{ACK}}(2) \quad (17)$$

[0116] Therefore, the following can be learned from the formulas (9) and (17):

$$G^{\text{CSI-part1}}(2) = M_2 \cdot N_L \cdot Q_m - G^{\text{CSI-part2}}(2) > M_2 \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}}(2)$$

[0117] That is, the quantity of coded bits of the CSI-part1 on the hop 2 is greater than a quantity of coded bits mapped onto a non-reserved RE, and the CSI-part1 cannot be carried by using a reserved RE. Therefore, the CSI-part1 is incompletely sent.

20 [0118] In addition, due to $G^{\text{CSI-part2}}(2) < G_{\text{rvd}}^{\text{ACK}}(2)$ (formula (17)), there may be reserved REs on which no data is sent, as shown in FIG. 3. If the PUSCH uses a single-carrier discrete Fourier transform spread orthogonal frequency division multiplexing (discrete Fourier transform spread orthogonal frequency division multiplexing, DFT-s-OFDM), the foregoing RE on which no data is sent may damage a single-carrier low peak-to-average power ratio (peak-to-average power ratio, PAPR) characteristic for uplink transmission on one or more symbols on the hop 2.

[0119] In addition, the symbol used in this application is a time unit, and may be an orthogonal frequency-division multiplexing (orthogonal frequency-division multiplexing, OFDM) symbol.

[0120] In view of this, this application provides a communication method, to resolve a problem that the CSI-part1 is incompletely sent, and further to resolve a problem that a single-carrier characteristic is damaged when a signal is sent on the hop 2 by using the DFT-s-OFDM waveform.

[0121] As shown in FIG. 4, the communication method includes the following steps.

5 **[0122]** S410. Receive downlink control information, where the downlink control information is used to schedule a PUSCH, the PUSCH is used to carry only UCI, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource.

10 **[0123]** That the PUSCH is used to carry only UCI refers to a UCI-only scenario defined in a communication protocol. The first frequency hopping resource and the second frequency hopping resource are, for example, the hop 1 and the hop 2 described above. Optionally, a frequency domain resource of the first frequency hopping resource is different from a frequency domain resource of the second frequency hopping resource, and the difference means that the frequency domain
 15 resource of the first frequency hopping resource partially overlaps or does not overlap the frequency domain resource of the second frequency hopping resource. Further, optionally, a time-frequency end position of the first frequency hopping resource is adjacent to a time-domain start position of the second frequency hopping resource. Alternatively, the first frequency hopping resource is consecutive or inconsecutive in time domain, and the second frequency hopping
 20 resource is consecutive or inconsecutive in time domain. The explanation of the frequency hopping resource may be applied to another method or implementation in this application.

[0124] The downlink control information described in S410 is, for example, downlink control information (downlink control information, DCI) transmitted on a PDCCH. A base station may indicate, by using different states of one bit in the DCI, whether the PUSCH is used to transmit
 25 only the UCI. In other words, whether a current communication scenario is the UCI-only scenario is indicated by using the different states of the bit.

[0125] S420. Send first UCI on the PUSCH, where the first UCI includes at least one of an HARQ-ACK, CSI-part1, and CSI-part2.

[0126] A quantity of coded bits that can be mapped onto reserved REs in the first frequency
 30 hopping resource is a first value, a quantity of coded bits that can be mapped onto reserved REs in the second frequency hopping resource is a second value, the first value is not less than the second

value, and the reserved RE in the first frequency hopping resource and the reserved RE in the second frequency hopping resource are reserved for transmitting potential HARQ-ACK which has less than or equal to 2 bits. Herein, the "potential HARQ-ACK transmission" is further explained. In this embodiment of this application, the HARQ-ACK may be transmitted on the PUSCH, or may not be actually transmitted. Regardless of whether the HARQ-ACK is transmitted, these REs are to be reserved. These to-be-reserved REs correspond to a specific quantity of coded bits to be mapped onto the REs. Specifically, the quantity of HARQ-ACK bits used in the "potential HARQ-ACK transmission" is not greater than 2. In addition, the quantity of coded bits mapped onto the reserved RE is specifically calculated based on the quantity of HARQ-ACK bits being equal to 2. In this embodiment of this application, if there is no actual transmission, the quantity of coded bits mapped onto the reserved RE may be understood as a quantity of coded bits that are capable of being mapped to the reserved RE, or a corresponding quantity of coded bits corresponding to the reserved RE.

[0127] A reason that information in the CSI-part1 is incompletely sent is that a quantity of coded bits that are of the CSI-part1 and that are mapped onto the second frequency hopping resource is relatively small. In other words, a quantity of REs on the second frequency hopping resource that are used to map the CSI-part1 is relatively small, and consequently, the CSI-part1 cannot be all mapped onto the second frequency hopping resource. Compared with the prior art, this application reduces a quantity of coded bits that are capable of being mapped onto reserved REs in the second frequency hopping resource, thereby increasing a quantity of REs that are in the second frequency hopping resource and that are used to map the CSI-part1. This resolves a problem that due to UCI transmission through frequency hopping in a UCI-only scenario, information in the CSI-part1 is incompletely sent.

[0128] In addition, in the foregoing solution, a quantity of reserved REs in the second frequency hopping resource is reduced, and a case in which no data is sent on the RE in the second frequency hopping resource is avoided. Therefore, in the method 400, the problem that the CSI-part1 is incompletely sent is resolved, and the problem shown in FIG. 3 is also resolved.

[0129] It should be noted that "a quantity of coded bits that can be mapped onto reserved REs in the first frequency hopping resource is a first value, a quantity of coded bits that can be mapped onto reserved REs in the second frequency hopping resource is a second value, and the first value is not less than the second value" means that the quantity of reserved REs in the second frequency

hopping resource is reduced, so that the second value is greater than or equal to the first value.

[0130] Optionally, the method 400 further includes:

5 determining a first quantity $G_{\text{rvd}}^{\text{ACK}}$ of coded bits, where $G_{\text{rvd}}^{\text{ACK}}$ is a sum of the quantities of coded bits that are capable of being mapped onto the reserved REs in the first frequency hopping resource and the second frequency hopping resource, and both the first value and the second value are determined based on $G_{\text{rvd}}^{\text{ACK}}$.

[0131] Specifically, the "quantities of coded bits mapped onto the reserved REs in the first frequency hopping resource and the second frequency hopping resource" refers to a sum of a quantity of coded bits that are capable of being mapped onto the reserved RE in the first frequency hopping resource and a quantity of coded bits that are capable of being mapped onto the reserved RE in the second frequency hopping resource, but should not be understood as a quantity of coded bits actually mapped onto the reserved RE in the first frequency hopping resource and a quantity of coded bits actually mapped onto the reserved RE in the second frequency hopping resource.

[0132] Optionally, the first value is $G_{\text{rvd}}^{\text{ACK}}(1)$, and $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$; and/or the second value is $G_{\text{rvd}}^{\text{ACK}}(2)$, and $G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$, where N_L is a quantity of transmission layers of the PUSCH, and Q_m is a modulation order of the first UCI, namely, a modulation order of the UCI transmitted on the PUSCH.

[0133] $G_{\text{rvd}}^{\text{ACK}}(2)$ is obtained by performing a rounding down operation on $G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m)$, and/or $G_{\text{rvd}}^{\text{ACK}}(2)$ is obtained by performing a rounding up operation on $G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m)$, so that the quantity of coded bits (namely, a quantity of reserved REs) mapped onto the reserved RE in the second frequency hopping resource is less than or equal to the quantity of coded bits (namely, a quantity of reserved REs) mapped onto the reserved RE in the first frequency hopping resource.

[0134] Optionally, $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$, and $G_{\text{rvd}}^{\text{ACK}}(2) = G_{\text{rvd}}^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(1)$;
25 or

$$G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor, \text{ and } G_{\text{rvd}}^{\text{ACK}}(1) = G_{\text{rvd}}^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(2).$$

[0135] Optionally, the method 400 further includes:

determining a quantity G^{ACK} of coded bits of the HARQ-ACK in the first UCI, where a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the first frequency hopping resource is $G^{\text{ACK}}(1)$, and a value of $G^{\text{ACK}}(1)$ is a smaller one of the following two values:

5 a quantity of coded bits mapped onto an RE that is after a first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data, and a third value that is determined based on G^{ACK} .

[0136] The foregoing description may be expressed by using the following formula:

$$G^{\text{ACK}}(1) = \min\left(N_L \cdot Q_m \cdot \lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil, M_3 \cdot N_L \cdot Q_m\right).$$

10 **[0137]** $N_L \cdot Q_m \cdot \lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$ represents the third value, and $M_3 \cdot N_L \cdot Q_m$ represents the quantity of coded bits mapped onto the RE that is after the first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data, or is referred to as the quantity of coded bits mapped onto the RE that is after the first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of
15 being used to carry data, and the DMRS symbol is a symbol used to carry a DMRS. M_3 is a quantity of REs that are after the first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data, N_L is the quantity of transmission layers of the PUSCH, and Q_m is the modulation order of the first UCI. There may be one or more symbols in the first group of consecutive DMRS symbols.

20 **[0138]** In this application, it should be noted that the first group of consecutive DMRS symbols start from the first DMRS symbol on a corresponding resource in time domain, and ends with the last consecutive DMRS symbol. For details, refer to FIG. 5. In FIG. 5, four PUSCH resources, namely, a PUSCH 1, a PUSCH 2, a PUSCH 3, and a PUSCH 4 are shown from top to bottom (the top-to-bottom sequence is used only to logically distinguish between the four PUSCH resources,
25 and imposes no limitation on a frequency-domain position relationship). Start symbols of the PUSCH 1 and the PUSCH 3 are DMRS symbols, and start symbols of the PUSCH 2 and the PUSCH 4 are not DMRS symbols. In addition, the first group of consecutive DMRS symbols in each of the PUSCH 1 and the PUSCH 2 include only one symbol, and the first group of consecutive

DMRS symbols in each of the PUSCH 3 and the PUSCH 4 include a plurality of symbols.

[0139] Optionally, a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the second frequency hopping resource is $G^{\text{ACK}}(2)$, where $G^{\text{ACK}}(2) = G^{\text{ACK}} - G^{\text{ACK}}(1)$.

5 [0140] For explanations of related terms in this application, refer to definitions in a communication protocol (section 6.2.7 in 3GPP TS38.212 v15.2.0).

[0141] The following further provides an example of frequency hopping transmission provided in this application.

[0142] Step 1: A gNB configures parameters such as a scale parameter α and a code rate compensation parameter ($\beta_{\text{offset}}^{\text{HARQ-ACK}}$, $\beta_{\text{offset}}^{\text{CSI-1}}$, and $\beta_{\text{offset}}^{\text{CSI-2}}$) for the UE by using RRC signaling, where a value of the scale parameter α is greater than 0 and less than or equal to 1, and one or more groups of values may be configured for the code rate compensation parameter. If one group of values are configured, the group of values are directly used in a subsequent step. If a plurality of groups of values are configured, downlink control information (downlink control information, DCI) in step 2 may be used to indicate indexes of the groups of values.

15 [0143] Step 2: The gNB sends DCI to the UE on a PDCCH, where the DCI includes but is not limited to the following information: a PUSCH resource allocated to the UE, whether the PUSCH is UCI-only (or whether the PUSCH includes a UL-SCH), whether frequency hopping is performed for the PUSCH, the quantity of transmission layers of the PUSCH, and parameters such as a modulation and coding scheme index (I_{MCS}), the quantity N_L of transmission layers of the PUSCH, and indexes (optional) of $\beta_{\text{offset}}^{\text{HARQ-ACK}}$, $\beta_{\text{offset}}^{\text{CSI-1}}$, and $\beta_{\text{offset}}^{\text{CSI-2}}$.

20 [0144] Step 3: After receiving the DCI, the UE parses the DCI to obtain the PUSCH resource allocated to the UE, whether the PUSCH is UCI-only, whether frequency hopping is performed for the PUSCH, and the parameters such as I_{MCS} and the quantity N_L of transmission layers of the PUSCH. The UE obtains a code rate R and the modulation order Q_m through table lookup by using I_{MCS} . If the DCI includes the indexes of $\beta_{\text{offset}}^{\text{HARQ-ACK}}$, $\beta_{\text{offset}}^{\text{CSI-1}}$, and $\beta_{\text{offset}}^{\text{CSI-2}}$, the UE obtains, through parsing, values of $\beta_{\text{offset}}^{\text{HARQ-ACK}}$, $\beta_{\text{offset}}^{\text{CSI-1}}$, and $\beta_{\text{offset}}^{\text{CSI-2}}$ based on the indexes, and uses the values in a subsequent step.

[0145] Step 4: If the UE obtains, through parsing, that the PUSCH is UCI-only, and a quantity of HARQ-ACK information bits that need to be sent by the UE is not greater than 2 (that is, the quantity of HARQ-ACK information bits is 0, 1, or 2), the UE calculates, according to the following formula (in the following formula, 2 on the denominator indicates that calculation is performed based on the quantity of HARQ-ACK information bits being 2), a quantity of reserved REs reserved for an HARQ-ACK:

$$Q'_{\text{ACK}} = \min \left\{ \left\lceil \frac{2 \cdot \beta_{\text{offset}}^{\text{HARQ-ACK}}}{R \cdot Q_m} \right\rceil, \left\lceil \alpha \cdot \sum_{l=l_0}^{N_{\text{symb,all}}^{\text{PUSCH}}-1} M_{\text{sc}}^{\text{UCI}}(l) \right\rceil \right\}$$

[0146] $M_{\text{sc}}^{\text{UCI}}(l)$ is a quantity of REs that can carry UCI on a symbol l on the PUSCH, l_0 is an index of the first DMRS symbol of the PUSCH or is an index of the first symbol that does not include a DMRS and that is after a first group of consecutive multiple DMRS symbol sets, and

$N_{\text{symb,all}}^{\text{PUSCH}}$ is a quantity of symbols of the PUSCH.

[0147] Then, a quantity $G_{\text{rvd}}^{\text{ACK}}$ of coded bits mapped onto the reserved REs that may need to be reserved for the HARQ-ACK is calculated based on obtained Q'_{ACK} .

[0148] In addition, the UE calculates a quantity G^{ACK} of coded bits of the HARQ-ACK, a quantity $G^{\text{CSI-part1}}$ of coded bits of the CSI-part1, and a quantity $G^{\text{CSI-part2}}$ of coded bits of the CSI-part2 based on the parameters such as α , $\beta_{\text{offset}}^{\text{HARQ-ACK}}$, $\beta_{\text{offset}}^{\text{CSI-1}}$, $\beta_{\text{offset}}^{\text{CSI-2}}$, R , Q_m , and N_L .

[0149] Step 5: If the UE needs to perform frequency hopping to parse the PUSCH, the UE calculates a quantity of coded bits of the HARQ-ACK, a quantity of coded bits of the CSI-part1, and a quantity of coded bits of the CSI-part2 respectively on the hop 1 and the hop 2 according to the following formulas:

$$G^{\text{ACK}}(1) = \min \left(N_L \cdot Q_m \cdot \left\lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \right\rceil, M_3 \cdot N_L \cdot Q_m \right); \text{ or}$$

$$G^{\text{ACK}}(1) = \min \left(N_L \cdot Q_m \cdot \left\lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \right\rceil, M_3 \cdot N_L \cdot Q_m \right);$$

$$G^{\text{ACK}}(2) = G^{\text{ACK}} - G^{\text{ACK}}(1);$$

$$G^{\text{CSI-part1}}(1) = \min \left(N_L \cdot Q_m \cdot \left\lceil G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \right\rceil, M_1 \cdot N_L \cdot Q_m - \max \left(G^{\text{ACK}}(1), G_{\text{rvd}}^{\text{ACK}}(1) \right) \right);$$

$$G^{\text{CSI-part1}}(2) = G^{\text{CSI-part1}} - G^{\text{CSI-part1}}(1);$$

$$G^{\text{CSI-part2}}(1) = M_1 \cdot N_L \cdot Q_m - G^{\text{CSI-part1}}(1); \text{ and}$$

$$G^{\text{CSI-part2}}(2) = M_2 \cdot N_L \cdot Q_m - G^{\text{CSI-part1}}(2).$$

[0150] The UE calculates the quantities of coded bits mapped onto the reserved REs that are reserved for the HARQ-ACK on the hop 1 and the hop 2 according to the following formulas:

5
$$G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \left\lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \right\rceil ; \text{ and}$$

$$G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \left\lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \right\rfloor.$$

[0151] Step 6: The UE maps the coded bits of the HARQ-ACK, the CSI-part1, and the CSI-part2 onto the PUSCH based on the parameters calculated in step 5.

[0152] The following uses several examples to describe beneficial effects brought by calculating, by using the communication method (for example, frequency hopping transmission is

10 performed by using $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \left\lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \right\rceil$ and

$G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \left\lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \right\rfloor$) provided in this application, the quantities of coded bits

mapped onto the two hops. Table 1 is a result obtained by using a method in the prior art, and Table 2 is a result obtained by using the method in this application.

Table 1

Parameter	Incorrect example value		
	Example 1	Example 2	Example 3
Quantity of transmission layers (Layer number): N_L	1	1	1
Modulation order (Modulation order): Q_m	4	6	4
$G_{\text{rvd}}^{\text{ACK}}$	132	162	116
$G^{\text{CSI-part1}}$	348	414	172
$G^{\text{CSI-part2}}$	132	162	116
Hop 1	M_1	48	36
	$G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$	78	56
	$G^{\text{CSI-part1}}(1) = \min(N_L \cdot Q_m \cdot \lceil G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \rceil, M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1))$	204	84
	$G^{\text{CSI-part2}}(1) = M_1 \cdot N_L \cdot Q_m - G^{\text{CSI-part1}}(1)$	84	60
Hop 2	M_2	48	36
	$G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$	84	60

Parameter	Incorrect example value		
	Example 1	Example 2	Example 3
Quantity of coded bits transmitted on a non-reserved RE: $M_2 \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}}(2)$	172	204	84
$G^{\text{CSI-part1}}(2) = G^{\text{CSI-part1}} - G^{\text{CSI-part1}}(1)$	176	210	88
$G^{\text{CSI-part2}}(2) = M_2 \cdot N_L \cdot Q_m - G^{\text{CSI-part1}}(2)$	64	78	56

[0153] It can be learned from the second last row and the third last row in Table 1 that, the quantity of coded bits transmitted on the non-reserved RE on the hop 2 is different from a quantity of coded bits that are of the CSI-part1 and that are mapped onto the non-reserved RE. Therefore, the CSI-part1 cannot be completely carried on the non-reserved RE on the hop 2, and consequently, the CSI-part1 is incompletely sent. It can be learned from the last row and the fourth last row in Table 1 that, the quantity $G_{\text{rvd}}^{\text{ACK}}(2)$ of coded bits mapped onto the reserved RE on the hop 2 is greater than a quantity of coded bits that are of the CSI-part2 and that are mapped onto the hop 2. Therefore, there is no data to be sent on some reserved REs. When the PUSCH uses DFT-s-OFDM, a single-carrier low PAPR characteristic is damaged.

[0154] The foregoing example is merely for description.

[0155] Table 2 shows a result of calculation by using the communication method provided in this application. It can be learned from the second last row and the third last row in Table 2 that, the quantity of coded bits transmitted on the non-reserved RE on the hop 2 is the same as the quantity of coded bits that are of the CSI-part1 and that are mapped onto the non-reserved RE. It can be learned from the last row and the fourth last row in Table 2 that, the quantity $G_{\text{rvd}}^{\text{ACK}}(2)$ of coded bits mapped onto the reserved RE on the hop 2 is equal to the quantity of coded bits that are of the CSI-part2 and that are mapped onto the hop 2, and there is data to be sent on all reserved REs. It can be learned that, in the calculation method in the present invention, both the quantities of coded bits mapped onto the non-reserved REs in the two hops and the quantities of coded bits of the CSI-part1 on the two hops are consistent, thereby resolving the problem in the prior art.

Table 2

Parameter	Incorrect example value		
	Example 1	Example 2	Example 3
Quantity of transmission layers (Layer number): N_L	1	1	1
Modulation order (Modulation order): Q_m	4	6	4
$G_{\text{rvd}}^{\text{ACK}}$	132	162	116
$G^{\text{CSI-part1}}$	348	414	172
$G^{\text{CSI-part2}}$	132	162	116
Hop 1	M_1	48	36
	$G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$	84	60
	$G^{\text{CSI-part1}}(1) = \min(N_L \cdot Q_m \cdot \lfloor G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \rfloor, M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1))$	204	84
	$G^{\text{CSI-part2}}(1) = M_1 \cdot N_L \cdot Q_m - G^{\text{CSI-part1}}(1)$	84	60
Hop 2	M_2	48	36
	$G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$	78	56

Parameter	Incorrect example value		
	Example 1	Example 2	Example 3
Quantity of coded bits transmitted on a non-reserved RE: $M_2 \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}}(2)$	176	210	88
$G^{\text{CSI-part1}}(2) = G^{\text{CSI-part1}} - G^{\text{CSI-part1}}(1)$	176	210	88
$G^{\text{CSI-part2}}(2) = M_2 \cdot N_L \cdot Q_m - G^{\text{CSI-part1}}(2)$	64	78	56

[0156] A frequency hopping splitting rule for coded bits of an HARQ-ACK provided in the prior art is as follows:

[0157] Assuming that a quantity of coded bits of the HARQ-ACK is G^{ACK} , quantities of coded bits of the HARQ-ACK that are sent on the hop 1 and the hop 2 are respectively:

$$5 \quad G^{\text{ACK}}(1) = \min\left(N_L \cdot Q_m \cdot \left\lfloor G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \right\rfloor, M_3 \cdot N_L \cdot Q_m\right) \quad (\text{X})$$

$$G^{\text{ACK}}(2) = G^{\text{ACK}} - G^{\text{ACK}}(1) .$$

[0158] A problem of the foregoing splitting rule is that a non-reserved RE on the hop 1 is insufficient to carry a quantity of coded bits of the CSI-part1 on the hop 1, and consequently, the CSI-part1 is incompletely sent.

10 [0159] Reasons are as follows:

[0160] In the formula (X), a function of taking a parameter $M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)$ on the right of the minimum function $\min(\cdot, \cdot)$ is to set an upper limit (referred to as a first upper limit below) for a resource occupied for the CSI-part1 on the hop 1, that is, the CSI-part1 cannot occupy a resource for the HARQ-ACK on the hop 1. However, based on a specification in a communication protocol, the CSI-part1 cannot occupy the reserved RE resource on the hop 1, that is, the CSI-part1 should not be greater than an upper limit $M_1 \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}}(1)$ (which is referred to as a second upper limit below).

[0161] When the quantity of HARQ-ACK information bits is 0, 1, or 2, G^{ACK} is a quantity of coded bits that is calculated based on an actual quantity of HARQ-ACK information bits, and
 20 $G_{\text{rvd}}^{\text{ACK}}$ is a quantity that is of coded bits mapped onto the reserved RE and that is calculated based on the quantity of HARQ-ACK information bits being 2. Therefore, if the actual quantity of HARQ-ACK information bits is 0 or 1, $G^{\text{ACK}} < G_{\text{rvd}}^{\text{ACK}}$, and $G^{\text{ACK}}(1) < G_{\text{rvd}}^{\text{ACK}}(1)$ for the hop 1. In this case, the first upper limit is greater than the second upper limit. Consequently, the non-reserved RE on the hop 1 may be insufficient to carry the quantity $G^{\text{CSI-part1}}(1)$ of coded bits of the CSI-part1 on the hop 1.

25 [0162] In view of this, this application provides another communication method 600. The method 600 may be implemented based on the foregoing method, or may be implemented in

combination with the foregoing method, or may be independently implemented. As shown in FIG. 6, the method includes the following steps:

[0163] S610. Receive downlink control information, where the downlink control information is used to schedule a PUSCH, the PUSCH is used to carry only UCI, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource.

[0164] S620. Send first UCI on the PUSCH, where the first UCI includes at least one of an HARQ-ACK, CSI-part1, and CSI-part2.

[0165] A quantity $G^{\text{CSI-part1}}(1)$ of coded bits that are of the CSI-part1 in the first UCI and that are mapped onto the first frequency hopping resource is a smaller one of a fourth value and a fifth value, the fourth value is determined based on a quantity $G^{\text{CSI-part1}}$ of coded bits of the CSI-part1 in the first UCI, and the fifth value is determined based on a larger value in $G^{\text{ACK}}(1)$ and $G_{\text{rvd}}^{\text{ACK}}(1)$, or the fifth value is determined based on $G^{\text{ACK}}(1)$, where $G^{\text{ACK}}(1)$ is a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the first frequency hopping resource, and $G_{\text{rvd}}^{\text{ACK}}(1)$ is a quantity of coded bits that can be mapped onto reserved REs in the first frequency hopping resource.

[0166] In the prior art, the fifth value is determined based only on $G^{\text{ACK}}(1)$. For example, the fifth value is $M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)$ in the prior art, and this parameter sets an upper limit (namely, a first upper limit) for a resource occupied by the CSI-part1 on the first frequency hopping resource. In addition, the CSI-part1 cannot occupy the reserved RE in the first frequency hopping resource. That is, $G^{\text{CSI-part1}}(1)$ should also not be greater than an upper limit $M_1 \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}}(1)$ (namely, a second upper limit). When a quantity of HARQ-ACK information bits is 0, 1, or 2, $G^{\text{ACK}}(1)$ is a quantity of coded bits that is calculated based on an actual quantity of HARQ-ACK information bits, and $G_{\text{rvd}}^{\text{ACK}}$ is a quantity that is of coded bits mapped onto the reserved RE and that is calculated based on the quantity of HARQ-ACK information bits being 2. Therefore, if the actual quantity of HARQ-ACK information bits is 0 or 1, $G^{\text{ACK}} < G_{\text{rvd}}^{\text{ACK}}$, and $G^{\text{ACK}}(1) < G_{\text{rvd}}^{\text{ACK}}(1)$.

That is, on the first frequency hopping resource, $G^{\text{ACK}} < G_{\text{rvd}}^{\text{ACK}}$. In this case, the first upper limit is greater than the second upper limit. In the prior art, if the fifth value is determined based only on $G^{\text{ACK}}(1)$, a non-reserved RE in the first frequency hopping resource may be insufficient for carrying the quantity $G^{\text{CSI-part1}}(1)$ of coded bits of the CSI-part1 on the first frequency hopping resource.

5

[0167] In the solution provided in this application, the fifth value is determined based on the larger one of $G^{\text{ACK}}(1)$ and $G_{\text{rvd}}^{\text{ACK}}(1)$ (where when the quantity of HARQ-ACK bits is greater than 2, $G_{\text{rvd}}^{\text{ACK}}(1)$ is equal to 0), to ensure that $G^{\text{CSI-part1}}(1)$ is calculated by using an actual non-reserved RE in the first frequency hopping resource as a reference, thereby avoiding the foregoing problem that the CSI-part1 is incompletely sent.

10

[0168] Optionally, that the fifth value is determined based on a larger value in $G^{\text{ACK}}(1)$ and $G_{\text{rvd}}^{\text{ACK}}(1)$ includes that the fifth value is equal to $M_1 \cdot N_L \cdot Q_m - \max(G^{\text{ACK}}(1), G_{\text{rvd}}^{\text{ACK}}(1))$; or

that the fifth value is determined based on $G^{\text{ACK}}(1)$ includes: the fifth value is equal to $M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)$ when the quantity of HARQ-ACK bits is greater than 2; or the fifth value is equal to $M_1 \cdot N_L \cdot Q_m - \max(G^{\text{ACK}}(1), G_{\text{rvd}}^{\text{ACK}}(1))$ when the quantity of HARQ-ACK bits is less than or equal to 2.

15

[0169] M_1 is a quantity of REs that can carry data and that are in the first frequency hopping resource, N_L is a quantity of transmission layers of the PUSCH, and Q_m is a modulation order of the first UCI.

20

[0170] Optionally, that the fourth value is determined based on a quantity $G^{\text{CSI-part1}}$ of coded bits of the CSI-part1 in the first UCI includes: the fourth value is equal to $N_L \cdot Q_m \cdot \lfloor G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \rfloor$, where N_L is the quantity of transmission layers of the PUSCH, and Q_m is the modulation order of the first UCI.

25

[0171] The method 600 may be separately implemented, or may be jointly implemented with the method 400.

[0172] This application further provides a communication method. As shown in FIG. 7, the

method 700 includes the following steps:

[0173] S710. Send downlink control information, where the downlink control information is used to schedule a PUSCH, the PUSCH is used to carry only UCI, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource.

[0174] S720. Receive first UCI on the PUSCH, where the first UCI includes at least one of an HARQ-ACK, CSI-part1, and CSI-part2, where a quantity of coded bits that can be mapped onto reserved REs in the first frequency hopping resource is a first value, a quantity of coded bits that can be mapped onto reserved REs in the second frequency hopping resource is a second value, the first value is not less than the second value, and the reserved RE in the first frequency hopping resource and the reserved RE in the second frequency hopping resource are reserved for transmitting potential HARQ-ACK which has less than or equal to 2 bits.

[0175] A reason that information in the CSI-part1 is incompletely sent is that a quantity of coded bits that are of the CSI-part1 and that are mapped onto the second frequency hopping resource is relatively small. In other words, a quantity of REs on the second frequency hopping resource that are used to map the CSI-part1 is relatively small, and consequently, the CSI-part1 cannot be all mapped onto the second frequency hopping resource. Compared with the prior art, this application reduces a quantity of coded bits that are capable of being mapped onto reserved REs in the second frequency hopping resource, thereby increasing a quantity of REs that are in the second frequency hopping resource and that are used to map the CSI-part1. This resolves a problem that due to UCI transmission through frequency hopping in a UCI-only scenario, information in the CSI-part1 is incompletely sent.

[0176] A person skilled in the art may understand that the method 700 corresponds to the method 400. For brevity, details are not described herein again.

[0177] Optionally, the first value is $G_{\text{rvd}}^{\text{ACK}}(1)$, and $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$; and/or

the second value is $G_{\text{rvd}}^{\text{ACK}}(2)$, and $G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$, where

N_L is a quantity of transmission layers of the PUSCH, and Q_m is a modulation order

of the first UCI.

[0178] Optionally, $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$, and $G_{\text{rvd}}^{\text{ACK}}(2) = G^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(1)$;

or

$$G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor, \text{ and } G_{\text{rvd}}^{\text{ACK}}(1) = G^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(2).$$

[0179] Optionally, a quantity of coded bits that are of the HARQ-ACK in the first UCI and
 5 that are mapped onto the first frequency hopping resource is $G^{\text{ACK}}(1)$, and a value of $G^{\text{ACK}}(1)$ is a smaller one of the following two values:

a quantity of coded bits mapped onto an RE that is after a first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data, and a third value that is determined based on G^{ACK} , where G^{ACK} is a quantity of coded bits
 10 of the HARQ-ACK in the first UCI.

[0180] Optionally, a value of the quantity of coded bits mapped onto the RE that is after the first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data is equal to $M_3 \cdot N_L \cdot Q_m$, where M_3 is a quantity of REs that are after the first group of consecutive DMRS symbols on the first frequency hopping resource
 15 and that are capable of being used to carry data, N_L is the quantity of transmission layers of the PUSCH, Q_m is the modulation order of the first UCI, and the third value is $N_L \cdot Q_m \cdot \lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$. The quantity of bits of the HARQ-ACK in the first UCI is not greater than 2.

[0181] The foregoing solution is content described in a formula
 20 $G^{\text{ACK}}(1) = \min\left(N_L \cdot Q_m \cdot \lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil, M_3 \cdot N_L \cdot Q_m\right)$.

[0182] Optionally, a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the second frequency hopping resource is $G^{\text{ACK}}(2)$, where
 $G^{\text{ACK}}(2) = G^{\text{ACK}} - G^{\text{ACK}}(1)$.

[0183] This application further provides a communication method. As shown in FIG. 8, the
 25 method 800 includes the following steps:

[0184] S810. Send downlink control information, where the downlink control information is used to schedule a PUSCH, the PUSCH is used to carry only UCI, the PUSCH includes a first

frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource.

[0185] S820. Receive first UCI on the PUSCH, where the first UCI includes at least one of an HARQ-ACK, CSI-part1, and CSI-part2.

[0186] A quantity $G^{\text{CSI-part1}}(1)$ of coded bits that are of the CSI-part1 in the first UCI and that are mapped onto the first frequency hopping resource is a smaller one of a fourth value and a fifth value, the fourth value is determined based on a quantity $G^{\text{CSI-part1}}$ of coded bits of the CSI-part1 in the first UCI, and the fifth value is determined based on a larger value in $G^{\text{ACK}}(1)$ and $G_{\text{rvd}}^{\text{ACK}}(1)$, or the fifth value is determined based on $G^{\text{ACK}}(1)$, where $G^{\text{ACK}}(1)$ is a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the first frequency hopping resource, and $G_{\text{rvd}}^{\text{ACK}}(1)$ is a quantity of coded bits that can be mapped onto reserved REs in the first frequency hopping resource.

[0187] In the prior art, the fifth value is determined based only on $G^{\text{ACK}}(1)$. For example, the fifth value is $M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)$ in the prior art, and this parameter sets an upper limit (namely, a first upper limit) for a resource occupied by the CSI-part1 on the first frequency hopping resource. In addition, the CSI-part1 cannot occupy the reserved RE in the first frequency hopping resource. That is, $G^{\text{CSI-part1}}(1)$ should also not be greater than an upper limit $M_1 \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}}(1)$ (namely, a second upper limit). When a quantity of HARQ-ACK information bits is 0, 1, or 2, $G^{\text{ACK}}(1)$ is a quantity of coded bits that is calculated based on an actual quantity of HARQ-ACK information bits, and $G_{\text{rvd}}^{\text{ACK}}$ is a quantity that is of coded bits mapped onto the reserved RE and that is calculated based on the quantity of HARQ-ACK information bits being 2. Therefore, if the actual quantity of HARQ-ACK information bits is 0 or 1, $G^{\text{ACK}} < G_{\text{rvd}}^{\text{ACK}}$, and $G^{\text{ACK}}(1) < G_{\text{rvd}}^{\text{ACK}}(1)$. That is, on the first frequency hopping resource, $G^{\text{ACK}} < G_{\text{rvd}}^{\text{ACK}}$. In this case, the first upper limit is greater than the second upper limit. In the prior art, if the fifth value is determined based only on $G^{\text{ACK}}(1)$, a non-reserved RE in the first frequency hopping resource may be insufficient for

carrying the quantity $G^{\text{CSI-part1}}(1)$ of coded bits of the CSI-part1 on the first frequency hopping resource.

[0188] In the solution provided in this application, the fifth value is determined based on the larger one of $G^{\text{ACK}}(1)$ and $G_{\text{rvd}}^{\text{ACK}}(1)$ (where when the quantity of HARQ-ACK bits is greater than 2, $G_{\text{rvd}}^{\text{ACK}}(1)$ is equal to 0), to ensure that $G^{\text{CSI-part1}}(1)$ is calculated by using an actual non-reserved RE in the first frequency hopping resource as a reference, thereby avoiding the foregoing problem that the CSI-part1 is incompletely sent.

[0189] A person skilled in the art may understand that the method 800 corresponds to the method 600. For brevity, details are not described herein again.

10 [0190] Optionally, that the fifth value is determined based on a larger value in $G^{\text{ACK}}(1)$ and $G_{\text{rvd}}^{\text{ACK}}(1)$ includes that the fifth value is equal to $M_1 \cdot N_L \cdot Q_m - \max(G^{\text{ACK}}(1), G_{\text{rvd}}^{\text{ACK}}(1))$; or

that the fifth value is determined based on $G^{\text{ACK}}(1)$ includes: the fifth value is equal to $M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)$ when the quantity of HARQ-ACK bits is greater than 2; or the fifth value is equal to $M_1 \cdot N_L \cdot Q_m - \max(G^{\text{ACK}}(1), G_{\text{rvd}}^{\text{ACK}}(1))$ when the quantity of HARQ-ACK bits is less than or equal to 2.

[0191] M_1 is a quantity of REs that can carry data and that are in the first frequency hopping resource, N_L is a quantity of transmission layers of the PUSCH, and Q_m is a modulation order of the first UCI.

20 [0192] Optionally, that the fourth value is determined based on a quantity $G^{\text{CSI-part1}}$ of coded bits of the CSI-part1 in the first UCI includes: the fourth value is equal to $N_L \cdot Q_m \cdot \lfloor G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \rfloor$, where N_L is the quantity of transmission layers of the PUSCH, and Q_m is the modulation order of the first UCI.

[0193] In another implementation, a communication method is provided, where the method includes:

25 receiving indication information, where the indication information is used to schedule a physical uplink shared channel PUSCH, the PUSCH includes a first frequency hopping resource

and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and

5 sending first UCI on the PUSCH, where the first UCI includes at least one of a transmission hybrid automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2.

[0194] A quantity of coded bits that can be mapped onto reserved resource elements REs in the first frequency hopping resource is a first value, a quantity of coded bits that can be mapped onto reserved REs in the second frequency hopping resource is a second value, the first value is not less than the second value, and the reserved RE in the first frequency hopping resource and the reserved RE in the second frequency hopping resource are reserved for transmitting potential HARQ-ACK which a bit quantity is not greater than 2.

[0195] Optionally, the method may be performed by a terminal device, or may be performed by an apparatus or a chip that is integrated into a terminal device or that is independent from a terminal device.

[0196] Correspondingly, this implementation provides an apparatus, where the apparatus includes:

a receiving unit, configured to receive indication information, where the indication information is used to schedule a physical uplink shared channel PUSCH, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and

a sending unit, for sending first UCI on the PUSCH, where the first UCI includes at least one of a transmission hybrid automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2.

[0197] A quantity of coded bits that can be mapped onto reserved resource elements REs in the first frequency hopping resource is a first quantity, a quantity of coded bits that can be mapped onto reserved REs in the second frequency hopping resource is a second quantity, the first quantity is not less than the second quantity, and the reserved RE in the first frequency hopping resource and the reserved RE in the second frequency hopping resource are reserved for potential HARQ-ARK transmission in which a bit quantity is not greater than 2.

[0198] This implementation further provides another communication method, corresponding to the previous communication method provided by this implementation. The two communication methods are performed by both interaction parties. The method includes:

5 sending indication information, where the indication information is used to schedule a physical uplink shared channel PUSCH, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and

10 receiving first UCI on the PUSCH, where the first UCI includes at least one of a transmission hybrid automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2.

[0199] A quantity of coded bits that can be mapped onto reserved resource elements REs in the first frequency hopping resource is a first quantity, a quantity of coded bits that can be mapped onto reserved REs in the second frequency hopping resource is a second quantity, the first quantity is not less than the second quantity, and the reserved RE in the first frequency hopping resource and the reserved RE in the second frequency hopping resource are reserved for potential HARQ-ARK transmission in which a bit quantity is not greater than 2.

15

[0200] Optionally, the method may be performed by a network device, or may be performed by an apparatus or a chip that is integrated into a network device or that is independent from a network device.

20

[0201] Correspondingly, this implementation provides an apparatus, where the apparatus includes:

25 a sending unit, configured to send indication information, where the indication information is used to schedule a physical uplink shared channel PUSCH, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and

30 a receiving unit, configured to receive first UCI on the PUSCH, where the first UCI includes at least one of a transmission hybrid automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2.

[0202] A quantity of coded bits that can be mapped onto reserved resource elements REs in the first frequency hopping resource is a first quantity, a quantity of coded bits that can be mapped onto reserved REs in the second frequency hopping resource is a second quantity, the first quantity is not less than the second quantity, and the reserved RE in the first frequency hopping resource and the reserved RE in the second frequency hopping resource are reserved for potential HARQ-ACK transmission in which a bit quantity is not greater than 2.

[0203] Further, in this implementation:

[0204] In an optional design, the PUSCH includes an uplink shared channel UL-SCH, the first UCI includes the HARQ-ACK, a quantity of coded bits that are of the HARQ-ACK and that are mapped onto the first frequency hopping resource is a sixth value, and a quantity of coded bits that are of the HARQ-ACK and that are mapped onto the second frequency hopping resource is a seventh value, where the sixth value is not less than the seventh value.

[0205] In an optional design, a quantity of mapped coded bits of the HARQ-ACK included in the first UCI is $G^{\text{ACK,withUL-SCH}}$; and

the sixth value is $G^{\text{ACK,withUL-SCH}}(1)$, and

$$G^{\text{ACK,withUL-SCH}}(1) = N_L \cdot Q_m \cdot \left\lceil G^{\text{ACK,withUL-SCH}} / (2 \cdot N_L \cdot Q_m) \right\rceil; \text{ and/or}$$

the seventh value is $G^{\text{ACK,withUL-SCH}}(2)$, and

$$G^{\text{ACK,withUL-SCH}}(2) = N_L \cdot Q_m \cdot \left\lfloor G^{\text{ACK,withUL-SCH}} / (2 \cdot N_L \cdot Q_m) \right\rfloor, \text{ where}$$

N_L is a quantity of transmission layers of the PUSCH, and Q_m is a modulation order of the UL-SCH and the first UCI.

[0206] In an optional design, the sixth value is

$$G^{\text{ACK,withUL-SCH}}(1) = N_L \cdot Q_m \cdot \left\lceil G_{\text{rvd}}^{\text{ACK,withUL-SCH}} / (2 \cdot N_L \cdot Q_m) \right\rceil, \text{ and the seventh value is}$$

$$G^{\text{ACK,withUL-SCH}}(2) = G^{\text{ACK,withUL-SCH}} - G^{\text{ACK,withUL-SCH}}(1); \text{ or}$$

the seventh value is $G^{\text{ACK,withUL-SCH}}(2) = N_L \cdot Q_m \cdot \left\lfloor G^{\text{ACK,withUL-SCH}} / (2 \cdot N_L \cdot Q_m) \right\rfloor$, and the

sixth value is $G^{\text{ACK,withUL-SCH}}(1) = G^{\text{ACK,withUL-SCH}} - G^{\text{ACK,withUL-SCH}}(2)$.

[0207] It should be noted that, for definitions of the parameters used in this implementation, refer to the foregoing description and explanation.

[0208] The foregoing describes in detail examples of the communication methods provided in this application. It can be understood that, to implement the foregoing functions, the communications apparatus includes a corresponding hardware structure and/or software module for performing each function. A person skilled in the art should easily be aware that, in combination with units and algorithm steps of the examples described in the embodiments disclosed in this specification, this application may be implemented by hardware or a combination of hardware and computer software. Whether a function is performed by hardware or hardware driven by computer software depends on particular applications and design constraints of the technical solutions. A person skilled in the art may use different methods to implement the described functions for each particular application, but it should not be considered that the implementation goes beyond the scope of this application.

[0209] In this application, the communications apparatus may be divided into functional units based on the foregoing method examples. For example, each functional unit may be obtained through division based on a corresponding function, or two or more functions may be integrated into one processing unit. The integrated unit may be implemented in a form of hardware, or may be implemented in a form of a software functional unit. It should be noted that, unit division in this application is an example, and is merely logical function division. During actual implementation, another division manner may be used.

[0210] When an integrated unit is used, FIG. 9 is a possible schematic structural diagram of a communications apparatus according to this application. The apparatus 900 includes a processing unit 901, a receiving unit 902, and a sending unit 903. The processing unit 901 is configured to control the apparatus 900 to perform the steps of the communication method shown in FIG. 4. The processing unit 901 may be further configured to perform another process of the technology described in this specification. The apparatus 900 may further include a storage unit, configured to store program code and data of the apparatus 900.

[0211] For example, the processing unit 901 is configured to control the receiving unit 902 to receive downlink control information, where the downlink control information is used to schedule a physical uplink shared channel PUSCH, the PUSCH is used to carry only uplink control information UCI, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource.

[0212] The processing unit 901 is further configured to control the sending unit 903 to send first UCI on the PUSCH, where the first UCI includes at least one of a hybrid automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2.

5 [0213] A quantity of coded bits that can be mapped onto reserved resource elements REs in the first frequency hopping resource is a first value, a quantity of coded bits that can be mapped onto reserved REs in the second frequency hopping resource is a second value, the first value is not less than the second value, and the reserved RE in the first frequency hopping resource and the reserved RE in the second frequency hopping resource are reserved for transmitting potential
10 HARQ-ACK which has less than or equal to 2 bits.

[0214] The processing unit 901 may be a processor or a controller, such as a central processing unit (central processing unit, CPU), a general-purpose processor, a digital signal processor (digital signal processor, DSP), an application-specific integrated circuit (application-specific integrated circuit, ASIC), a field programmable gate array (field programmable gate array, FPGA), or another
15 programmable logical device, a transistor logical device, a hardware component, or any combination thereof. The processor may implement or execute various example logical blocks, modules, and circuits described with reference to content disclosed in this application. Alternatively, the processor may be a combination implementing a computing function, for example, a combination of one or more microprocessors, or a combination of a DSP and a
20 microprocessor. For example, the sending unit 902 and the receiving unit 903 are a transceiver, and the storage unit may be a memory.

[0215] When the processing unit 901 is a processor, the sending unit 902 and the receiving unit 903 are a transceiver, and the storage unit is a memory, the communications apparatus in this application may be an apparatus shown in FIG. 10.

25 [0216] Referring to FIG. 10, the apparatus 1000 includes a processor 1001, a transceiver 1002, and a memory 1003 (optional). The processor 1001, the transceiver 1002, and the memory 1003 may communicate with each other by using an internal connection path, to transfer a control signal and/or a data signal.

[0217] It may be clearly understood by a person skilled in the art that, for ease of brief
30 description, for detailed working processes of the foregoing apparatuses and units, refer to corresponding processes in the foregoing method embodiments, and details are not described

herein again.

[0218] According to the communications apparatus provided in this application, a CSI-part1 mapping rule is changed, to resolve a problem that due to UCI transmission through frequency hopping in a UCI-only scenario, information in CSI-part1 is incompletely sent.

5 [0219] When an integrated unit is used, FIG. 11 is a possible schematic structural diagram of another communications apparatus according to this application. The apparatus 1100 includes a processing unit 1101, a receiving unit 1102, and a sending unit 1103. The processing unit 1101 is configured to control the apparatus 1100 to perform the steps of the communication method shown in FIG. 6. The processing unit 1101 may be further configured to perform another process of the
10 technology described in this specification. The apparatus 1100 may further include a storage unit, configured to store program code and data of the apparatus 1100.

[0220] For example, the processing unit 1101 is configured to control the receiving unit 1102 to receive downlink control information, where the downlink control information is used to schedule a PUSCH, the PUSCH is used to carry only UCI, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the
15 first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource.

[0221] The processing unit 1101 is further configured to control the sending unit 1103 to send first UCI on the PUSCH, where the first UCI includes at least one of an HARQ-ACK, CSI-part1,
20 and CSI-part2.

[0222] A quantity $G^{\text{CSI-part1}}(1)$ of coded bits that are of the CSI-part1 in the first UCI and that are mapped onto the first frequency hopping resource is a smaller one of a fourth value and a fifth value, the fourth value is determined based on a quantity $G^{\text{CSI-part1}}$ of coded bits of the CSI-part1 in the first UCI, and the fifth value is determined based on a larger value in $G^{\text{ACK}}(1)$ and
25 $G_{\text{rvd}}^{\text{ACK}}(1)$, or the fifth value is determined based on $G^{\text{ACK}}(1)$, where $G^{\text{ACK}}(1)$ is a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the first frequency hopping resource, and $G_{\text{rvd}}^{\text{ACK}}(1)$ is a quantity of coded bits that can be mapped onto reserved REs in the first frequency hopping resource.

[0223] The processing unit 1101 may be a processor or a controller, for example, may be a

CPU, a general-purpose processor, a DSP, an ASIC, an FPGA, or another programmable logic device, a transistor logic device, a hardware component, or any combination thereof. The processor may implement or execute various example logical blocks, modules, and circuits described with reference to content disclosed in this application. Alternatively, the processor may be a
 5 combination implementing a computing function, for example, a combination of one or more microprocessors, or a combination of a DSP and a microprocessor. For example, the sending unit 1102 and the receiving unit 1103 are a transceiver, and the storage unit may be a memory.

[0224] When the processing unit 1101 is a processor, the sending unit 1102 and the receiving unit 1103 are a transceiver, and the storage unit is a memory, the communications apparatus in this
 10 application may be an apparatus shown in FIG. 12.

[0225] Referring to FIG. 12, the apparatus 1200 includes a processor 1201, a transceiver 1202, and a memory 1203 (optional). The processor 1201, the transceiver 1202, and the memory 1203 may communicate with each other by using an internal connection path, to transfer a control signal and/or a data signal.

[0226] It may be clearly understood by a person skilled in the art that, for ease of brief description, for detailed working processes of the foregoing apparatuses and units, refer to corresponding processes in the foregoing method embodiments, and details are not described herein again.

[0227] According to the communications apparatus provided in this application, a CSI-part1 mapping rule is changed, to resolve a problem that due to UCI transmission through frequency hopping in a UCI-only scenario, information in CSI-part1 is incompletely sent.

[0228] When an integrated unit is used, FIG. 13 is a possible schematic structural diagram of a communications apparatus according to this application. The apparatus 1300 includes a processing unit 1301, a receiving unit 1302, and a sending unit 1303. The processing unit 1301 is
 25 configured to control the apparatus 1300 to perform the steps of the communication method shown in FIG. 7. The processing unit 1301 may be further configured to perform another process of the technology described in this specification. The apparatus 1300 may further include a storage unit, configured to store program code and data of the apparatus 1300.

[0229] For example, the processing unit 1301 is configured to control the sending unit 1303
 30 to send downlink control information, where the downlink control information is used to schedule a physical uplink shared channel PUSCH, the PUSCH is used to carry only uplink control

information UCI, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource.

5 [0230] The processing unit 1301 is further configured to control the receiving unit 1302 to receive first UCI on the PUSCH, where the first UCI includes at least one of a hybrid automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2.

10 [0231] A quantity of coded bits that can be mapped onto reserved resource elements REs in the first frequency hopping resource is a first value, a quantity of coded bits that can be mapped onto reserved REs in the second frequency hopping resource is a second value, the first value is not less than the second value, and the reserved RE in the first frequency hopping resource and the reserved RE in the second frequency hopping resource are reserved for transmitting potential HARQ-ACK which has less than or equal to 2 bits.

15 [0232] The processing unit 1301 may be a processor or a controller, such as a central processing unit (central processing unit, CPU), a general-purpose processor, a digital signal processor (digital signal processor, DSP), an application-specific integrated circuit (application-specific integrated circuit, ASIC), a field programmable gate array (field programmable gate array, FPGA), or another programmable logical device, a transistor logical device, a hardware component, or any combination thereof. The processor may implement or execute various example
20 logical blocks, modules, and circuits described with reference to content disclosed in this application. Alternatively, the processor may be a combination implementing a computing function, for example, a combination of one or more microprocessors, or a combination of a DSP and a microprocessor. For example, the sending unit 1302 and the receiving unit 1303 are a transceiver, and the storage unit may be a memory.

25 [0233] When the processing unit 1301 is a processor, the sending unit 1302 and the receiving unit 1303 are a transceiver, and the storage unit is a memory, the communications apparatus in this application may be an apparatus shown in FIG. 14.

30 [0234] Referring to FIG. 14, the apparatus 1400 includes a processor 1401, a transceiver 1402, and a memory 1403 (optional). The processor 1401, the transceiver 1402, and the memory 1403 may communicate with each other by using an internal connection path, to transfer a control signal and/or a data signal.

[0235] It may be clearly understood by a person skilled in the art that, for ease of brief description, for detailed working processes of the foregoing apparatuses and units, refer to corresponding processes in the foregoing method embodiments, and details are not described herein again.

5 [0236] According to the communications apparatus provided in this application, a CSI-part1 mapping rule is changed, to resolve a problem that due to UCI transmission through frequency hopping in a UCI-only scenario, information in CSI-part1 is incompletely sent.

[0237] When an integrated unit is used, FIG. 15 is a possible schematic structural diagram of another communications apparatus according to this application. The apparatus 1500 includes a
10 processing unit 1501, a receiving unit 1502, and a sending unit 1503. The processing unit 1501 is configured to control the apparatus 1500 to perform the steps of the communication method shown in FIG. 8. The processing unit 1501 may be further configured to perform another process of the technology described in this specification. The apparatus 1500 may further include a storage unit, configured to store program code and data of the apparatus 1500.

15 [0238] For example, the processing unit 1501 is configured to control the sending unit 1503 to send downlink control information, where the downlink control information is used to schedule a PUSCH, the PUSCH is used to carry only UCI, the PUSCH includes a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping
20 resource.

[0239] The processing unit 1501 is further configured to control the receiving unit 1503 to receive first UCI on the PUSCH, where the first UCI includes at least one of an HARQ-ACK, CSI-part1, and CSI-part2.

[0240] A quantity $G^{\text{CSI-part1}}(1)$ of coded bits that are of the CSI-part1 in the first UCI and that
25 are mapped onto the first frequency hopping resource is a smaller one of a fourth value and a fifth value, the fourth value is determined based on a quantity $G^{\text{CSI-part1}}$ of coded bits of the CSI-part1 in the first UCI, and the fifth value is determined based on a larger value in $G^{\text{ACK}}(1)$ and $G_{\text{rvd}}^{\text{ACK}}(1)$, or the fifth value is determined based on $G^{\text{ACK}}(1)$, where $G^{\text{ACK}}(1)$ is a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the first frequency

hopping resource, and $G_{\text{rvd}}^{\text{ACK}}(1)$ is a quantity of coded bits that can be mapped onto reserved REs in the first frequency hopping resource.

5 [0241] The processing unit 1501 may be a processor or a controller, for example, may be a CPU, a general-purpose processor, a DSP, an ASIC, an FPGA, or another programmable logic device, a transistor logic device, a hardware component, or any combination thereof. The processor may implement or execute various example logical blocks, modules, and circuits described with reference to content disclosed in this application. Alternatively, the processor may be a combination implementing a computing function, for example, a combination of one or more microprocessors, or a combination of a DSP and a microprocessor. For example, the sending unit 10 1502 and the receiving unit 1503 are a transceiver, and the storage unit may be a memory.

[0242] When the processing unit 1501 is a processor, the sending unit 1502 and the receiving unit 1503 are a transceiver, and the storage unit is a memory, the communications apparatus in this application may be an apparatus shown in FIG. 16.

15 [0243] Referring to FIG. 16, the apparatus 1600 includes a processor 1601, a transceiver 1602, and a memory 1603 (optional). The processor 1601, the transceiver 1602, and the memory 1603 may communicate with each other by using an internal connection path, to transfer a control signal and/or a data signal.

20 [0244] It may be clearly understood by a person skilled in the art that, for ease of brief description, for detailed working processes of the foregoing apparatuses and units, refer to corresponding processes in the foregoing method embodiments, and details are not described herein again.

[0245] According to the communications apparatus provided in this application, a CSI-part1 mapping rule is changed, to resolve a problem that due to UCI transmission through frequency hopping in a UCI-only scenario, information in CSI-part1 is incompletely sent.

25 [0246] The apparatus embodiments completely correspond to the method embodiments. For example, a communications unit performs an obtaining step in the method embodiments, and all steps other than the obtaining step and the sending step may be performed by the processing unit or the processor. For a function of a specific unit, refer to a corresponding method embodiment. Details are not described herein again.

30 [0247] It should be understood that sequence numbers of the foregoing processes do not mean

execution sequences in various embodiments of this application. The execution sequences of the processes should be determined based on functions and internal logic of the processes, and should not be construed as any limitation on the implementation processes of this application.

5 [0248] In addition, the term "and/or" in this specification describes only an association relationship for describing associated objects and represents that three relationships may exist. For example, A and/or B may represent the following three cases: Only A exists, both A and B exist, and only B exists. In addition, the character "/" in this specification generally indicates an "or" relationship between the associated objects.

10 [0249] Method or algorithm steps described in combination with the content disclosed in this application may be implemented by hardware, or may be implemented by a processor by executing a software instruction. The software instruction may include a corresponding software module. The software module may be stored in a random access memory (random access memory, RAM), a flash memory, a read-only memory (read only memory, ROM), an erasable programmable read only memory (erasable programmable ROM, EPROM), an electrically erasable programmable
15 read only memory (electrically EPROM, EEPROM), a register, a hard disk, a mobile hard disk, a compact disc read-only memory (CD-ROM), or any other form of storage medium well-known in the art. For example, a storage medium is coupled to a processor, so that the processor can read information from the storage medium or write information into the storage medium. Certainly, the storage medium may be a component of the processor. The processor and the storage medium may
20 be located in the ASIC.

[0250] All or some of the foregoing embodiments may be implemented by using software, hardware, firmware, or any combination thereof. When software is used to implement the embodiments, the embodiments may be implemented completely or partially in a form of a computer program product. The computer program product includes one or more computer
25 instructions. When the computer program instructions are loaded and executed on the computer, the procedure or functions according to this application are all or partially generated. The computer may be a general-purpose computer, a dedicated computer, a computer network, or other programmable apparatuses. The computer instructions may be stored in a computer-readable storage medium, or may be transmitted by using the computer-readable storage medium. The
30 computer instructions may be transmitted from a website, computer, server, or data center to another website, computer, server, or data center in a wired (for example, a coaxial cable, an optical

fiber, or a digital subscriber line (digital subscriber line, DSL)) or wireless (for example, infrared, radio, or microwave) manner. The computer-readable storage medium may be any usable medium accessible by a computer, or a data storage device, such as a server or a data center, integrating one or more usable media. The usable medium may be a magnetic medium (for example, a floppy
5 disk, a hard disk, or a magnetic tape), an optical medium (for example, a digital versatile disc (digital versatile disc, DVD), a semiconductor medium (for example, a solid-state drive (solid state disk, SSD)), or the like.

[0251] The objectives, technical solutions, and benefits of this application are further described in detail in the foregoing specific embodiments. It should be understood that the
10 foregoing descriptions are merely specific embodiments of this application, but are not intended to limit the protection scope of this application. Any modification, equivalent replacement or improvement made based on technical solutions of this application shall fall within the protection scope of this application.

CLAIMS

What is claimed is:

1. A communication method, comprising:

receiving downlink control information, wherein the downlink control information is used to
 5 schedule a physical uplink shared channel PUSCH, the PUSCH is used to carry only uplink control
 information UCI, the PUSCH comprises a first frequency hopping resource and a second
 frequency hopping resource, and a time-domain start symbol of the first frequency hopping
 resource is before a time-domain start symbol of the second frequency hopping resource; and

10 sending first UCI on the PUSCH, wherein the first UCI comprises at least one of a hybrid
 automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-
 part1, and a channel state information part 2 CSI-part2, wherein

15 a quantity of coded bits that can be mapped onto reserved resource elements REs in the first
 frequency hopping resource is a first value, a quantity of coded bits that can be mapped onto a
 reserved REs in the second frequency hopping resource is a second value, the first value is not less
 than the second value, and the reserved REs in the first frequency hopping resource and the
 reserved REs in the second frequency hopping resource are reserved for transmitting potential
 HARQ-ACK which has less than or equal to 2 bits.

2. The method according to claim 1, wherein the method further comprises:

20 determining a first quantity $G_{\text{rvd}}^{\text{ACK}}$ of coded bits, wherein $G_{\text{rvd}}^{\text{ACK}}$ is a sum of the quantities
 of coded bits that can be mapped onto the reserved REs in the first frequency hopping resource
 and the second frequency hopping resource, and both the first value and the second value are
 determined based on $G_{\text{rvd}}^{\text{ACK}}$.

3. The method according to claim 2, wherein

the first value is $G_{\text{rvd}}^{\text{ACK}}(1)$, and $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$; and/or

25 the second value is $G_{\text{rvd}}^{\text{ACK}}(2)$, and $G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$, wherein

N_L is a quantity of transmission layers of the PUSCH, and Q_m is a modulation order of
 the first UCI.

4. The method according to claim 3, wherein

the first value is $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$, and the second value is

$$G_{\text{rvd}}^{\text{ACK}}(2) = G_{\text{rvd}}^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(1); \text{ or}$$

the second value is $G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$, and the first value is

$$G_{\text{rvd}}^{\text{ACK}}(1) = G_{\text{rvd}}^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(2).$$

5 5. The method according to any one of claims 1 to 4, wherein the method further comprises:
determining a quantity G^{ACK} of coded bits of the HARQ-ACK in the first UCI, wherein
a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto
the first frequency hopping resource is $G^{\text{ACK}}(1)$, and a value of $G^{\text{ACK}}(1)$ is a smaller one of the
following two values:

10 a quantity of coded bits mapped onto REs that are after a first group of consecutive
demodulation reference signal DMRS symbols on the first frequency hopping resource and that
are capable of being used to carry data, and a third value determined based on G^{ACK} .

6. The method according to claim 5, wherein

15 a value of the quantity of coded bits mapped onto the REs that are after the first group of
consecutive DMRS symbols on the first frequency hopping resource and that are capable of being
used to carry data is equal to $M_3 \cdot N_L \cdot Q_m$, wherein M_3 is a quantity of REs that are after the
first group of consecutive DMRS symbols on the first frequency hopping resource and that are
capable of being used to carry data, N_L is the quantity of transmission layers of the PUSCH,
 Q_m is the modulation order of the first UCI, and the third value is $N_L \cdot Q_m \cdot \lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$;

20 and

the quantity of bits of the HARQ-ACK in the first UCI is not greater than 2.

7. The method according to claim 6, wherein a quantity of coded bits that are of the HARQ-
ACK in the first UCI and that are mapped onto the second frequency hopping resource is $G^{\text{ACK}}(2)$,
wherein $G^{\text{ACK}}(2) = G^{\text{ACK}} - G^{\text{ACK}}(1)$.

25 8. A communication method, comprising:

sending downlink control information, wherein the downlink control information is used to
schedule a physical uplink shared channel PUSCH, the PUSCH is used to carry only uplink control

information UCI, the PUSCH comprises a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and

receiving first UCI on the PUSCH, wherein the first UCI comprises at least one of a hybrid
 5 automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2, wherein

a quantity of coded bits that can be mapped onto a reserved resource elements REs in the first frequency hopping resource is a first value, a quantity of coded bits that can be mapped onto a reserved REs in the second frequency hopping resource is a second value, the first value is not less
 10 than the second value, and the reserved REs in the first frequency hopping resource and the reserved REs in the second frequency hopping resource are reserved for transmitting potential HARQ-ACK which has less than or equal to 2 bits.

9. The method according to claim 8, wherein

both the first value and the second value correspond to a first quantity $G_{\text{rvd}}^{\text{ACK}}$ of coded bits,
 15 and $G_{\text{rvd}}^{\text{ACK}}$ is a sum of the quantities of coded bits mapped onto the reserved REs in the first frequency hopping resource and the second frequency hopping resource.

10. The method according to claim 9, wherein

the first value is $G_{\text{rvd}}^{\text{ACK}}(1)$, and $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$; and/or

the second value is $G_{\text{rvd}}^{\text{ACK}}(2)$, and $G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$, wherein

20 N_L is a quantity of transmission layers of the PUSCH, and Q_m is a modulation order of the first UCI.

11. The method according to claim 10, wherein

the first value is $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$, and the second value is

$$G_{\text{rvd}}^{\text{ACK}}(2) = G_{\text{rvd}}^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(1); \text{ or}$$

25 the second value is $G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$, and the first value is

$$G_{\text{rvd}}^{\text{ACK}}(1) = G_{\text{rvd}}^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(2).$$

12. The method according to any one of claims 8 to 11, wherein

a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto

the first frequency hopping resource is $G^{\text{ACK}}(1)$, and a value of $G^{\text{ACK}}(1)$ is a smaller one of the following two values:

5 a quantity of coded bits mapped onto REs that are after a first group of consecutive demodulation reference signal DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data, and a third value that is determined based on G^{ACK} , wherein G^{ACK} is a quantity of coded bits of the HARQ-ACK in the first UCI.

13. The method according to claim 12, wherein

10 a value of the quantity of coded bits mapped onto the REs that are after the first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data is equal to $M_3 \cdot N_L \cdot Q_m$, wherein M_3 is a quantity of REs that are after the first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data, N_L is the quantity of transmission layers of the PUSCH, Q_m is the modulation order of the first UCI, and the third value is $N_L \cdot Q_m \cdot \lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$;

and

15 the quantity of bits of the HARQ-ACK in the first UCI is not greater than 2.

14. The method according to claim 13, wherein a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the second frequency hopping resource is $G^{\text{ACK}}(2)$, wherein $G^{\text{ACK}}(2) = G^{\text{ACK}} - G^{\text{ACK}}(1)$.

15. A communications apparatus, comprising a receiving unit and a sending unit, wherein

20 the receiving unit is configured to receive downlink control information, wherein the downlink control information is used to schedule a physical uplink shared channel PUSCH, the PUSCH is used to carry only uplink control information UCI, the PUSCH comprises a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and

25

the sending unit is configured to send first UCI on the PUSCH, wherein the first UCI comprises at least one of a hybrid automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2,

wherein

a quantity of coded bits that can be mapped onto a reserved resource elements REs in the first frequency hopping resource is a first value, a quantity of coded bits that can be mapped onto a reserved REs in the second frequency hopping resource is a second value, the first value is not less than the second value, and the reserved REs in the first frequency hopping resource and the reserved REs in the second frequency hopping resource are reserved for transmitting potential HARQ-ACK which has less than or equal to 2 bits.

16. The apparatus according to claim 15, wherein the apparatus further comprises a processing unit, configured to:

10 determine a first quantity $G_{\text{rvd}}^{\text{ACK}}$ of coded bits, wherein $G_{\text{rvd}}^{\text{ACK}}$ is a sum of quantities of coded bits mapped onto the reserved REs in the first frequency hopping resource and the second frequency hopping resource, and both the first value and the second value are determined based on $G_{\text{rvd}}^{\text{ACK}}$.

17. The apparatus according to claim 16, wherein

15 the first value is $G_{\text{rvd}}^{\text{ACK}}(1)$, and $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$; and/or

the second value is $G_{\text{rvd}}^{\text{ACK}}(2)$, and $G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$, wherein

N_L is a quantity of transmission layers of the PUSCH, and Q_m is a modulation order of the first UCI.

18. The apparatus according to claim 17, wherein

20 the first value is $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$, and the second value is

$G_{\text{rvd}}^{\text{ACK}}(2) = G_{\text{rvd}}^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(1)$; or

the second value is $G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$, and the first value is

$G_{\text{rvd}}^{\text{ACK}}(1) = G_{\text{rvd}}^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(2)$.

19. The apparatus according to any one of claims 15 to 18, wherein the apparatus further comprises the processing unit, configured to:

determine a quantity G^{ACK} of coded bits of the HARQ-ACK in the first UCI, wherein

a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto

the first frequency hopping resource is $G^{\text{ACK}}(1)$, and a value of $G^{\text{ACK}}(1)$ is a smaller one of the following two values:

a quantity of coded bits mapped onto REs that are after a first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data,
 5 and a third value that is determined based on G^{ACK} .

20. The apparatus according to claim 19, wherein

a value of the quantity of coded bits mapped onto the REs that are after the first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data is equal to $M_3 \cdot N_L \cdot Q_m$, wherein M_3 is a quantity of REs that are after the
 10 first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data, N_L is the quantity of transmission layers of the PUSCH, Q_m is the modulation order of the first UCI, and the third value is $N_L \cdot Q_m \cdot \lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$;
 and

the quantity of bits of the HARQ-ACK in the first UCI is not greater than 2.

15 21. The apparatus according to claim 20, wherein a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the second frequency hopping resource is $G^{\text{ACK}}(2)$, wherein $G^{\text{ACK}}(2) = G^{\text{ACK}} - G^{\text{ACK}}(1)$.

22. A communications apparatus, comprising a sending unit and a receiving unit, wherein

the sending unit is configured to send downlink control information, wherein the downlink
 20 control information is used to schedule a physical uplink shared channel PUSCH, the PUSCH is used to carry only uplink control information UCI, the PUSCH comprises a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and

25 the receiving unit is configured to receive first UCI on the PUSCH, wherein the first UCI comprises at least one of a hybrid automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2, wherein

a quantity of coded bits that can be mapped onto a reserved resource elements REs in the first

frequency hopping resource is a first value, a quantity of coded bits that can be mapped onto a reserved REs in the second frequency hopping resource is a second value, the first value is not less than the second value, and the reserved REs in the first frequency hopping resource and the reserved REs in the second frequency hopping resource are reserved for transmitting potential HARQ-ACK which has less than or equal to 2 bits.

23. The apparatus according to claim 22, wherein

both the first value and the second value correspond to a first quantity $G_{\text{rvd}}^{\text{ACK}}$ of coded bits, and $G_{\text{rvd}}^{\text{ACK}}$ is a sum of the quantities of coded bits mapped onto the reserved REs in the first frequency hopping resource and the second frequency hopping resource.

24. The apparatus according to claim 23, wherein

the first value is $G_{\text{rvd}}^{\text{ACK}}(1)$, and $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$; and/or

the second value is $G_{\text{rvd}}^{\text{ACK}}(2)$, and $G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$, wherein

N_L is a quantity of transmission layers of the PUSCH, and Q_m is a modulation order of the first UCI.

25. The apparatus according to claim 24, wherein

the first value is $G_{\text{rvd}}^{\text{ACK}}(1) = N_L \cdot Q_m \cdot \lceil G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$, and the second value is

$$G_{\text{rvd}}^{\text{ACK}}(2) = G_{\text{rvd}}^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(1); \text{ or}$$

the second value is $G_{\text{rvd}}^{\text{ACK}}(2) = N_L \cdot Q_m \cdot \lfloor G_{\text{rvd}}^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rfloor$, and the first value is

$$G_{\text{rvd}}^{\text{ACK}}(1) = G_{\text{rvd}}^{\text{ACK}} - G_{\text{rvd}}^{\text{ACK}}(2).$$

26. The apparatus according to any one of claims 22 to 25, wherein

a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the first frequency hopping resource is $G^{\text{ACK}}(1)$, and a value of $G^{\text{ACK}}(1)$ is a smaller one of the following two values:

a quantity of coded bits mapped onto REs that are after a first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data, and a third value that is determined based on G^{ACK} , wherein G^{ACK} is a quantity of coded bits of the HARQ-ACK in the first UCI.

27. The apparatus according to claim 26, wherein

a value of the quantity of coded bits mapped onto the REs that are after the first group of consecutive DMRS symbols on the first frequency hopping resource and that are capable of being used to carry data is equal to $M_3 \cdot N_L \cdot Q_m$, wherein M_3 is a quantity of REs that are after the first group of consecutive DMRS symbols on the first frequency hopping resource and that are

5 capable of being used to carry data, N_L is the quantity of transmission layers of the PUSCH, Q_m is the modulation order of the first UCI, and the third value is $N_L \cdot Q_m \cdot \lceil G^{\text{ACK}} / (2 \cdot N_L \cdot Q_m) \rceil$;

and

the quantity of bits of the HARQ-ACK in the first UCI is not greater than 2.

10 28. The apparatus according to claim 27, wherein a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the second frequency hopping resource is $G^{\text{ACK}}(2)$, wherein $G^{\text{ACK}}(2) = G^{\text{ACK}} - G^{\text{ACK}}(1)$.

29. A communications apparatus, comprising a processor, wherein when executing program instructions stored in a memory, the processor implements the method according to any one of claims 1 to 7 or the method according to any one of claims 8 to 14.

15

30. A computer-readable storage medium, wherein the computer-readable storage medium stores a computer program, and when a processor invokes the computer program, the method according to any one of claims 1 to 7 or the method according to any one of claims 8 to 14 is implemented.

20 31. A communication method, comprising:

receiving downlink control information, wherein the downlink control information is used to schedule a physical uplink shared channel PUSCH, the PUSCH is used to carry only uplink control information UCI, the PUSCH comprises a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and

25

sending first UCI on the PUSCH, wherein the first UCI comprises at least one of a hybrid automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2, wherein

a quantity $G^{\text{CSI-part1}}(1)$ of coded bits that are of the CSI-part1 in the first UCI and that are

mapped onto the first frequency hopping resource is a smaller one of a fourth value and a fifth value, and the fourth value is determined based on a quantity $G^{\text{CSI-part1}}$ of coded bits of the CSI-part1 in the first UCI; and

when a quantity of HARQ-ACK bits is greater than 2, the fifth value is equal to
 5 $M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)$;

when a quantity of HARQ-ACK bits is less than or equal to 2, the fifth value is equal to $M_1 \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}}(1)$, wherein

$$M_1 = \sum_{l=0}^{N_{\text{symlhop}}^{\text{PUSCH}}(1)-1} M_{\text{sc}}^{\text{UCI}}(l), \quad N_{\text{symlhop}}^{\text{PUSCH}}(1) \text{ is a quantity of symbols in the first frequency hopping}$$

resource, $M_{\text{sc}}^{\text{UCI}}(l)$ is a quantity of resource elements REs that can carry UCI on a symbol l ,
 10 N_L is a quantity of transmission layers of the PUSCH, Q_m is a modulation order of the PUSCH,
 $G^{\text{ACK}}(1)$ is a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are
 mapped onto the first frequency hopping resource, $G_{\text{rvd}}^{\text{ACK}}(1)$ is a quantity of coded bits that can
 be mapped onto reserved REs in the first frequency hopping resource, and the reserved REs in the
 first frequency hopping resource are reserved for transmitting potential HARQ-ACK which has
 15 less than or equal to 2 bits.

32. The method according to claim 31, wherein

the fourth value is equal to $N_L \cdot Q_m \cdot \lfloor G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \rfloor$.

33. A communication method, comprising:

20 sending downlink control information, wherein the downlink control information is used to
 schedule a physical uplink shared channel PUSCH, the PUSCH is used to carry only uplink control
 information UCI, the PUSCH comprises a first frequency hopping resource and a second
 frequency hopping resource, and a time-domain start symbol of the first frequency hopping
 resource is before a time-domain start symbol of the second frequency hopping resource; and

receiving first UCI on the PUSCH, wherein the first UCI comprises at least one of a hybrid
 25 automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-
 part1, and a channel state information part 2 CSI-part2, wherein

a quantity $G^{\text{CSI-part1}}(1)$ of coded bits that are of the CSI-part1 in the first UCI and that are

mapped onto the first frequency hopping resource is a smaller one of a fourth value and a fifth value, and the fourth value is determined based on a quantity $G^{\text{CSI-part1}}$ of coded bits of the CSI-part1 in the first UCI; and

when a quantity of HARQ-ACK bits is greater than 2, the fifth value is equal to
 5 $M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)$;

when a quantity of HARQ-ACK bits is less than or equal to 2, the fifth value is equal to $M_1 \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}}(1)$, wherein

$$M_1 = \sum_{l=0}^{N_{\text{sybm,hop}}^{\text{PUSCH}}(1)-1} M_{\text{sc}}^{\text{UCI}}(l), \quad N_{\text{sybm,hop}}^{\text{PUSCH}}(l) \text{ is a quantity of symbols in the first frequency hopping}$$

resource, $M_{\text{sc}}^{\text{UCI}}(l)$ is a quantity of resource elements REs that can carry UCI on a symbol l ,
 10 N_L is a quantity of transmission layers of the PUSCH, Q_m is a modulation order of the PUSCH, $G^{\text{ACK}}(1)$ is a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the first frequency hopping resource, $G_{\text{rvd}}^{\text{ACK}}(1)$ is a quantity of coded bits that can be mapped onto reserved REs in the first frequency hopping resource, and the reserved RE in the first frequency hopping resource is reserved for transmitting potential HARQ-ACK which has
 15 less than or equal to 2 bits.

34. The method according to claim 33, wherein

the fourth value is equal to $N_L \cdot Q_m \cdot \lfloor G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \rfloor$.

35. A communications apparatus, comprising a receiving unit and a sending unit, wherein

the receiving unit is configured to receive downlink control information, wherein the
 20 downlink control information is used to schedule a physical uplink shared channel PUSCH, the PUSCH is used to carry only uplink control information UCI, the PUSCH comprises a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and

the sending unit is configured to send first UCI on the PUSCH, wherein the first UCI
 25 comprises at least one of a hybrid automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2,

wherein

a quantity $G^{\text{CSI-part1}}(1)$ of coded bits that are of the CSI-part1 in the first UCI and that are mapped onto the first frequency hopping resource is a smaller one of a fourth value and a fifth value, and the fourth value is determined based on a quantity $G^{\text{CSI-part1}}$ of coded bits of the CSI-part1 in the first UCI; and when a quantity of HARQ-ACK bits is greater than 2, the fifth value is equal to $M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)$; or when a quantity of HARQ-ACK bits is less than or equal to 2, the fifth value is equal to $M_1 \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}}(1)$, wherein

$$M_1 = \sum_{l=0}^{N_{\text{sym,hop}}^{\text{PUSCH}}(1)-1} M_{\text{sc}}^{\text{UCI}}(l), \quad N_{\text{sym,hop}}^{\text{PUSCH}}(1) \text{ is a quantity of symbols in the first frequency hopping}$$

resource, $M_{\text{sc}}^{\text{UCI}}(l)$ is a quantity of resource elements REs that can carry UCI on a symbol l , N_L is a quantity of transmission layers of the PUSCH, Q_m is a modulation order of the PUSCH, $G^{\text{ACK}}(1)$ is a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the first frequency hopping resource, $G_{\text{rvd}}^{\text{ACK}}(1)$ is a quantity of coded bits that can be mapped onto reserved REs in the first frequency hopping resource, and the reserved RE in the first frequency hopping resource is reserved for transmitting potential HARQ-ACK which has less than or equal to 2 bits.

36. The apparatus according to claim 35, wherein

the fourth value is equal to $N_L \cdot Q_m \cdot \lfloor G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \rfloor$.

37. A communications apparatus, comprising a sending unit and a receiving unit, wherein

the sending unit is configured to send downlink control information, wherein the downlink control information is used to schedule a physical uplink shared channel PUSCH, the PUSCH is used to carry only uplink control information UCI, the PUSCH comprises a first frequency hopping resource and a second frequency hopping resource, and a time-domain start symbol of the first frequency hopping resource is before a time-domain start symbol of the second frequency hopping resource; and

the receiving unit is configured to receive first UCI on the PUSCH, wherein the first UCI comprises at least one of a hybrid automatic repeat request-acknowledgment HARQ-ACK, a channel state information part 1 CSI-part1, and a channel state information part 2 CSI-part2,

wherein

a quantity $G^{\text{CSI-part1}}(1)$ of coded bits that are of the CSI-part1 in the first UCI and that are mapped onto the first frequency hopping resource is a smaller one of a fourth value and a fifth value, and the fourth value is determined based on a quantity $G^{\text{CSI-part1}}$ of coded bits of the CSI-part1 in the first UCI; and when a quantity of HARQ-ACK bits is greater than 2, the fifth value is equal to $M_1 \cdot N_L \cdot Q_m - G^{\text{ACK}}(1)$; or when a quantity of HARQ-ACK bits is less than or equal to 2, the fifth value is equal to $M_1 \cdot N_L \cdot Q_m - G_{\text{rvd}}^{\text{ACK}}(1)$, wherein

$$M_1 = \sum_{l=0}^{N_{\text{sym,hop}}^{\text{PUSCH}}(1)-1} M_{\text{sc}}^{\text{UCI}}(l), \quad N_{\text{sym,hop}}^{\text{PUSCH}}(1) \text{ is a quantity of symbols in the first frequency hopping}$$

resource, $M_{\text{sc}}^{\text{UCI}}(l)$ is a quantity of resource elements REs that can carry UCI on a symbol l , N_L is a quantity of transmission layers of the PUSCH, Q_m is a modulation order of the PUSCH, $G^{\text{ACK}}(1)$ is a quantity of coded bits that are of the HARQ-ACK in the first UCI and that are mapped onto the first frequency hopping resource, $G_{\text{rvd}}^{\text{ACK}}(1)$ is a quantity of coded bits that can be mapped onto reserved REs in the first frequency hopping resource, and the reserved RE in the first frequency hopping resource is reserved for transmitting potential HARQ-ACK which has less than or equal to 2 bits.

38. The apparatus according to claim 37, wherein

the fourth value is equal to $N_L \cdot Q_m \cdot \lfloor G^{\text{CSI-part1}} / (2 \cdot N_L \cdot Q_m) \rfloor$.

39. A communications apparatus, comprising a processor, wherein when executing program instructions stored in a memory, the processor implements the method according to claim 31 or 32.

40. A communications apparatus, comprising a processor, wherein when executing program instructions stored in a memory, the processor implements the method according to claim 33 or 34.

41. A computer-readable storage medium, wherein the computer-readable storage medium stores a computer program, and when a processor invokes the computer program, the method according to claim 31 or 32 is implemented.

42. A computer-readable storage medium, wherein the computer-readable storage medium stores a computer program, and when a processor invokes the computer program, the method according to claim 33 or 34 is implemented.

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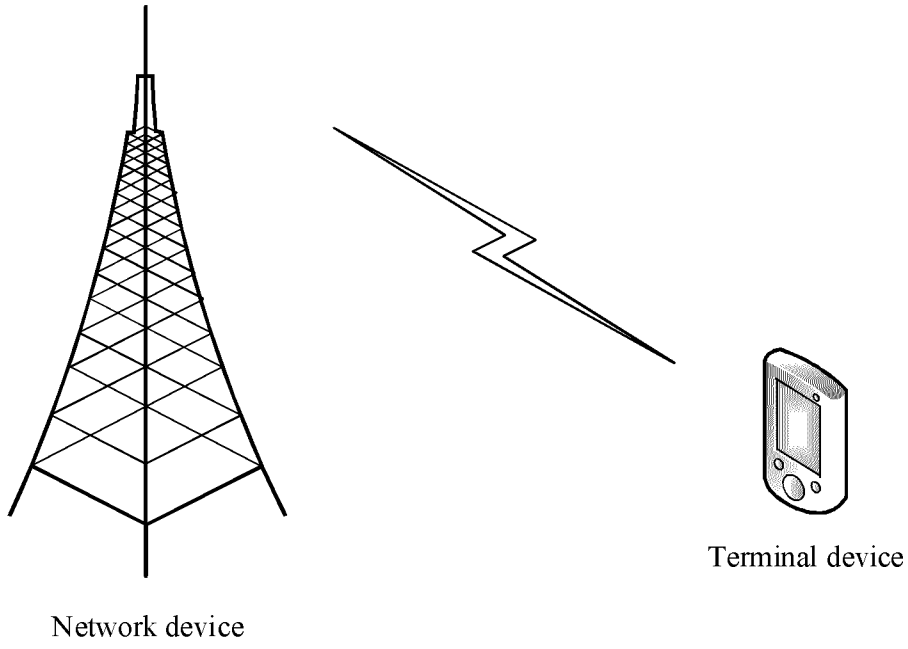


FIG. 1

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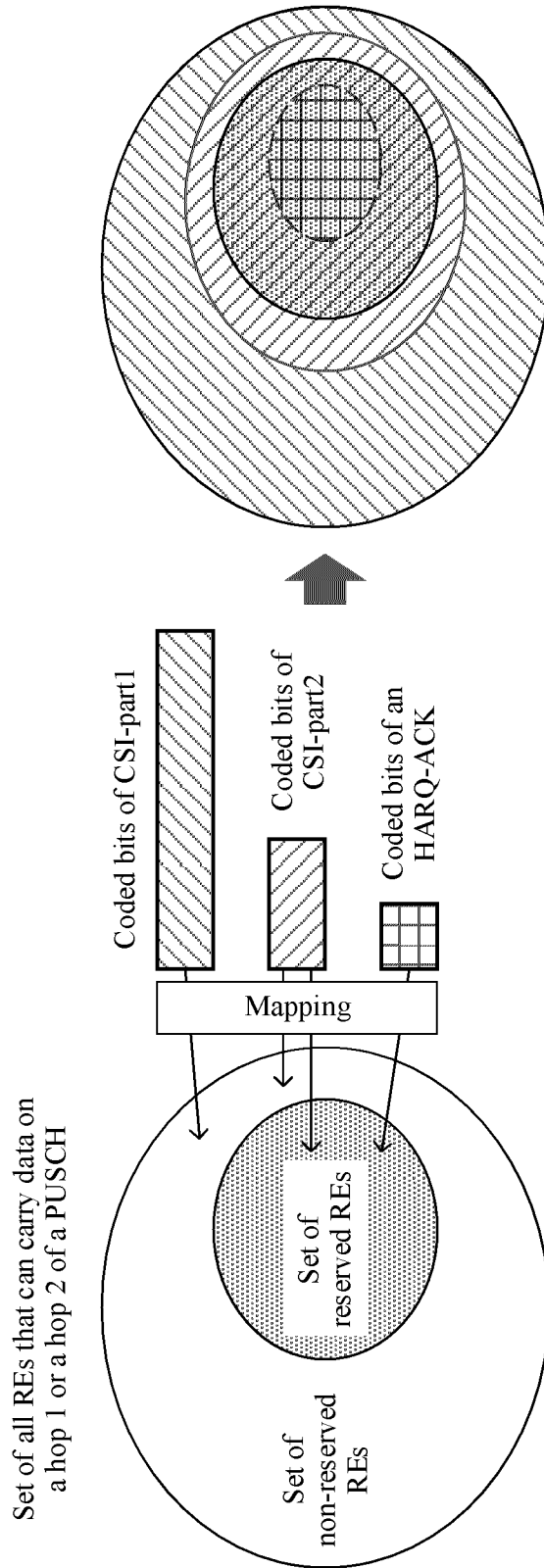


FIG. 2

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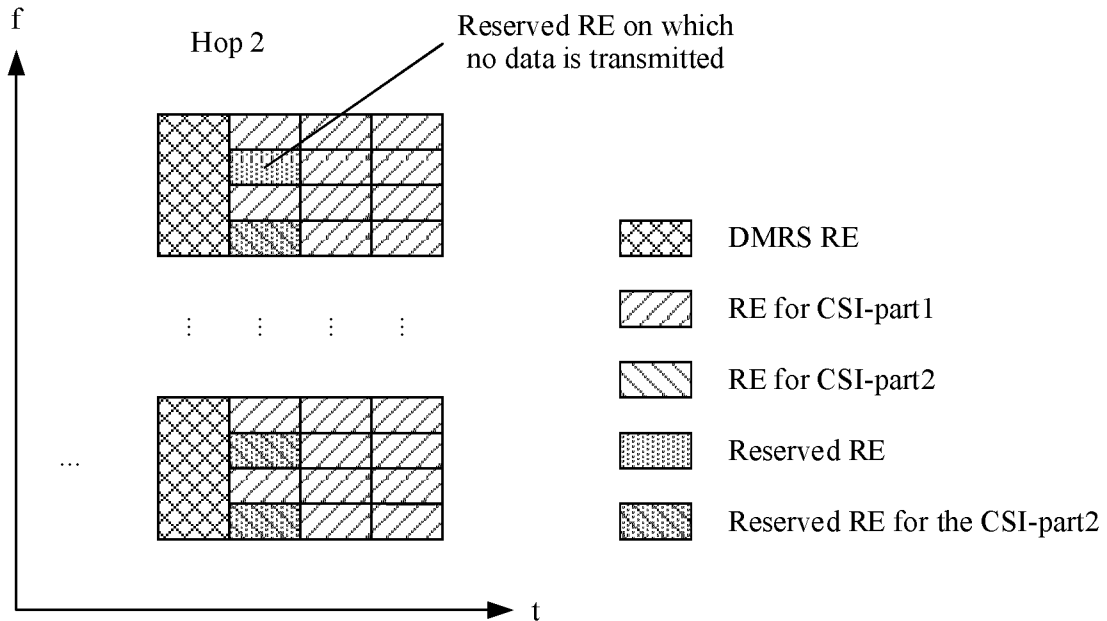


FIG. 3

400

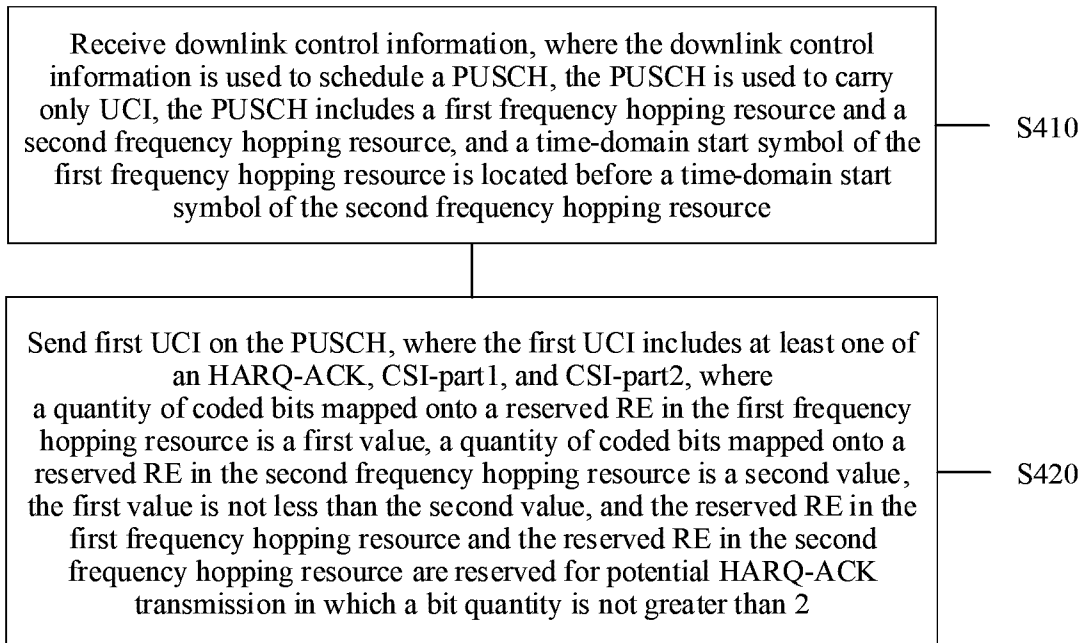


FIG. 4

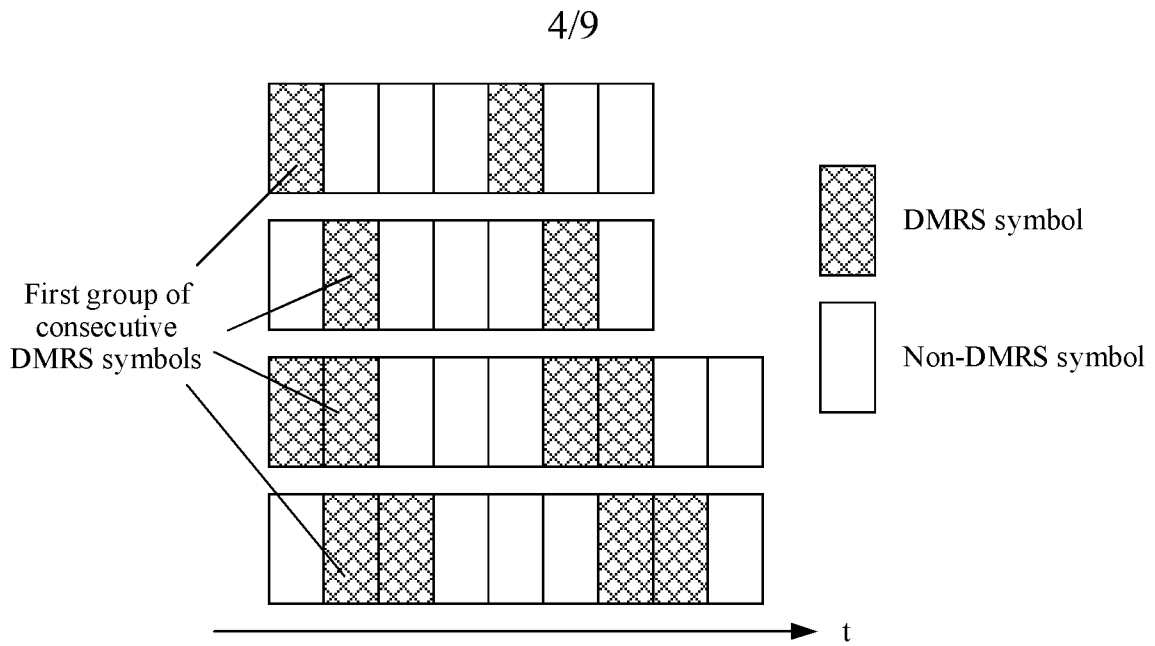


FIG. 5

600

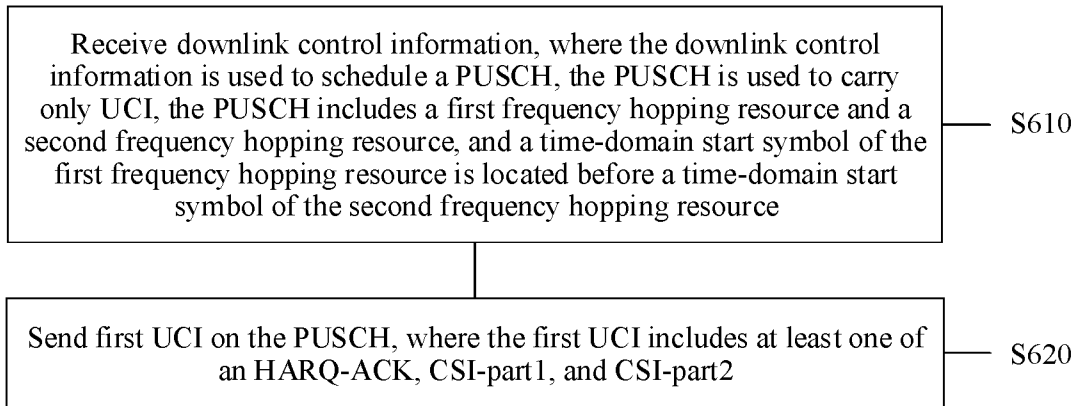


FIG. 6

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700

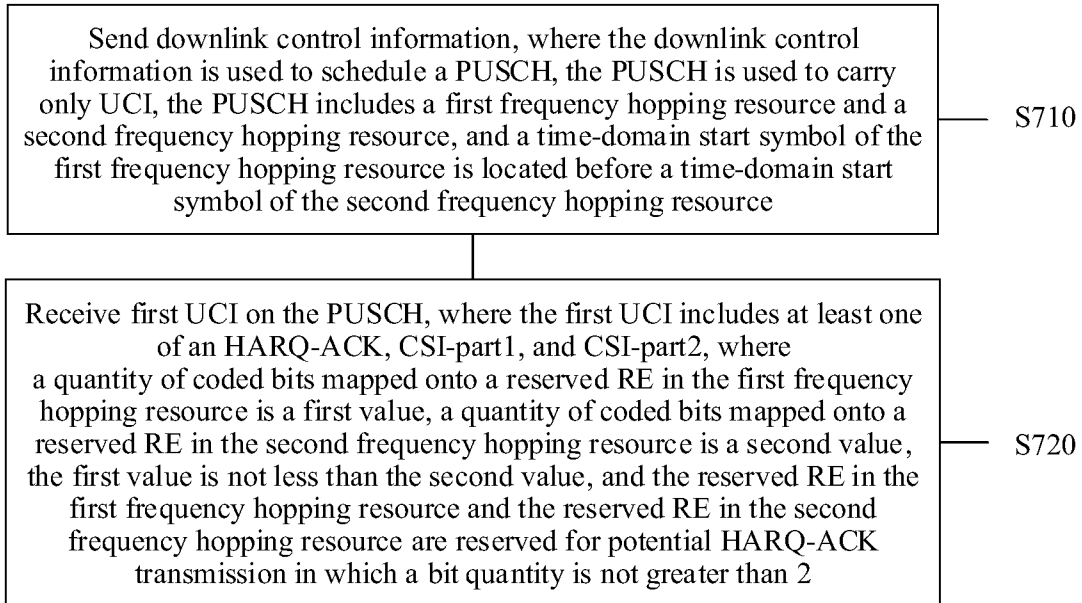


FIG. 7

800

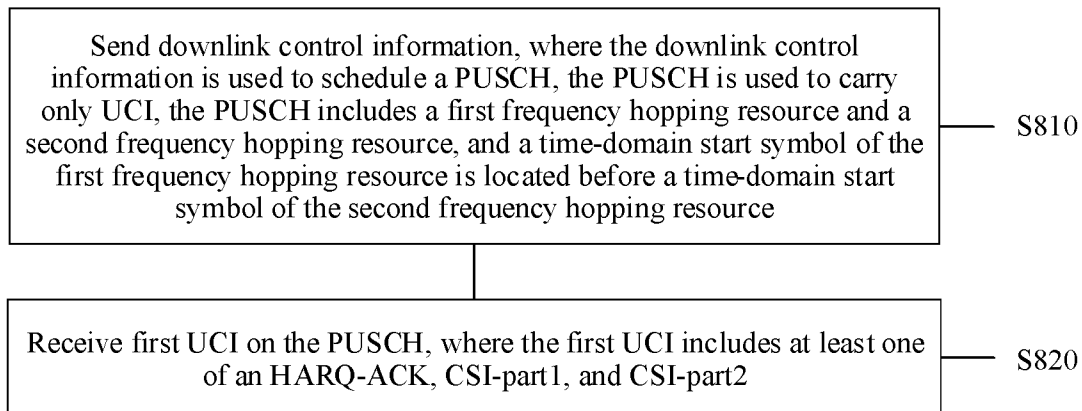


FIG. 8

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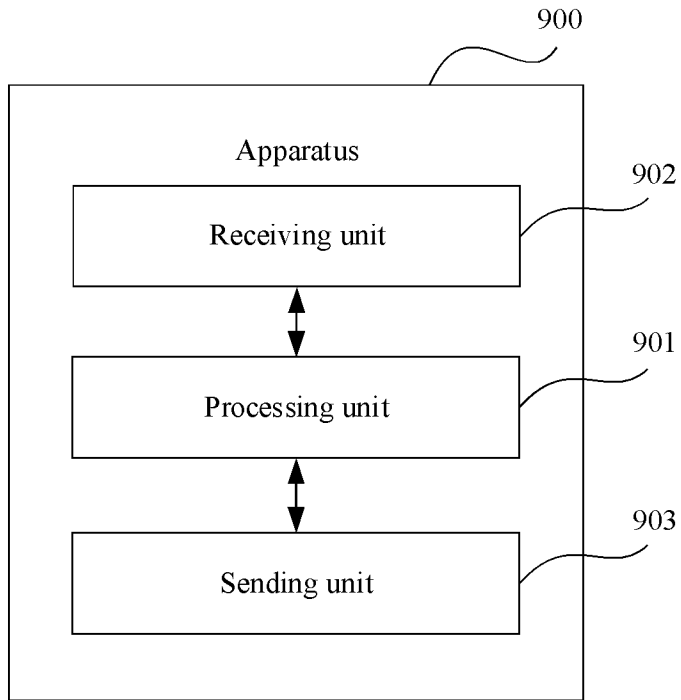


FIG. 9

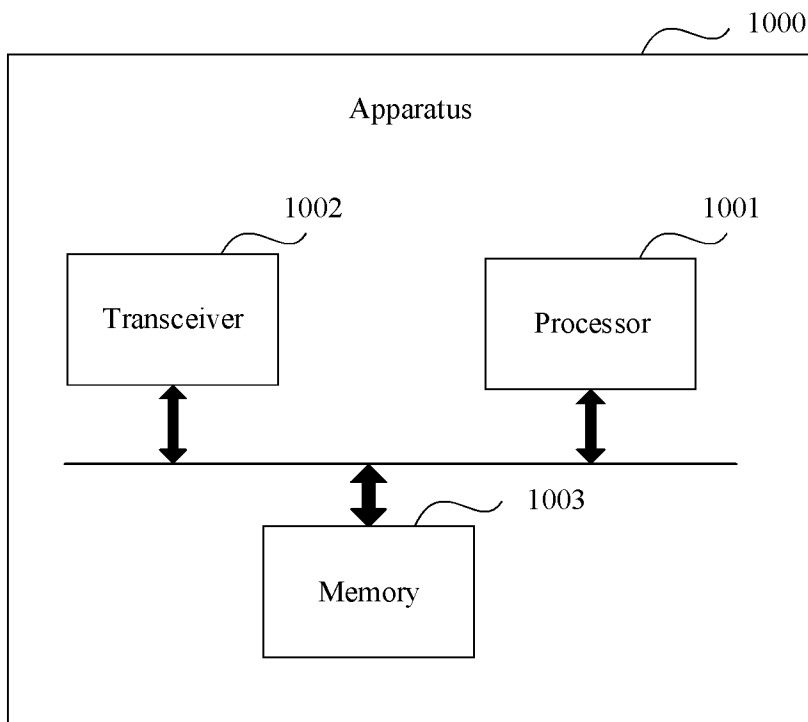


FIG. 10

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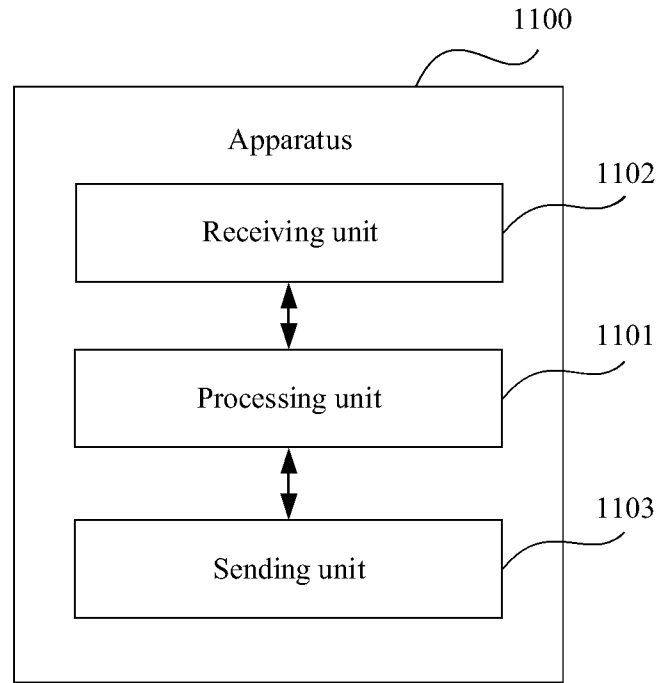


FIG. 11

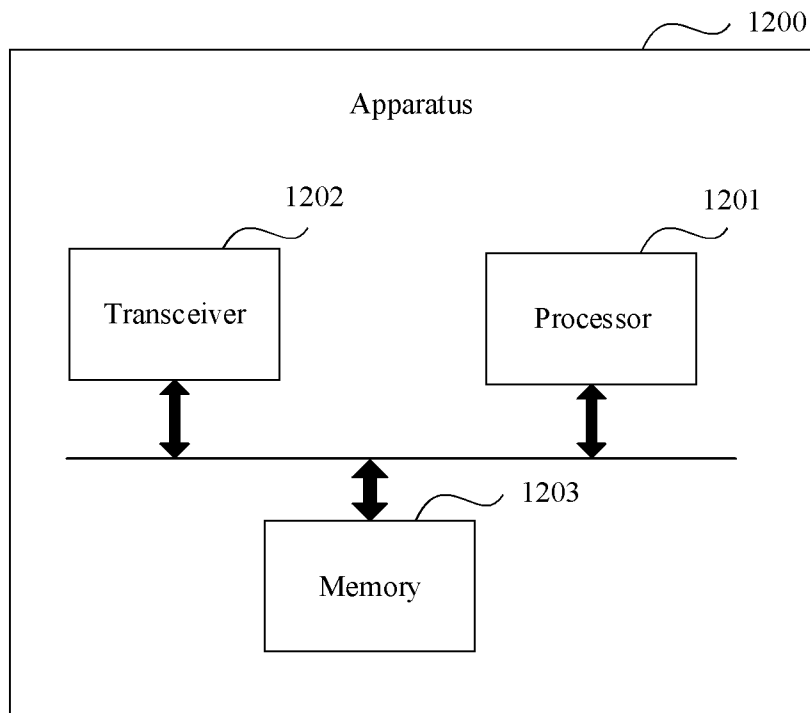


FIG. 12

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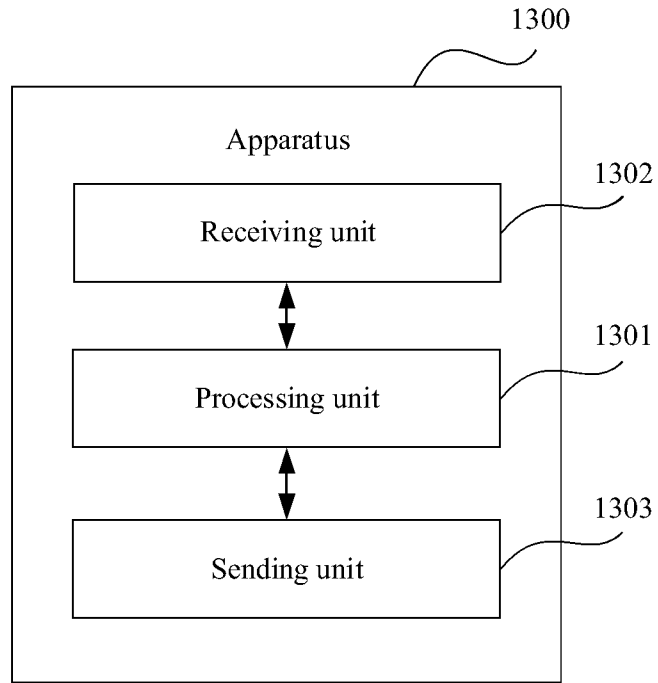


FIG. 13

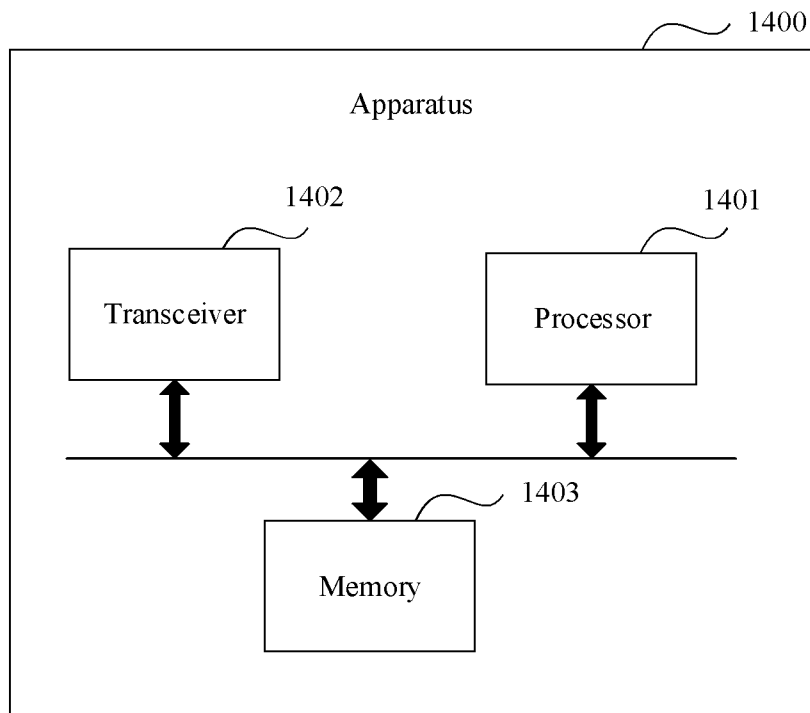


FIG. 14

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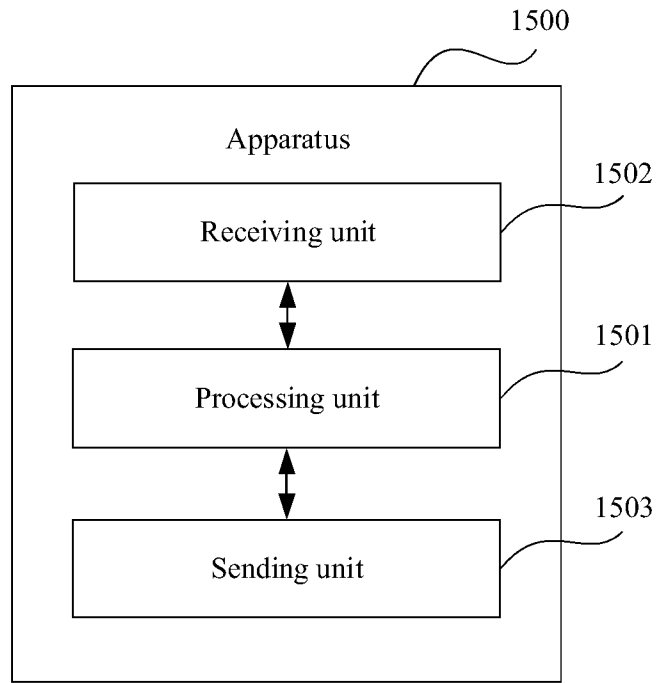


FIG. 15

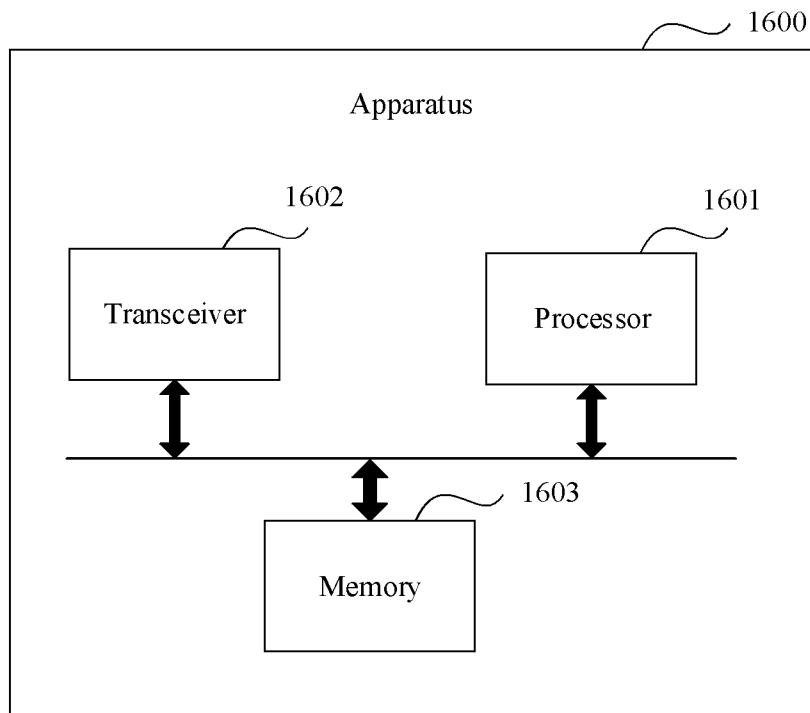


FIG. 16

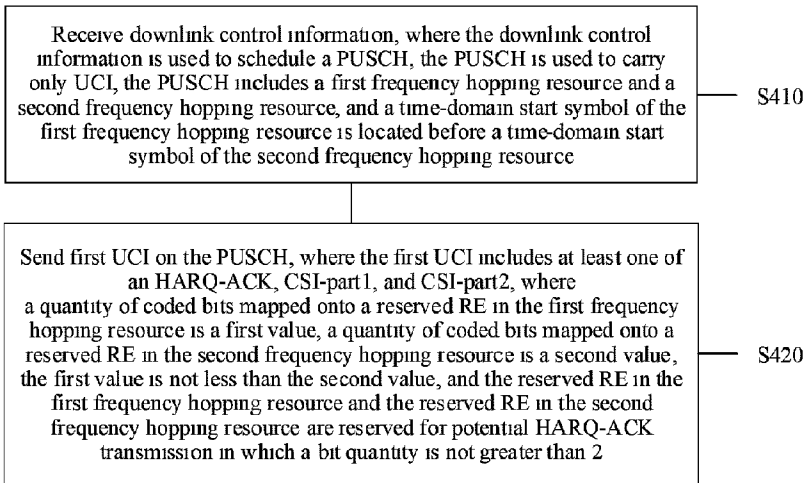


FIG. 4