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(54) **UPLINK SCHEDULING METHOD AND DEVICE, NETWORK DEVICE AND READABLE STORAGE MEDIUM**

VERFAHREN UND VORRICHTUNG ZUR UPLINK-PLANUNG, NETZWERKVORRICHTUNG UND LESBARES SPEICHERMEDIUM

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(73) Proprietor: **Huawei Technologies Co., Ltd.**
Shenzhen, Guangdong 518129 (CN)

(72) Inventor: **HUANG, Hai**
Shenzhen, Guangdong 518129 (CN)

(74) Representative: **Goddar, Heinz J.**
Boehmert & Boehmert
Anwaltspartnerschaft mbB
Pettenkoferstrasse 22
80336 München (DE)

(56) References cited:
WO-A1-2016/190711
WO-A1-2019/029747
CN-A- 108 476 539
CN-A- 109 392 061
US-A1- 2018 176 847

- **ZTE: "Details on PRACH repetition for MTC enhancement", 3GPP TSG RAN WG1 Meeting #80b R1-151735, 24 April 2015 (2015-04-24), XP050950135,**
- **NOKIA et al.: "Wake-Up Signal Configurations and Procedures", 3GPP TSG RAN WG1 Meeting #92bis R1-1804249, 20 April 2018 (2018-04-20), XP051413195,**
- **INTERDIGITAL: "Remaining open issues related to Random Access", 3GPP TSG-RAN WG2 #92 R2-156622, 20 November 2015 (2015-11-20), XP051024865,**

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Description

[0001] This application claims priority to Chinese Patent Application No. 201910470190.6, filed with the China National Intellectual Property Administration on May 31, 2019 and entitled "UPLINK SCHEDULING METHOD AND APPARATUS, NETWORK DEVICE, AND READABLE STORAGE MEDIUM.

TECHNICAL FIELD

[0002] This application relates to the field of communication technologies, and in particular, to an uplink scheduling method and apparatus, and a computer-readable storage medium

BACKGROUND

[0003] A conventional mobile communication network, for example, an LTE network, is mainly used to support a communication service between people. A market demand for future home device communication and a large-scale Internet of Things deployment pose a new requirement on a mobile communication network. In other words, the mobile communication network needs to support a low-cost (low-cost) machine type communication (machine type communication, MTC) service. Different from a conventional terminal device (for example, a mobile phone, a tablet computer, or a smartwatch), most low-cost machines (or MTC terminal devices) need to be installed in an area with weak network signals. To ensure low-cost MTC, the mobile communication network needs to enhance the network coverage for the low-cost machines.

[0004] In a mobile communication network (for example, NB-IoT) that supports the low-cost MTC, when uplink data arrives, an MTC terminal device may initiate a random access procedure to request a base station to schedule an uplink resource for the MTC terminal device. After receiving an uplink scheduling grant message sent by a network device in the random access procedure, the MTC terminal device may send the uplink data by using an allocated time-frequency resource. The mobile communication network (for example, the NB-IoT) that supports the low-cost MTC generally supports coverage technologies of different coverage levels. When uplink data arrives, the MTC terminal device in a connected state at a coverage level (for ease of description, the coverage level is referred to as a first coverage level) may need to initiate a random access procedure to the network device (for example, a base station) at another coverage level (the another coverage level is referred to as a second coverage level). After sending the uplink data by using an uplink resource that is allocated by the base station to the MTC terminal device and obtained in the random access procedure, the MTC terminal device restores to monitor, at the first coverage level, a next uplink scheduling grant message sent by the base station. In the prior art, after the base station sends, to a terminal device in a random access procedure, information about an uplink resource used to send uplink data, if demodulation of a signal in the uplink resource fails, it is considered that the terminal device does not receive the information about the uplink resource. In this case, the base station sends retransmission control information to the terminal device at the second coverage level, to indicate the terminal device to resend the uplink data.

[0005] However, if the terminal device receives the information about the uplink resource sent by the base station, the terminal device restores to monitor downlink data of the base station at the first coverage level after sending the uplink data. In this case, if the demodulation performed by the base station on the signal in the uplink resource fails, the terminal device cannot detect the retransmission control information that is sent by the base station at the second coverage level, and consequently cannot resend the uplink data. As a result, uplink data transmission by the terminal device fails.

[0006] Prior art is US2018/176847 and WO2019/029747A1.

SUMMARY

[0007] The invention is defined by all features present in and required by the independent claims 1, 7 and 13 which define the scope of the invention and represent embodiments of the invention. Further features of exemplary embodiments are defined in dependent claims. The subject-matter of the following description and figures, even if described or named as "embodiment(s)", "invention(s)", "aspect(s)", "example(s)" or "disclosure(s)" etc., does not or does not fully and thus only partly correspond to the invention as defined in the claims (e.g. due to one or more features present in and required by the independent claims which are missing in the "embodiment(s)", "invention(s)", "aspect(s)", "example(s)" or "disclosure(s)" etc., for example due to the use of expressions like "or", "alternative", "alternatively, "may", "preferably", "optional(ly)", "can", "could", "as an/for example" etc. replacing one or more features present in and required by the independent claims and/or rendering one or more features present in and required by the independent claims as optional). The subject-matter of the following description and figures is therefore either not falling within the subject-matter of the claims for which protection is sought, or is not encompassed by the wording of the claims but are considered as useful for understanding the invention.

[0008] Embodiments of this application provide an uplink scheduling method and apparatus, a network device, and a computer-readable storage medium, to select, based on a demodulation result, a coverage level for sending retransmission control information, to improve a success rate of sending uplink data by a terminal device. To resolve the foregoing technique problem, the embodiments of this application provide the following technical solutions.

[0009] An aspect of the embodiments of this application provides an uplink scheduling method, including: A network device receives a random access request sent by a terminal device at a second coverage level, where the terminal device is in a connected state at a first coverage level. The network device sends information about a first uplink resource to the terminal device at the second coverage level, to indicate the terminal device to send uplink data on the first uplink resource. The network device receives and demodulates a first signal in the first uplink resource, to obtain a first demodulation result. If the first demodulation result is "incorrect", the network device determines, based on the first demodulation result, whether the first uplink resource carries the uplink data. If determining that the first uplink resource carries the uplink data, the network device sends first retransmission control information to the terminal device at the first coverage level, where the first retransmission control information is used to indicate the terminal device to resend the uplink data on a second uplink resource. If determining that the first uplink resource does not carry the uplink data, the network device sends first retransmission control information to the terminal device at the second coverage level.

[0010] When the first demodulation result is "incorrect", the network device can determine, based on the first demodulation result, whether the first uplink resource carries the uplink data, and select a corresponding coverage level based on a determining result for the first retransmission. Because the coverage level corresponding to the determining result can reflect a coverage level selected by the terminal device when the terminal device monitors downlink data, it is helpful for the network device to send the first retransmission control information at the coverage level selected by the terminal device. Therefore, this helps the terminal device receive the first retransmission control information and resend the uplink data based on the first retransmission control information, thereby increasing a packet transmission success rate of the uplink data.

[0011] Optionally, that the network device determines, based on the first demodulation result, whether the first uplink resource carries the uplink data includes: determining whether signal quality of the first signal is higher than a threshold; and if it is determined that the signal quality of the first signal is higher than the threshold, determining that the first uplink resource carries the uplink data; or if it is determined that the signal quality of the first signal is lower than the threshold, determining that the first uplink resource does not carry the uplink data.

[0012] Optionally, the first coverage level corresponds to normal coverage, and the second coverage level corresponds to enhanced coverage.

[0013] Optionally, after the network device receives the random access request sent by the terminal device at the second coverage level, and before the network device sends the information about the first uplink resource to the terminal device at the second coverage level, the method further includes: The network device sends a random access response to the terminal device at the second coverage level. The network device receives, at the second coverage level, a contention message sent by the terminal device, where the contention message includes identification information of the terminal device. That the network device sends information about a first uplink resource to the terminal device at the second coverage level includes: The network device sends a contention resolution message to the terminal device at the second coverage level, where the contention resolution message includes the information about the first uplink resource.

[0014] Optionally, the method further includes: After the network device sends $(n-1)^{th}$ retransmission control information to the terminal device, the network device receives and demodulates an n^{th} signal in an n^{th} uplink resource to obtain an n^{th} demodulation result, where the $(n-1)^{th}$ retransmission control information is used to indicate the terminal device to resend the uplink data on the n^{th} uplink resource, and n is an integer greater than 1. If the n^{th} demodulation result is "incorrect", the network device sends n^{th} retransmission control information to the terminal device at the first coverage level, where the n^{th} retransmission control information is used to indicate the terminal device to resend the uplink data on an $(n+1)^{th}$ uplink resource.

[0015] Optionally, the method further includes: After the network device sends $(n-1)^{th}$ retransmission control information to the terminal device, the network device receives and demodulates an n^{th} signal in an n^{th} uplink resource to obtain an n^{th} demodulation result, where the $(n-1)^{th}$ retransmission control information is used to indicate the terminal device to resend the uplink data on the n^{th} uplink resource, and n is an integer greater than 1. If the n^{th} demodulation result is "incorrect", the network device determines whether an $(n-1)^{th}$ uplink resource carries the uplink data. If the $(n-1)^{th}$ uplink resource carries the uplink data, the network device sends n^{th} retransmission control information to the terminal device at the first coverage level, where the n^{th} retransmission control information is used to indicate the terminal device to resend the uplink data on an $(n+1)^{th}$ uplink resource. If the $(n-1)^{th}$ uplink resource does not carry the uplink data, the network device determines, based on the n^{th} demodulation result, whether the n^{th} uplink resource carries the uplink data. If the n^{th} uplink resource carries the uplink data, the network device sends n^{th} retransmission control information to the terminal device at the first coverage level. If the n^{th} uplink resource does not carry the uplink data, the network device sends the n^{th} retransmission control information to the terminal device at the second coverage level.

[0016] A second aspect of the embodiments of this application provides an uplink scheduling apparatus, including: a receiving module, configured to receive a random access request sent by a terminal device at a second coverage level, where the terminal device is in a connected state at a first coverage level; a sending module, configured to send information about a first uplink resource to the terminal device at the second coverage level, to indicate the terminal device to send uplink data on the first uplink resource, where the receiving module is further configured to receive a first signal in the first uplink resource; a demodulation module, configured to demodulate the first signal that is in the first uplink resource and that is received by the receiving module, to obtain a first demodulation result; and a determining module, configured to: when the first demodulation result obtained by the demodulation module is "incorrect", determine, based on the first demodulation result, whether the first uplink resource carries the uplink data, where the sending module is further configured to: when the determining module determines that the first uplink resource carries the uplink data, send first retransmission control information to the terminal device at the first coverage level, where the first retransmission control information is used to indicate the terminal device to resend the uplink data on a second uplink resource; or the sending module is further configured to: when the determining module determines that the first uplink resource does not carry the uplink data, send first retransmission control information to the terminal device at the second coverage level.

[0017] Optionally, the determining module is further configured to: determine whether signal quality of the first signal is higher than a threshold, and when the signal quality of the first signal is higher than the threshold, determine that the first uplink resource carries the uplink data, or when the signal quality of the first signal is lower than the threshold, determine that the first uplink resource does not carry the uplink data.

[0018] Optionally, the first coverage level corresponds to normal coverage, and the second coverage level corresponds to enhanced coverage.

[0019] Optionally, the sending module is further configured to: after the receiving module receives the random access request sent by the terminal device at the second coverage level, send a random access response to the terminal device at the second coverage level. The receiving module is further configured to receive, at the second coverage level, a contention message sent by the terminal device, where the contention message includes identification information of the terminal device. The sending module is further configured to: after the receiving module receives, at the second coverage level, the contention message sent by the terminal device, send a contention resolution message to the terminal device at the second coverage level, where the contention resolution message includes the information about the first uplink resource.

[0020] Optionally, the receiving module is further configured to: after the sending module sends $(n-1)^{th}$ retransmission control information to the terminal device, receive an n^{th} signal in an n^{th} uplink resource, where the $(n-1)^{th}$ retransmission control information is used to indicate the terminal device to resend the uplink data on the n^{th} uplink resource, and n is an integer greater than 1. The demodulation module is further configured to: after the receiving module receives the n^{th} signal, demodulate the n^{th} signal to obtain an n^{th} demodulation result. The sending module is further configured to: when the n^{th} demodulation result obtained by the demodulation module is "incorrect", send n^{th} retransmission control information to the terminal device at the first coverage level, where the n^{th} retransmission control information is used to indicate the terminal device to resend the uplink data on an $(n+1)^{th}$ uplink resource.

[0021] Optionally, the receiving module is further configured to: after the sending module sends $(n-1)^{th}$ retransmission control information to the terminal device, receive an n^{th} signal in an n^{th} uplink resource, where the $(n-1)^{th}$ retransmission control information is used to indicate the terminal device to resend the uplink data on the n^{th} uplink resource, and n is an integer greater than 1. The demodulation module is further configured to: after the receiving module receives the n^{th} signal, demodulate the n^{th} signal to obtain an n^{th} demodulation result. The determining module is further configured to: when the n^{th} demodulation result obtained by the demodulation module is "incorrect", determine whether an $(n-1)^{th}$ uplink resource carries the uplink data. The sending module is further configured to: when the determining module determines that the $(n-1)^{th}$ uplink resource carries the uplink data, send n^{th} retransmission control information to the terminal device at the first coverage level, where the n^{th} retransmission control information is used to indicate the terminal device to resend the uplink data on an $(n+1)^{th}$ uplink resource. The determining module is further configured to: when the $(n-1)^{th}$ uplink resource does not carry the uplink data, determine, based on the n^{th} demodulation result, whether the n^{th} uplink resource carries the uplink data. The sending module is further configured to: when the determining module determines that the n^{th} uplink resource carries the uplink data, send n^{th} retransmission control information to the terminal device at the first coverage level, or when the determining module determines that the n^{th} uplink resource does not carry the uplink data, send the n^{th} retransmission control information to the terminal device at the second coverage level.

[0022] A third aspect of the embodiments of this application provides a network device, including at least one processor, a memory, a communication line, at least one communication interface, and computer-executable instructions that are stored in the memory and that can be run on the processor, where when the computer-executable instructions are executed by the processor, the processor performs the method according to any one of the first aspect or the possible implementations of the first aspect of the embodiments of this application.

[0023] A fourth aspect of the embodiments of this application provides a computer-readable storage medium storing one or more computer-executable instructions, where when the computer-executable instructions are executed by a

processor, the processor performs the method according to any one of the first aspect or the possible implementations of the first aspect of the embodiments of this application.

BRIEF DESCRIPTION OF DRAWINGS

[0024]

FIG. 1 is a schematic diagram of a structure of an LTE network;
FIG. 2 is a schematic diagram of an existing uplink scheduling method;
FIG. 3 is a schematic diagram of an embodiment of an uplink scheduling method according to this application;
FIG. 4 is a schematic diagram of another embodiment of an uplink scheduling method according to this application;
FIG. 5 is a schematic diagram of another embodiment of an uplink scheduling method according to this application;
FIG. 6 is a schematic diagram of another embodiment of an uplink scheduling method according to this application;
FIG. 7 is a schematic diagram of an embodiment of a network device according to this application; and
FIG. 8 is a schematic diagram of a hardware structure of a network device according to this application.

DESCRIPTION OF EMBODIMENTS

[0025] A conventional mobile communication network, for example, a universal mobile telecommunications system (universal mobile telecommunications system, UMTS) network, a global system for mobile communications (global system for mobile communications, GSM) network, an LTE network, or a 5G network, is mainly used to support communication services between people. A terminal device can perform wireless communication in a mobile communication network (or a wireless communication network). The communication may be performed by using one or more core networks (core networks, CNs) and a radio access network (radio access network, RAN) that are included in the communication network. FIG. 1 is a schematic diagram of a structure of an LTE network. Refer to FIG. 1. The LTE network includes an access node, an evolved nodeB (evolved nodeB, eNB), and further includes a core network element. A mobility management entity (mobility management entity, MME) and a serving gateway (serving gateway, S-GW) are used as examples in FIG. 1. The terminal device is connected to an external network by using the eNB and the S-GW. The eNB is connected to the terminal device through a radio channel. The S-GW is a device that provides a data bearer, and generates or removes the data bearer under control of the MME. The MME manages various control functions and mobility management functions of the terminal device, and is connected to the eNB. A market demand for future home device communication and a large-scale Internet of Things deployment pose a new requirement on a mobile communication network. In other words, the mobile communication network needs to support a low-cost (low-cost) machine type communication (machine type communication, MTC) service. Low-cost MTC is a data communication service that does not require human intervention. The low-cost MTC can be used in fields such as security, tracking, payment, measurement, and digital consumption, and is related to specific applications include video surveillance, supply chain tracking, smart meters, and the like. The low-cost MTC requires low power consumption and supports low data transmission rates and low mobility.

[0026] Different from a conventional terminal device (for example, a mobile phone, a tablet computer, or a smartwatch), most low-cost machines (or referred to as MTC terminal devices) need to be installed in an area with weak network signals, for example, in basements of residential buildings, or in remote areas with sparse network devices. To ensure low-cost MTC, the mobile communication network needs to enhance the network coverage for the low-cost machines. To enhance the network coverage, a relatively feasible method is to use a coverage enhancement technology such as repeat transmission for an existing channel. Different degrees of the network coverage enhancement may be obtained when the repeat transmission is performed for different times. Whether the network coverage enhancement is required and a required degree of the network coverage enhancement mainly depend on factors such as network signal strength, a communication service type, and network resource status. These factors generally vary with changes of geographic locations and time. That is, different low-cost machines may require different degrees of the network coverage enhancement, and some low-cost machines do not even require the network coverage enhancement. A same low-cost machine may require different degrees of coverage enhancement at different moments. Therefore, the mobile communication network needs to be able to provide different degrees of the network coverage enhancement. Currently, the mobile communication network can support two coverage enhancement technologies: a coverage level 1 and a coverage level 2. A higher coverage level indicates a higher degree of the network coverage enhancement. A "coverage level 0" mentioned in the application document refers to a normal coverage technology, that is, no network coverage enhancement is performed.

[0027] Currently, there are two types of mobile communication networks that can support the low-cost MTC. One is that a technology supporting the low-cost MTC is introduced into a conventional mobile communication network (for example, an LTE network). The other is to provide an independent mobile communication network to support the low-

cost MTC, for example, narrowband internet of things (narrowband internet of things, NB-IoT) specified by 3 GPP. Although the NB-IoT is an independent communication technology, it may also be integrated with the conventional mobile communication network (such as the LTE network) in different degrees. In a mobile communication network (for example, the NB-IoT) that supports the low-cost MTC, when uplink data arrives, an MTC terminal device may initiate a random access procedure to request a base station to schedule a resource for the MTC terminal device. After receiving an uplink scheduling grant message sent by a network device in the random access procedure, the MTC terminal device may send the uplink data by using an allocated time-frequency resource. The mobile communication network (for example, the NB-IoT) that supports the low-cost MTC generally supports coverage technologies of different coverage levels. When uplink data arrives, the MTC terminal device in a connected state at a coverage level (for ease of description, the coverage level is referred to as a first coverage level) may need to initiate a random access procedure at another coverage level (the another coverage level is referred to as a second coverage level). After sending the uplink data by using a time-frequency resource obtained in the random access procedure, the MTC terminal device restores to monitor, at the first coverage level, a next uplink scheduling grant message sent by the network device. FIG. 2 is a schematic diagram of an existing uplink scheduling method. An example in which a terminal device initiates a contention random access procedure is used. Referring to FIG. 2, the existing uplink scheduling method includes the following steps.

[0028] 201: The terminal device sends a random access request to a base station at a coverage level 1.

[0029] The terminal device is in a connected state at a coverage level 0. When uplink data needs to be sent, if it is detected that channel quality deteriorates, the terminal device may select a random access preamble (preamble) sequence and a PRACH resource at the coverage level 1, and send the random access request to the base station by using the PRACH resource and a Msg1. The random access request includes a selected random access preamble.

[0030] 202: The base station sends a random access response to the terminal device at the coverage level 1.

[0031] After receiving the random access preamble sent by the terminal device at the coverage level 1, the base station may send the random access response to UE at the coverage level 1 by using a Msg2. The random access response includes information about an uplink resource that is scheduled for the terminal device for sending first uplink data. The uplink resource specified in the random access response is a resource at the coverage level 1.

[0032] 203: The terminal device sends a contention message to the base station at the coverage level 1.

[0033] After detecting the random access response sent by the base station at the coverage level 1, the terminal device may obtain the information about the uplink resource in the random access response, and send the contention message by using the uplink resource specified in the random access response (the resource at the coverage level 1) and a Msg3. The contention message includes identification information of the terminal device, for example, a cell radio network temporary identifier (cell radio network temporary identifier, C-RNTI).

[0034] 204: The base station sends a contention resolution message to the terminal device at the coverage level 1.

[0035] After receiving the contention message sent by the terminal device at the coverage level 1, the base station may send the contention resolution message to the terminal device at the coverage level 1. The contention resolution message includes the information about the uplink resource that is scheduled for the terminal device for sending the first uplink data. The uplink resource specified in the contention resolution message is the resource at the coverage level 1.

[0036] Step 201 to step 204 correspond to the contention random access procedure.

[0037] 205: The terminal device sends the first uplink data to the base station at the coverage level 1.

[0038] After step 203, the terminal device monitors the contention resolution message at the coverage level 1. If the terminal device receives the contention resolution message sent by the base station at the coverage level 1, the terminal device may send the first uplink data on the uplink resource (the resource at the coverage level 1) specified in the contention resolution message.

[0039] 206: The base station demodulates a signal in the uplink resource specified in the contention resolution message.

[0040] The signal in the uplink resource is a baseband signal, and a network device may demodulate the signal on the uplink resource specified in the contention resolution message.

[0041] 207: If the demodulation succeeds, the base station sends an uplink scheduling grant message to the terminal device at a coverage level 0.

[0042] Because the connected state is at the coverage level 0, after step 206, if the demodulation succeeds, the base station sends the uplink scheduling grant message to the terminal device at the coverage level 0. The uplink scheduling grant message includes information about an uplink resource that is scheduled for the terminal device for sending second uplink data. The uplink resource specified in the uplink scheduling grant message is a resource at the coverage level 0. After step 205, the terminal device monitors the uplink scheduling grant message at the coverage level 0, to send the second uplink data on the uplink resource specified in the uplink scheduling grant message.

[0043] 208: If the demodulation fails, the base station sends retransmission control information to the terminal device at the coverage level 1.

[0044] After step 204, the base station demodulates the signal in the uplink resource specified for the terminal device in the contention resolution message. If the demodulation by the base station fails, in an application scenario in which uplink ACK feedback is omitted, the base station considers that the terminal device does not send the first uplink data

because the terminal device does not receive the contention resolution message. In this case, the base station sends the retransmission control information to the terminal device at the coverage level 1. The retransmission control information includes information about an uplink resource that is scheduled for the terminal device for resending the first uplink data, and is used to indicate the terminal device to resend the first uplink data on the specified uplink resource.

[0045] However, it can be learned from the foregoing description that, after step 204, if the terminal device detects the contention resolution message, after sending the first uplink data, the terminal device monitors a downlink message of the base station at the coverage level 0. In this case, the terminal device cannot detect the retransmission control information sent by the base station at the coverage level 1, and cannot resend the first uplink data by using the uplink resource specified in the retransmission control information. Consequently, the terminal device fails to transmit the uplink data. It can be learned that, in the prior art, for an MTC terminal device in a connected state at a coverage level, when uplink data arrives, if a random access procedure is initiated at another coverage level to request an uplink resource, a packet transmission success rate of the uplink data is relatively low.

[0046] To improve the packet transmission success rate of the uplink data, the embodiments of this application provide an uplink scheduling method and apparatus, a network device, and a computer-readable storage medium. A mobile communication network on which the embodiments of this application are based may be NB-IoT, or may be a conventional mobile communication network that supports low-cost MTC, for example, a UMTS network, a GSM network, an LTE network, a 5G network, or any other mobile communication network that can support both the low-cost MTC and communication services between people. A terminal device in the embodiments of this application is not limited to an MTC terminal device, for example, an electric meter, or a household appliance, and may also be a conventional terminal device that supports a coverage enhancement technology, for example, a mobile phone, a tablet computer, or a smartwatch that supports the coverage enhancement technology. A network device in the embodiments of this application is not limited to a network device specially deployed in the NB-IoT, or may be a network device in the conventional mobile communication network. The network device may be an access device, for example, an eNB in the LTE network.

[0047] First, the uplink scheduling method provided in the embodiments of this application is described. FIG. 3 is a schematic diagram of an embodiment of an uplink scheduling method according to this application. Referring to FIG. 3, an embodiment of the uplink scheduling method according to this application includes the following steps.

[0048] 301: A network device receives a random access request sent by a terminal device at a second coverage level in a connected state at a first coverage level.

[0049] It is assumed that the terminal device is in an RRC connected state at the first coverage level. When the terminal device needs to send uplink data, the terminal device may initiate a random access procedure to request an uplink resource for sending the uplink data. If the terminal device needs to change a coverage level, for example, initiates the random access procedure at the second coverage level, or detects that channel quality deteriorates, the terminal device may send the random access request to the network device at the second coverage level. The network device can receive the random access request sent by the terminal device at the second coverage level. The random access request generally includes a random access preamble. The second coverage level is different from the first coverage level. For example, the second coverage level and the first coverage level may respectively be a coverage level 0 and a coverage level 1, a coverage level 1 and a coverage level 0, a coverage level 1 and a coverage level 2, a coverage level 2 and a coverage level 1, a coverage level 0 and a coverage level 2, or a coverage level 2 and a coverage level 0.

[0050] 302: The network device sends, at the second coverage level, information about a first uplink resource allocated to the terminal device.

[0051] After receiving the random access request sent by the terminal device at the second coverage level, the network device may send, to the terminal device at the second coverage level, the information about the first uplink resource allocated to the terminal device. After detecting the information about the first uplink resource at the second coverage level, the terminal device may send the uplink data to the network device by using the first uplink resource.

[0052] 303: The network device receives and demodulates a first signal in the first uplink resource to obtain a first demodulation result.

[0053] After sending the information about the first uplink resource, the network device may receive the first uplink resource, and demodulate a signal (which is referred to as the first signal for ease of description) in the first uplink resource to obtain the first demodulation result. The first demodulation result may include a demodulated first signal and signal quality of the first signal. The signal quality includes, but is not limited to, a signal-to-noise ratio and/or a signal strength.

[0054] 304: If the first demodulation result is "incorrect", the network device determines, based on the first demodulation result, whether the first uplink resource carries the uplink data, and if yes, triggers step 305, or if no, triggers step 306.

[0055] If the first demodulation result is "incorrect", to determine whether the terminal device receives the information about the first uplink resource, the network device may determine, based on the first demodulation result, whether the first uplink resource carries the uplink data. If the uplink data is carried, it indicates that the terminal device receives a contention resolution message and is monitoring downlink data at the first coverage level. If it is determined that the uplink data is not carried, it indicates that the terminal device probably does not receive the contention resolution message

and is monitoring the downlink data at the second coverage level. If the first demodulation result is "correct", optionally, refer to step 207. The network device sends an uplink scheduling grant message to the terminal device at the first coverage level, to indicate the terminal device to continue sending the uplink data on the specified uplink resource.

[0056] The following describes an example of a method in which the network device determines, based on the first demodulation result, whether the first uplink resource carries the uplink data. In actual application, another method may alternatively be used to determine whether the first uplink resource carries the uplink data. The method in which the network device determines, based on the first demodulation result, whether the first uplink resource carries the uplink data may include: If the signal quality of the first signal is lower than a threshold, it can be determined that the first uplink resource does not carry the uplink data. If the signal quality of the first signal is higher than the threshold, but the first demodulation result is "incorrect" due to a reason, for example, a decoding failure of the demodulated first signal, it can be determined that the first uplink resource carries the uplink data.

[0057] 305: The network device sends first retransmission control information to the terminal device at the first coverage level.

[0058] If the network device determines that the first uplink resource carries the uplink data, it indicates that the terminal device receives the contention resolution message and is monitoring the downlink data at the first coverage level. In this case, the network device can send the first retransmission control information to the terminal device at the first coverage level. The first retransmission control information includes information about a second uplink resource allocated for the uplink data, and is used to indicate the terminal device to resend the uplink data on the second uplink resource.

[0059] 306: The network device sends first retransmission control information to the terminal device at the second coverage level.

[0060] If the network device determines that the first uplink resource does not carry the uplink data, it indicates that the terminal device probably does not receive the contention resolution message and is monitoring the downlink data at the second coverage level. In this case, the network device can send the first retransmission control information to the terminal device at the second coverage level.

[0061] The first retransmission control information is retransmission control information sent by the network device after the first demodulation fails. The second uplink resource is an uplink resource that is allocated to the terminal device for performing the first retransmission. Because uplink resources at different coverage levels are generally different, specific content of the first retransmission control information sent by the network device at the first coverage level may be different from specific content of the first retransmission control information sent by the network device at the second coverage level.

[0062] In this embodiment of this application, when the first demodulation result is "incorrect", the network device can determine, based on the first demodulation result, whether the first uplink resource carries the uplink data, and select, based on a determining result, a corresponding coverage level for the first retransmission. Because the coverage level corresponding to the determining result can reflect a coverage level selected by the terminal device when the terminal device monitors downlink data, it is helpful for the network device to send the first retransmission control information at the coverage level selected by the terminal device. Therefore, this helps the terminal device receive the first retransmission control information and resend the uplink data based on the first retransmission control information, thereby increasing a packet transmission success rate of the uplink data.

[0063] Step 304 to step 306 correspond to a first retransmission process of the network device, and step 301 to step 302 correspond to a random access procedure. The random access procedure is generally classified into a contention random access procedure and a non-contention random access procedure. For different random access procedures, the network device may carry the information about the first uplink resource in step 302 by using different messages.

[0064] An example in which the terminal device initiates contention random access to request an uplink resource is used. Referring to FIG. 4, another embodiment of the uplink scheduling method in this application includes the following steps.

[0065] 401: A network device receives a random access request sent by a terminal device at a second coverage level in a connected state at a first coverage level.

[0066] 402: The network device sends a random access response to the terminal device at the second coverage level.

[0067] 403: The network device receives, at the second coverage level, a contention message sent by the terminal device.

[0068] 404: The network device sends a contention resolution message to the terminal device at the second coverage level, where the contention resolution message includes information about a first uplink resource allocated to uplink data.

[0069] Step 401 to step 404 may be understood with reference to step 201 to step 204, and details are not described herein again.

[0070] 405: The network device demodulates a first signal in the first uplink resource specified in the contention resolution message, to obtain a first demodulation result.

[0071] 406: If the first demodulation result is "incorrect", the network device determines, based on the first demodulation result, whether the first uplink resource carries the uplink data, and if yes, triggers step 407, or if no, triggers step 408.

[0072] 407: The network device sends first retransmission control information to the terminal device at the first coverage level.

[0073] 408: The network device sends first retransmission control information to the terminal device at the second coverage level.

[0074] Step 405 to step 408 may be understood with reference to step 303 to step 306 in the embodiment corresponding to FIG. 3. Details are not described herein again.

[0075] An example in which the terminal device initiates non-contention random access to request an uplink resource is used. Referring to FIG. 5, another embodiment of the uplink scheduling method in this application includes the following steps.

[0076] 501: A network device sends a dedicated random access preamble to a terminal device.

[0077] The network device may send a Msg0 to the terminal device, to allocate, to the terminal device, the dedicated random access preamble used for non-contention random access.

[0078] 502: The network device receives a random access request sent by the terminal device at a second coverage level in a connected state at a first coverage level.

[0079] After receiving the dedicated random access preamble, if uplink data arrives and a coverage level needs to be switched, the terminal device can send the random access request to the network device at the second coverage level by using a Msg1. The random access request includes the dedicated random access preamble.

[0080] 503: The network device sends a random access response to the terminal device at the second coverage level, where the random access response includes information about a first uplink resource allocated to the uplink data.

[0081] After receiving the random access request sent by the terminal device, the network device can send the random access response to the terminal device at the second coverage level by using a Msg2. The random access response includes the information about the first uplink resource allocated to the uplink data of the terminal device.

[0082] 504: The network device demodulates a first signal in the first uplink resource specified in the random access response, to obtain a first demodulation result.

[0083] After sending the random access response, the network device can demodulate a signal (which is referred to as the first signal for ease of description) in the first uplink resource specified in the random access response, to obtain the first demodulation result. The first demodulation result may include a demodulated first signal and signal quality of the first signal. The signal quality includes, but is not limited to, an SNR and signal strength.

[0084] 505: If the first demodulation result is "incorrect", the network device determines, based on the first demodulation result, whether the first uplink resource carries the uplink data, and if yes, triggers step 506, or if no, triggers step 507.

[0085] 506: The network device sends first retransmission control information to the terminal device at the first coverage level.

[0086] 507: The network device sends first retransmission control information to the terminal device at the second coverage level.

[0087] Step 504 to step 507 may be understood with reference to step 303 to step 306, and details are not described herein again. In the embodiment corresponding to FIG. 4, step 401 to step 404 correspond to the contention random access procedure. In the embodiment corresponding to FIG. 5, step 501 to step 503 are corresponding to the non-contention random access procedure.

[0088] In the embodiments corresponding to FIG. 3 to FIG. 5, only a first retransmission process is described. In actual application, after the network device sends the first retransmission control information to the terminal device, a second demodulation result obtained by the network device by demodulating a second uplink resource may still be "incorrect". Optionally, if the second demodulation result obtained by the network device by demodulating the second uplink resource is "incorrect", the network device can perform second retransmission, and send second retransmission control information to the terminal device at the first coverage level or the second coverage level. The second retransmission control information includes information about a third uplink resource allocated to the uplink data of the terminal device, and is used to indicate the terminal device to resend the uplink data on the third uplink resource.

Table 1

After the information about the first uplink resource is sent		First retransmission				Second retransmission	
Receiving and sending of the terminal device	Coverage level at which the terminal device monitors downlink data	Whether the first uplink resource carries the uplink data	Coverage level at which the network device sends the first retransmission control information	Receiving and sending of the terminal device	Coverage level at which the terminal device monitors the downlink data	Whether the second uplink resource carries the uplink data	Coverage level at which the network device sends the second retransmission control information
The information about the first uplink resource is received and retransmitted as required	First coverage level	Yes	First coverage level	The first retransmission control information is received and retransmitted as required	First coverage level	Yes	First coverage level
				The first retransmission control information is received, but not retransmitted as required	First coverage level	No	
				No first retransmission control information is received	First coverage level		

(continued)

After the information about the first uplink resource is sent		First retransmission				Second retransmission	
The information about the first uplink resource is received, but the uplink data is not sent as required	First coverage level	No	Second coverage level	No first retransmission control information is received	First coverage level	No	To be determined
No information about the first uplink resource is received, and no uplink data is sent	Second coverage level			The first retransmission control information is received and retransmitted as required	First coverage level	Yes	
				The first retransmission control information is received, but not retransmitted as required	First coverage level	No	
				No first retransmission control information is	Second coverage level		
				received			

[0089] Table 1 is an analysis chart of data sending and receiving of the terminal device and the network device. The following can be learned from Table 1:

(1) After the terminal device sends the uplink data by using the first uplink resource, the network device may also determine that the first uplink resource does not carry the uplink data. For example, sending power is relatively low, and the signal quality of the first signal is excessively low. However, in actual application, a probability of this occurrence is generally low.

(2) If the network device determines that the first uplink resource carries the uplink data, after the network device sends the first retransmission control information at the first coverage level, if the second demodulation result is "incorrect", the terminal device monitors the downlink data at the first coverage level regardless of whether the second uplink resource carries the uplink data. Therefore, the network device should continue to send the second retransmission control information at the first coverage level, so that it is helpful for the terminal device to receive the second retransmission control information.

(3) If the network device determines that the first uplink resource does not carry the uplink data, after the network device sends the first retransmission control information at the second coverage level, if the second demodulation result is "incorrect", when it is determined that the second uplink resource carries the uplink data, the terminal device monitors the downlink data at the first coverage level. In this case, the network device should continue to send the second retransmission control information at the first coverage level, so that it is helpful for the terminal device to receive the second retransmission control information.

(4) If the network device determines that the first uplink resource does not carry the uplink data, after the network device sends the first retransmission control information at the second coverage level, if the second demodulation result is "incorrect", when it is determined that the second uplink resource carries the uplink data, the terminal device may monitor the downlink data at the first coverage level, or may monitor the downlink data at the second coverage level. In this case, the network device may monitor the downlink data at the first coverage level or the second coverage level.

[0090] According to the analysis of the foregoing results (1) to (4), the following provides two methods for sending retransmission control information by the network device in an n^{th} retransmission process, n is an integer greater than or equal to 2.

[0091] For the case of (4), if a network method selects to send the retransmission control information at the first coverage level, in this case, a method A for sending the retransmission control information in the n^{th} retransmission process may include the following steps.

[0092] Step A1: The network device receives and demodulates an n^{th} signal in an n^{th} uplink resource, to obtain an n^{th} demodulation result.

[0093] The n^{th} uplink resource is information about an uplink resource in retransmission control information that is sent by the network device during $(n-1)^{th}$ retransmission.

[0094] Step A2: If the n^{th} demodulation result is "incorrect", the network device sends n^{th} retransmission control information to the terminal device at the first coverage level.

[0095] The n^{th} retransmission control information includes information about an $(n+1)^{th}$ uplink resource allocated to the uplink data, and is used to indicate the terminal device to resend the uplink data on the $(n+1)^{th}$ uplink resource.

[0096] For the case of (4), if a network method selects to send the retransmission control information at the second coverage level, in this case, a method B for sending the retransmission control information in the n^{th} retransmission process may include the following steps.

[0097] Step B1: The network device receives and demodulates an n^{th} signal in an n^{th} uplink resource, to obtain an n^{th} demodulation result.

[0098] The n^{th} uplink resource is information about an uplink resource in retransmission control information that is sent by the network device during $(n-1)^{th}$ retransmission.

[0099] Step B2: If the n^{th} demodulation result is "incorrect", the network device determines whether an $(n-1)^{th}$ uplink resource carries the uplink data.

[0100] The network device may determine, based on an $(n-1)^{th}$ demodulation result, whether the $(n-1)^{th}$ uplink resource carries the uplink data, or may store a determined determining result in the $(n-1)^{th}$ retransmission process, that is, a determining result of whether the $(n-1)^{th}$ uplink resource carries the uplink data. In an n^{th} retransmission process, the determining result stored in the previous retransmission process may be directly obtained.

[0101] Step B3: If the $(n-1)^{th}$ uplink resource carries the uplink data, the network device sends n^{th} retransmission control information to the terminal device at a first coverage level.

[0102] The n^{th} retransmission control information includes information about an $(n+1)^{th}$ uplink resource allocated to the uplink data, and is used to indicate the terminal device to resend the uplink data on the $(n+1)^{th}$ uplink resource.

[0103] Step B4: If the $(n-1)^{th}$ uplink resource does not carry the uplink data, the network device determines, based on

the n^{th} demodulation result, whether the n^{th} uplink resource carries the uplink data, and if yes, triggers step B5, or if no, triggers step B6.

[0104] Step B5: The network device sends the n^{th} retransmission control information to the terminal device at the first coverage level.

[0105] Step B6: The network device sends the n^{th} retransmission control information to the terminal device at the second coverage level.

[0106] Based on any embodiment corresponding to FIG. 3 to FIG. 5, in an n^{th} (n is an integer greater than 1) retransmission process, the network device can send the n^{th} retransmission control information by using the foregoing method A or method B, to indicate the terminal device to resend the uplink data on the $(n+1)^{th}$ uplink resource. In addition, a method used by the network device in the n^{th} retransmission process may be different from a method used in an $(n+1)^{th}$ retransmission process.

[0107] The following describes another embodiment of the uplink scheduling method provided in this application by using an example in which the method A is used in a second retransmission process. Referring to FIG. 6, another embodiment of the uplink scheduling method provided in this application may include the following steps.

[0108] 601: A network device receives a random access request sent by a terminal device at a second coverage level in a connected state at a first coverage level.

[0109] 602: The network device sends, at the second coverage level, information about a first uplink resource allocated to the terminal device.

[0110] 603: The network device receives and demodulates a first signal in the first uplink resource, to obtain a first demodulation result.

[0111] 604: If the first demodulation result is "incorrect", the network device determines, based on the first demodulation result, whether the first uplink resource carries uplink data.

[0112] 605: If yes, the network device sends first retransmission control information to the terminal device at the first coverage level.

[0113] 606: If no, the network device sends first retransmission control information to the terminal device at the second coverage level.

[0114] For step 601 to step 606, refer to step 301 to step 306 in the embodiment corresponding to FIG. 3. Details are not described herein again.

[0115] 607: The network device receives and demodulates a second signal in a second uplink resource, to obtain a second demodulation result.

[0116] 608: If the second demodulation result is "incorrect", the network device sends second retransmission control information to the terminal device at the first coverage level.

[0117] The foregoing describes the method embodiments of this application, and the following describes apparatuses provided in this application.

[0118] The foregoing describes the method in the embodiments of this application. It may be understood that, to implement the foregoing functions, the network device includes a corresponding hardware structure and/or software module for performing each of the functions. A person skilled in the art should be easily aware that, in combination with functions 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 constraint conditions 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.

[0119] In the foregoing method embodiments, from a functional perspective, the network device may be understood as an uplink scheduling apparatus, and the network device is configured to perform steps of the uplink scheduling method. In this application, the network device may be divided into functional units based on the foregoing method embodiments. For example, each functional unit may be obtained through division corresponding to each function, or two or more functions may be integrated into one functional unit. The integrated functional unit may be implemented in a form of hardware, or may be implemented in a form of a software functional unit. For example, when functional units are obtained in an integrated manner, FIG. 7 is a schematic diagram of a structure of an embodiment of a network device. As shown in FIG. 7, an embodiment of a network device 7 in this application may include:

a receiving module 701, configured to receive a random access request sent by a terminal device at a second coverage level, where the terminal device is in a connected state at a first coverage level;

a sending module 702, configured to send information about a first uplink resource to the terminal device at the second coverage level, to indicate the terminal device to send uplink data on the first uplink resource, where

the receiving module 701 is further configured to receive a first signal in the first uplink resource;

a demodulation module 703, configured to demodulate the first signal that is in the first uplink resource and that is received by the receiving module 701, to obtain a first demodulation result; and

a determining module 704, configured to: when the first demodulation result obtained by the demodulation module 703 is "incorrect", determine, based on the first demodulation result, whether the first uplink resource carries the uplink data, where

the sending module 702 is further configured to: when the determining module 704 determines that the first uplink resource carries the uplink data, send first retransmission control information to the terminal device at the first coverage level, where the first retransmission control information is used to indicate the terminal device to resend the uplink data on the second uplink resource; and

the sending module 702 is further configured to: when the determining module 704 determines that the first uplink resource does not carry the uplink data, send the first retransmission control information to the terminal device at the second coverage level.

[0120] In a possible implementation, the determining module 704 may be specifically configured to: determine whether signal quality of the first signal is higher than a threshold, and when the signal quality of the first signal is higher than the threshold, determine that the first uplink resource carries the uplink data, or when the signal quality of the first signal is lower than the threshold, determine that the first uplink resource does not carry the uplink data.

[0121] In a possible implementation, a first coverage level corresponds to normal coverage, and a second coverage level corresponds to enhanced coverage.

[0122] In a possible implementation, the sending module 702 is further configured to: after the receiving module 701 receives the random access request sent by the terminal device at the second coverage level, send a random access response to the terminal device at the second coverage level.

[0123] The receiving module 701 is further configured to receive, at the second coverage level, a contention message sent by the terminal device, where the contention message includes identification information of the terminal device.

[0124] The sending module 702 is further configured to: after the receiving module 701 receives, at the second coverage level, the contention message sent by the terminal device, send a contention resolution message to the terminal device at the second coverage level, where the contention resolution message includes the information about a first uplink resource.

[0125] In a possible implementation, the receiving module 701 is further configured to: after the sending module 702 sends $(n-1)^{th}$ retransmission control information to the terminal device, receive an n^{th} signal in an n^{th} uplink resource, where the $(n-1)^{th}$ retransmission control information is used to indicate the terminal device to resend uplink data on the n^{th} uplink resource, and n is an integer greater than 1.

[0126] The demodulation module 703 is further configured to: after the receiving module 701 receives the n^{th} signal, demodulate the n^{th} signal to obtain an n^{th} demodulation result.

[0127] The sending module 702 is further configured to: when the n^{th} demodulation result obtained by the demodulation module 703 is "incorrect", send n^{th} retransmission control information to the terminal device at a first coverage level, where the n^{th} retransmission control information is used to indicate the terminal device to resend the uplink data on an $(n+1)^{th}$ uplink resource.

[0128] In a possible implementation, the receiving module 701 is further configured to: after the sending module 702 sends $(n-1)^{th}$ retransmission control information to the terminal device, receive an n^{th} signal in an n^{th} uplink resource, where the $(n-1)^{th}$ retransmission control information is used to indicate the terminal device to resend the uplink data on the n^{th} uplink resource, and n is an integer greater than 1.

[0129] The demodulation module 703 is further configured to: after the receiving module 701 receives the n^{th} signal, demodulate the n^{th} signal to obtain an n^{th} demodulation result.

[0130] The determining module 704 is further configured to: when the n^{th} demodulation result obtained by the demodulation module 703 is "incorrect", determine whether an $(n-1)^{th}$ uplink resource carries the uplink data.

[0131] The sending module 702 is further configured to: when the determining module 704 determines that the $(n-1)^{th}$ uplink resource carries the uplink data, send n^{th} retransmission control information to the terminal device at a first coverage level, where the n^{th} retransmission control information is used to indicate the terminal device to resend the uplink data on an $(n+1)^{th}$ uplink resource.

[0132] The determining module 704 is further configured to: when the $(n-1)^{th}$ uplink resource does not carry the uplink data, determine, based on the n^{th} demodulation result, whether the n^{th} uplink resource carries the uplink data.

[0133] The sending module 702 is further configured to: when the determining module 704 determines that the n^{th} uplink resource carries the uplink data, send n^{th} retransmission control information to the terminal device at the first coverage level, or when the determining module determines that the n^{th} uplink resource does not carry the uplink data, send the n^{th} retransmission control information to the terminal device at the second coverage level.

[0134] Because the network device provided in the embodiments of this application may be configured to perform the method in the embodiments of this application, for technical effects that can be achieved by the functional apparatus embodiments of this application, refer to the foregoing corresponding method embodiments. Details are not described herein again.

[0135] From a perspective of an entity device, the network device in the methods in the foregoing embodiments may be implemented by one entity device, for example, a base station, or may be jointly implemented by a plurality of entity devices, or may be a logical functional unit in one entity device. This is not specifically limited in the embodiments of this application.

[0136] For example, the network device may be implemented by a network device in FIG. 8. FIG. 8 is a schematic diagram of a hardware structure of a network device according to an embodiment of this application. The network device includes at least one processor 801, a memory 802, a communication line 803, and at least one communication interface 804.

[0137] The processor 801 may be a general-purpose central processing unit (central processing unit, CPU), a microprocessor, an application-specific integrated circuit (application-specific integrated circuit, server IC), or one or more integrated circuits configured to control execution of programs in the solutions of this application.

[0138] The communication line 803 may include a path for transmitting information between the foregoing components.

[0139] The memory 802 may be a read-only memory (read-only memory, ROM), another type of static storage device capable of storing static information and instructions, a random access memory (random access memory, RAM), or another type of dynamic storage device capable of storing information and instructions, or may be an electrically erasable programmable read-only memory (electrically erasable programmable read-only memory, EEPROM), a compact disc read-only memory (compact disc read-only memory, CD-ROM), another compact disc storage, an optical disc storage (including a compressed optical disc, a laser disc, an optical disc, a digital versatile disc, a Blu-ray optical disc, and the like), a magnetic disk storage medium, another magnetic storage device, or any other medium capable of carrying or storing expected program code in a form of instructions or data structures and capable of being accessed by a computer, but the memory is not limited thereto. The memory may exist independently, and is connected to the processor 801 by using the communication line 803. Alternatively, the memory 802 may be integrated with the processor 801.

[0140] The memory 802 is configured to store computer-executable instructions for executing the solutions of this application, and the processor 801 controls the execution. The processor 801 is configured to execute the computer-executable instructions stored in the memory 802, to implement the method in the foregoing embodiments of this application.

[0141] The communication line 803 may include a path transmitting information between the foregoing components.

[0142] The communication interface 804 uses any apparatus such as a transceiver, to communicate with another device or a communication network, for example, the Ethernet, a radio access network (radio access network, RAN), or a wireless local area network (wireless local area network, WLAN).

[0143] In a possible implementation, the computer-executable instructions in the embodiments of this application may also be referred to as application program code. This is not specifically limited in the embodiments of this application.

[0144] In specific implementation, in an embodiment, the processor 801 may include one or more CPUs, for example, a CPU 0 and a CPU 1 in FIG. 8.

[0145] In specific implementation, in an embodiment, the computer apparatus may include a plurality of processors, for example, the processor 801 and a processor 805 in FIG. 8. Each of the processors may be a single-core (single-CPU) processor, or may be a multi-core (multi-CPU) processor. The processor herein may be one or more devices, circuits, and/or processing cores for processing data (for example, computer-executable instructions).

[0146] All or some of the foregoing method embodiments may be implemented by using software, hardware, firmware, or any combination thereof. When the software is used for implementation, all or some of the method embodiments may be implemented in a form of a computer program product.

[0147] The computer program product includes one or more computer-executable instructions. When the computer-executable instructions are loaded and executed on a computer, the procedure or functions according to the embodiments of this application are all or partially generated. The computer may be a general-purpose computer, a dedicated computer, a computer network, or another programmable apparatus. The computer instructions may be stored in a computer-readable storage medium or may be transmitted from a computer-readable storage medium to another computer-readable storage medium. For example, the 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 (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 disk, a hard disk, or a magnetic tape), an optical medium (for example, a DVD), a semiconductor medium (for example, a solid-state drive Solid-State Drive (SSD)), or the like.

[0148] The term "and/or" in this application may be an association relationship for describing associated objects, and may indicate three relationships. For example, A and/or B may indicate the following cases: Only A exists, both A and B exist, and only B exists, where A and B may be singular or plural. In addition, the character "/" in this application generally indicates an "or" relationship between the associated objects. In this application, "at least one" means one or more, and "a plurality of" means two or more. "At least one of the following items (pieces)" or a similar expression thereof

means any combination of these items, including a singular item (piece) or any combination of plural items (pieces). For example, at least one of a, b, or c may indicate: a, b, c, a and b, a and c, b and c, or a, b, and c, where a, b, and c may be singular or plural.

[0149] In the specification, claims, and the accompanying drawings of this application, the terms "first", "second", and the like are intended to distinguish between similar objects but do not necessarily indicate a specific order or sequence. It should be understood that the terms used in such a way are interchangeable in proper cases. This is merely a manner of distinguishing between objects with a same attribute in the embodiments of this application. In addition, the terms "include", "have", and any other variations thereof are intended to cover the non-exclusive inclusion, so that a process, method, system, product, or device that includes a series of units is not limited to those units, but may include other units not expressly listed or inherent to such a process, method, product, or device.

[0150] The technical solutions provided in this application are described in detail above. The principle and implementation of this application are described herein through specific examples. The description about the embodiments is merely provided to help understand the method and core ideas of this application. In addition, a person of ordinary skill in the art can make variations and modifications to this application in terms of specific implementations and application scopes according to the ideas of this application. Therefore, content of the specification shall not be construed as a limit to this application.

Claims

1. An uplink scheduling method, comprising:

   receiving, by a network device, a random access request sent by a terminal device at a second coverage level, wherein the terminal device is in a connected state at a first coverage level;
   sending, by the network device, information about a first uplink resource to the terminal device at the second coverage level, to indicate the terminal device to send uplink data on the first uplink resource;
   receiving and demodulating, by the network device, a first signal in the first uplink resource, to obtain a first demodulation result;
   if the first demodulation result is "incorrect", determining, by the network device based on the first demodulation result, whether the first uplink resource carries the uplink data; and
   if determining that the first uplink resource carries the uplink data, sending, by the network device, first retransmission control information to the terminal device at the first coverage level, wherein the first retransmission control information is used to indicate the terminal device to resend the uplink data on a second uplink resource; or
   if determining that the first uplink resource does not carry the uplink data, sending, by the network device, first retransmission control information to the terminal device at the second coverage level.

2. The method according to claim 1, wherein the determining, by the network device based on the first demodulation result, whether the first uplink resource carries the uplink data comprises:

   determining whether signal quality of the first signal is higher than a threshold; and
   if it is determined that the signal quality of the first signal is higher than the threshold, determining that the first uplink resource carries the uplink data; or
   if it is determined that the signal quality of the first signal is lower than the threshold, determining that the first uplink resource does not carry the uplink data.

3. The method according to claim 1, wherein the first coverage level corresponds to normal coverage, and the second coverage level corresponds to enhanced coverage.

4. The method according to claim 1, wherein after the receiving, by a network device, a random access request sent by a terminal device at a second coverage level, and before the sending, by the network device, information about a first uplink resource to the terminal device at the second coverage level, the method further comprises:

   sending, by the network device, a random access response to the terminal device at the second coverage level; and
   receiving, by the network device at the second coverage level, a contention message sent by the terminal device, wherein the contention message comprises identification information of the terminal device; and
   the sending, by the network device, information about a first uplink resource to the terminal device at the second coverage level comprises:

sending, by the network device, a contention resolution message to the terminal device at the second coverage level, wherein the contention resolution message comprises the information about the first uplink resource.

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

after the network device sends $(n-1)^{th}$ retransmission control information to the terminal device, receiving and demodulating, by the network device, an n^{th} signal in an n^{th} uplink resource to obtain an n^{th} demodulation result, wherein the $(n-1)^{th}$ retransmission control information is used to indicate the terminal device to resend the uplink data on the n^{th} uplink resource, and n is an integer greater than 1; and

if the n^{th} demodulation result is "incorrect", sending, by the network device, n^{th} retransmission control information to the terminal device at the first coverage level, wherein the n^{th} retransmission control information is used to indicate the terminal device to resend the uplink data on an $(n+1)^{th}$ uplink resource.

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

after the network device sends $(n-1)^{th}$ retransmission control information to the terminal device, receiving and demodulating, by the network device, an n^{th} signal in an n^{th} uplink resource to obtain an n^{th} demodulation result, wherein the $(n-1)^{th}$ retransmission control information is used to indicate the terminal device to resend the uplink data on the n^{th} uplink resource, and n is an integer greater than 1;

if the n^{th} demodulation result is "incorrect", determining, by the network device, whether an $(n-1)^{th}$ uplink resource carries the uplink data; and

if the $(n-1)^{th}$ uplink resource carries the uplink data, sending, by the network device, n^{th} retransmission control information to the terminal device at the first coverage level, wherein the n^{th} retransmission control information is used to indicate the terminal device to resend the uplink data on an $(n+1)^{th}$ uplink resource; or

if the $(n-1)^{th}$ uplink resource does not carry the uplink data, determining, by the network device based on the n^{th} demodulation result, whether the n^{th} uplink resource carries the uplink data; and

if the n^{th} uplink resource carries the uplink data, sending, by the network device, n^{th} retransmission control information to the terminal device at the first coverage level; or

if the n^{th} uplink resource does not carry the uplink data, sending, by the network device, n^{th} retransmission control information to the terminal device at the second coverage level.

7. An uplink scheduling apparatus, comprising:

a receiving module, configured to receive a random access request sent by a terminal device at a second coverage level, wherein the terminal device is in a connected state at a first coverage level;

a sending module, configured to send information about a first uplink resource to the terminal device at the second coverage level, to indicate the terminal device to send uplink data on the first uplink resource, wherein the receiving module is further configured to receive a first signal in the first uplink resource;

a demodulation module, configured to demodulate the first signal that is in the first uplink resource and that is received by the receiving module, to obtain a first demodulation result; and

a determining module, configured to: when the first demodulation result obtained by the demodulation module is "incorrect", determine, based on the first demodulation result, whether the first uplink resource carries the uplink data, wherein

the sending module is further configured to: when the determining module determines that the first uplink resource carries the uplink data, send first retransmission control information to the terminal device at the first coverage level, wherein the first retransmission control information is used to indicate the terminal device to resend the uplink data on a second uplink resource; or

the sending module is further configured to: when the determining module determines that the first uplink resource does not carry the uplink data, send first retransmission control information to the terminal device at the second coverage level.

8. The apparatus according to claim 7, wherein the determining module is further configured to: determine whether signal quality of the first signal is higher than a threshold, and when the signal quality of the first signal is higher than the threshold, determine that the first uplink resource carries the uplink data, or when the signal quality of the first signal is lower than the threshold, determine that the first uplink resource does not carry the uplink data.

9. The apparatus according to claim 7, wherein the first coverage level corresponds to normal coverage, and the second coverage level corresponds to enhanced coverage.

10. The apparatus according to claim 7, wherein the sending module is further configured to: after the receiving module receives the random access request sent by the terminal device at the second coverage level, send a random access response to the terminal device at the second coverage level;

the receiving module is further configured to receive, at the second coverage level, a contention message sent by the terminal device, wherein the contention message comprises identification information of the terminal device; and
the sending module is further configured to: after the receiving module receives, at the second coverage level, the contention message sent by the terminal device, send a contention resolution message to the terminal device at the second coverage level, wherein the contention resolution message comprises the information about the first uplink resource.

11. The apparatus according to any one of claims 7 to 10, wherein the receiving module is further configured to: after the sending module sends $(n-1)^{th}$ retransmission control information to the terminal device, receive an n^{th} signal in an n^{th} uplink resource, wherein the $(n-1)^{th}$ retransmission control information is used to indicate the terminal device to resend the uplink data on the n^{th} uplink resource, and n is an integer greater than 1;

the demodulation module is further configured to: after the receiving module receives the n^{th} signal, demodulate the n^{th} signal to obtain an n^{th} demodulation result; and
the sending module is further configured to: when the n^{th} demodulation result obtained by the demodulation module is "incorrect", send n^{th} retransmission control information to the terminal device at the first coverage level, wherein the n^{th} retransmission control information is used to indicate the terminal device to resend the uplink data on an $(n+1)^{th}$ uplink resource.

12. The apparatus according to any one of claims 7 to 10, wherein the receiving module is further configured to: after the sending module sends $(n-1)^{th}$ retransmission control information to the terminal device, receive an n^{th} signal in an n^{th} uplink resource, wherein the $(n-1)^{th}$ retransmission control information is used to indicate the terminal device to resend the uplink data on the n^{th} uplink resource, and n is an integer greater than 1;

the demodulation module is further configured to: after the receiving module receives the n^{th} signal, demodulate the n^{th} signal to obtain an n^{th} demodulation result;
the determining module is further configured to: when the n^{th} demodulation result obtained by the demodulation module is "incorrect", determine whether an $(n-1)^{th}$ uplink resource carries the uplink data; and
the sending module is further configured to: when the determining module determines that the $(n-1)^{th}$ uplink resource carries the uplink data, send n^{th} retransmission control information to the terminal device at the first coverage level, wherein the n^{th} retransmission control information is used to indicate the terminal device to resend the uplink data on an $(n+1)^{th}$ uplink resource; or
the determining module is further configured to: when the $(n-1)^{th}$ uplink resource does not carry the uplink data, determine, based on the n^{th} demodulation result, whether the n^{th} uplink resource carries the uplink data; and
the sending module is further configured to: when the determining module determines that the n^{th} uplink resource carries the uplink data, send n^{th} retransmission control information to the terminal device at the first coverage level, or when the determining module determines that the n^{th} uplink resource does not carry the uplink data, send the n^{th} retransmission control information to the terminal device at the second coverage level.

13. A computer-readable storage medium storing one or more computer-executable instructions, wherein when the computer-executable instructions are executed by a processor, the processor performs the method according to any one of claims 1 to 6.

Patentansprüche

1. Aufwärtsstreckenplanungsverfahren, das Folgendes umfasst:

Empfangen durch eine Netzvorrichtung einer Direktzugriffsanforderung, die durch eine Endgerätvorrichtung in einer zweiten Abdeckungsebene gesendet wird, wobei die Endgerätvorrichtung in einem verbundenen Zustand in einer ersten Abdeckungsebene ist;
Senden durch die Netzvorrichtung von Informationen zu einem ersten Aufwärtsstreckenbetriebsmittel an die Endgerätvorrichtung in der zweiten Abdeckungsebene, um für die Endgerätvorrichtung anzugeben, Aufwärts-

streckendaten auf dem ersten Aufwärtsstreckenbetriebsmittel zu senden,
Empfangen und Demodulieren durch die Netzvorrichtung eines ersten Signals in dem ersten Aufwärtsstreckenbetriebsmittel, um ein erstes Demodulationsergebnis zu erhalten;
falls das erste Demodulationsergebnis "inkorrekt" ist, Bestimmen durch die Netzvorrichtung basierend auf dem ersten Demodulationsergebnis, ob das erste Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, und
falls bestimmt wird, dass das erste Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, Senden durch die Netzvorrichtung erster Neuübertragungssteuerinformationen an die Endgerätvorrichtung in der ersten Abdeckungsebene, wobei die ersten Neuübertragungssteuerinformationen verwendet werden, um für die Endgerätvorrichtung anzugeben, die Aufwärtsstreckendaten auf einem zweiten Aufwärtsstreckenbetriebsmittel erneut zu senden, oder
falls bestimmt wird, dass das erste Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten nicht führt, Senden durch die Netzvorrichtung erster Neuübertragungssteuerinformationen an die Endgerätvorrichtung in der zweiten Abdeckungsebene.

2. Verfahren nach Anspruch 1, wobei das Bestimmen durch die Netzvorrichtung basierend auf dem ersten Demodulationsergebnis, ob das erste Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, Folgendes umfasst:

Bestimmen, ob die Signalqualität des ersten Signals höher als ein Schwellenwert ist; und
falls bestimmt wird, dass die Signalqualität des ersten Signals höher als der Schwellenwert ist, Bestimmen, dass das erste Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, oder
falls bestimmt wird, dass die Signalqualität des ersten Signals niedriger als der Schwellenwert ist, Bestimmen, dass das erste Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten nicht führt.

3. Verfahren nach Anspruch 1, wobei die erste Abdeckungsebene einer normalen Abdeckung entspricht und die zweite Abdeckungsebene einer erweiterten Abdeckung entspricht.

4. Verfahren nach Anspruch 1, wobei das Verfahren nach dem Empfangen durch eine Netzvorrichtung einer Direktzugriffsanforderung, die durch eine Endgerätvorrichtung in einer zweiten Abdeckungsebene gesendet wird, und vor dem Senden durch die Netzvorrichtung von Informationen zu einem ersten Aufwärtsstreckenbetriebsmittel an die Endgerätvorrichtung in der zweiten Abdeckungsebene ferner Folgendes umfasst:

Senden durch die Netzvorrichtung einer Direktzugriffsantwort an die Endgerätvorrichtung in der zweiten Abdeckungsebene, und
Empfangen durch die Netzvorrichtung in der zweiten Abdeckungsebene einer Konkurrenznachricht, die durch die Endgerätvorrichtung gesendet wird, wobei die Konkurrenznachricht Identifizierungsinformationen der Endgerätvorrichtung umfasst; und
wobei das Senden durch die Netzvorrichtung von Informationen zu einem ersten Aufwärtsstreckenbetriebsmittel an die Endgerätvorrichtung in der zweiten Abdeckungsebene Folgendes umfasst:
Senden durch die Netzvorrichtung einer Konkurrenzauflösungsnachricht an die Endgerätvorrichtung in der zweiten Abdeckungsebene, wobei die Konkurrenzauflösungsnachricht die Informationen zu dem ersten Aufwärtsstreckenbetriebsmittel umfasst.

5. Verfahren nach einem der Ansprüche 1 bis 4, wobei das Verfahren ferner Folgendes umfasst:

nachdem die Netzvorrichtung (n-1)-te Neuübertragungssteuerinformationen an die Endgerätvorrichtung gesendet hat, Empfangen und Demodulieren durch die Netzvorrichtung eines n-ten Signals in einem n-ten Aufwärtsstreckenbetriebsmittel, um ein n-tes Demodulationsergebnis zu erhalten, wobei die (n-1)-ten Neuübertragungssteuerinformationen verwendet werden, um für die Endgerätvorrichtung anzugeben, die Aufwärtsstreckendaten auf dem n-ten Aufwärtsstreckenbetriebsmittel erneut zu senden, und wobei n eine ganze Zahl größer als 1 ist; und
falls das n-te Demodulationsergebnis "inkorrekt" ist, Senden durch die Netzvorrichtung n-ter Neuübertragungssteuerinformationen an die Endgerätvorrichtung in der ersten Abdeckungsebene, wobei die n-ten Neuübertragungssteuerinformationen verwendet werden, um für die Endgerätvorrichtung anzugeben, die Aufwärtsstreckendaten auf einem (n+1)-ten Aufwärtsstreckenbetriebsmittel erneut zu senden.

6. Verfahren nach einem der Ansprüche 1 bis 4, wobei das Verfahren ferner Folgendes umfasst:

nachdem die Netzvorrichtung die (n-1)-ten Neuübertragungssteuerinformationen an die Endgerätvorrichtung

gesendet hat, Empfangen und Demodulieren durch die Netzvorrichtung eines n-ten Signals in einem n-ten Aufwärtsstreckenbetriebsmittel, um ein n-tes Demodulationsergebnis zu erhalten, wobei die (n-1)-ten Neuübertragungssteuerinformationen verwendet werden, um für die Endgerätvorrichtung anzugeben, die Aufwärtsstreckendaten auf dem n-ten Aufwärtsstreckenbetriebsmittel erneut zu senden, und wobei n eine ganze Zahl größer als 1 ist;
falls das n-te Demodulationsergebnis "inkorrekt" ist, Bestimmen durch die Netzvorrichtung, ob ein (n-1)-tes Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, und
falls das (n-1)-te Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, Senden durch die Netzvorrichtung n-ter Neuübertragungssteuerinformationen an die Endgerätvorrichtung in der ersten Abdeckungsebene, wobei die n-ten Neuübertragungssteuerinformationen verwendet werden, um für die Endgerätvorrichtung anzugeben, die Aufwärtsstreckendaten auf einem (n+1)-ten Aufwärtsstreckenbetriebsmittel erneut zu senden, oder
falls das (n-1)-te Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten nicht führt, Bestimmen durch die Netzvorrichtung basierend auf dem n-ten Demodulationsergebnis, ob das n-te Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, und
falls das n-te Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, Senden durch die Netzvorrichtung n-ter Neuübertragungssteuerinformationen an die Endgerätvorrichtung in der ersten Abdeckungsebene, oder
falls das n-te Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten nicht führt, Senden durch die Netzvorrichtung n-ter Neuübertragungssteuerinformationen an die Endgerätvorrichtung in der zweiten Abdeckungsebene.

7. Aufwärtsstreckenplanungseinrichtung, die Folgendes umfasst:

ein Empfangsmodul, das konfiguriert ist, eine Direktzugriffsanforderung, die durch eine Endgerätvorrichtung in einer zweiten Abdeckungsebene gesendet wird, zu empfangen, wobei die Endgerätvorrichtung in einem verbundenen Zustand in einer ersten Abdeckungsebene ist;
ein Sendemodul, das konfiguriert ist, Informationen zu einem ersten Aufwärtsstreckenbetriebsmittel an die Endgerätvorrichtung in der zweiten Abdeckungsebene zu senden, um für die Endgerätvorrichtung anzugeben, Aufwärtsstreckendaten auf dem ersten Aufwärtsstreckenbetriebsmittel zu senden, wobei
das Empfangsmodul ferner konfiguriert ist, ein erstes Signal in dem ersten Aufwärtsstreckenbetriebsmittel zu empfangen,
ein Demodulationsmodul, das konfiguriert ist, das erste Signal, das in dem ersten Aufwärtsstreckenbetriebsmittel ist und das durch das Empfangsmodul empfangen wird, zu demodulieren, um ein erstes Demodulationsergebnis zu erhalten; und
ein Bestimmungsmodul, das konfiguriert ist zum: wenn das erste durch das Demodulationsmodul erhaltene Demodulationsergebnis "inkorrekt" ist, Bestimmen basierend auf dem ersten Demodulationsergebnis, ob das erste Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, wobei
das Sendemodul ferner konfiguriert ist zum: wenn das Bestimmungsmodul bestimmt, dass das erste Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, Senden erster Neuübertragungssteuerinformationen an die Endgerätvorrichtung in der ersten Abdeckungsebene, wobei die ersten Neuübertragungssteuerinformationen verwendet werden, um für die Endgerätvorrichtung anzugeben, die Aufwärtsstreckendaten auf einem zweiten Aufwärtsstreckenbetriebsmittel erneut zu senden, oder
das Sendemodul ferner konfiguriert ist zum: wenn das Bestimmungsmodul bestimmt, dass das erste Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten nicht führt, Senden erster Neuübertragungssteuerinformationen an die Endgerätvorrichtung in der zweiten Abdeckungsebene.

8. Einrichtung nach Anspruch 7, wobei das Bestimmungsmodul ferner konfiguriert ist zum: Bestimmen, ob die Signalqualität des ersten Signals höher als ein Schwellenwert ist, und wenn die Signalqualität des ersten Signals höher als der Schwellenwert ist, Bestimmen, dass das Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, oder wenn die Signalqualität des ersten Signals niedriger als der Schwellenwert ist, Bestimmen, dass das erste Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten nicht führt.

9. Einrichtung nach Anspruch 7, wobei die erste Abdeckungsebene einer normalen Abdeckung entspricht und die zweite Abdeckungsebene einer erweiterten Abdeckung entspricht.

10. Einrichtung nach Anspruch 7, wobei das Sendemodul ferner konfiguriert ist zum: nachdem das Empfangsmodul die durch die Endgerätvorrichtung in der zweiten Abdeckungsebene gesendete Direktzugriffsanforderung empfangen hat, Senden einer Direktzugriffsantwort an die Endgerätvorrichtung in der zweiten Abdeckungsebene, wobei

das Empfangsmodul ferner konfiguriert ist, in der zweiten Abdeckungsebene eine durch die Endgerätvorrichtung gesendete Konkurrenznachricht zu empfangen, wobei die Konkurrenznachricht Identifizierungsinformationen der Endgerätvorrichtung umfasst; und
das Sendemodul ferner konfiguriert ist zum: nachdem das Empfangsmodul in der zweiten Abdeckungsebene die durch die Endgerätvorrichtung gesendete Konkurrenznachricht empfangen hat, Senden einer Konkurrenzauflösungsnachricht an die Endgerätvorrichtung in der zweiten Abdeckungsebene, wobei die Konkurrenzauflösungsnachricht die Informationen zu dem ersten Aufwärtsstreckenbetriebsmittel umfasst.

11. Einrichtung nach einem der einem der Ansprüche 7 bis 10, wobei das Empfangsmodul ferner konfiguriert ist zum: nachdem das Sendemodul (n-1)-te Neuübertragungssteuerinformationen an die Endgerätvorrichtung gesendet hat, Empfangen eines n-ten Signals in einem n-ten Aufwärtsstreckenbetriebsmittel, wobei die (n-1)-ten Neuübertragungssteuerinformationen verwendet werden, um für die Endgerätvorrichtung anzugeben, die Aufwärtsstreckendaten auf dem n-ten Aufwärtsstreckenbetriebsmittel erneut zu senden, und wobei n eine ganze Zahl größer als 1 ist;

wobei das Demodulationsmodul ferner konfiguriert ist zum: nachdem das Empfangsmodul das n-te Signal empfangen hat, Demodulieren des n-ten Signals, um ein n-tes Demodulationsergebnis zu erhalten; und
wobei das Sendemodul ferner konfiguriert ist zum: wenn das durch das Demodulationsmodul erhaltene n-te Demodulationsergebnis "inkorrekt" ist, Senden n-ter Neuübertragungssteuerinformationen an die Endgerätvorrichtung in der ersten Abdeckungsebene, wobei die n-ten Neuübertragungssteuerinformationen verwendet werden, um für die Endgerätvorrichtung anzugeben, die Aufwärtsstreckendaten auf einem (n+1)-ten Aufwärtsstreckenbetriebsmittel erneut zu senden.

12. Einrichtung nach einem der einem der Ansprüche 7 bis 10, wobei das Empfangsmodul ferner konfiguriert ist zum: nachdem das Sendemodul (n-1)-te Neuübertragungssteuerinformationen an die Endgerätvorrichtung gesendet hat, Empfangen eines n-ten Signals in einem n-ten Aufwärtsstreckenbetriebsmittel, wobei die (n-1)-ten Neuübertragungssteuerinformationen verwendet werden, um für die Endgerätvorrichtung anzugeben, die Aufwärtsstreckendaten auf dem n-ten Aufwärtsstreckenbetriebsmittel erneut zu senden, und wobei n eine ganze Zahl größer als 1 ist;

wobei das Demodulationsmodul ferner konfiguriert ist zum: nachdem das Empfangsmodul das n-te Signal empfangen hat, Demodulieren des n-ten Signals, um ein n-tes Demodulationsergebnis zu erhalten;
wobei das Bestimmungsmodul ferner konfiguriert ist zum: wenn das durch das Demodulationsmodul erhaltene n-te Demodulationsergebnis "inkorrekt" ist, Bestimmen, ob ein (n-1)-tes Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, und
wobei das Sendemodul ferner konfiguriert ist zum: wenn das Bestimmungsmodul bestimmt, dass das (n-1)-te Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, Senden n-ter Neuübertragungssteuerinformationen an die Endgerätvorrichtung in der ersten Abdeckungsebene, wobei die n-ten Neuübertragungssteuerinformationen verwendet werden, um für die Endgerätvorrichtung anzugeben, die Aufwärtsstreckendaten auf einem (n+1)-ten Aufwärtsstreckenbetriebsmittel erneut zu senden, oder
das Bestimmungsmodul ferner konfiguriert ist zum: wenn das (n-1)-te Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten nicht führt, Bestimmen basierend auf dem n-ten Demodulationsergebnis, ob das n-te Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, und
das Sendemodul ferner konfiguriert ist zum: wenn das Bestimmungsmodul bestimmt, dass das n-te Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten führt, Senden n-ter Neuübertragungssteuerinformationen an die Endgerätvorrichtung in der ersten Abdeckungsebene, oder wenn das Bestimmungsmodul bestimmt, dass das n-te Aufwärtsstreckenbetriebsmittel die Aufwärtsstreckendaten nicht führt, Senden der n-ten Neuübertragungssteuerinformationen an die Endgerätvorrichtung in der zweiten Abdeckungsebene.

13. Computerlesbares Speichermedium, das eine oder mehrere computerausführbare Anweisungen speichert, wobei dann, wenn die computerausführbaren Anweisungen durch einen Prozessor ausgeführt werden, das Prozessor das Verfahren nach einem der Ansprüche 1 bis 6 ausführt.

Revendications

1. Procédé de planification de liaison montante, comprenant les étapes suivantes :

recevoir, par un dispositif de réseau, une demande d'accès aléatoire envoyée par un dispositif terminal à un second niveau de couverture, dans lequel le dispositif terminal est dans un état connecté à un premier niveau

de couverture ;
envoyer, par le dispositif de réseau, des informations concernant une première ressource de liaison montante au dispositif terminal au second niveau de couverture, pour indiquer au dispositif terminal d'envoyer des données de liaison montante sur la première ressource de liaison montante ;
recevoir et démoduler, par le dispositif de réseau, un premier signal dans la première ressource de liaison montante, pour obtenir un premier résultat de démodulation ;
si le premier résultat de démodulation est « incorrect », déterminer, par le dispositif de réseau, sur la base du premier résultat de démodulation, si la première ressource de liaison montante transporte les données de liaison montante ; et
s'il est déterminé que la première ressource de liaison montante transporte les données de liaison montante, envoyer, par le dispositif de réseau, des premières informations de commande de retransmission au dispositif terminal au premier niveau de couverture, dans lequel les premières informations de commande de retransmission sont utilisées pour indiquer au dispositif terminal de renvoyer les données de liaison montante sur une deuxième ressource de liaison montante ; ou
s'il est déterminé que la première ressource de liaison montante ne transporte pas les données de liaison montante, envoyer, par le dispositif de réseau, des premières informations de commande de retransmission au dispositif terminal au second niveau de couverture.

2. Procédé selon la revendication 1, dans lequel la détermination, par le dispositif de réseau, sur la base du premier résultat de démodulation, si la première ressource de liaison montante transporte les données de liaison montante comprend les étapes suivantes :

déterminer si la qualité de signal du premier signal est supérieure à un seuil ; et
s'il est déterminé que la qualité de signal du premier signal est supérieure au seuil, déterminer que la première ressource de liaison montante transporte les données de liaison montante ; ou
s'il est déterminé que la qualité de signal du premier signal est inférieure au seuil, déterminer que la première ressource de liaison montante ne transporte pas les données de liaison montante.

3. Procédé selon la revendication 1, dans lequel le premier niveau de couverture correspond à une couverture normale, et le second niveau de couverture correspond à une couverture améliorée.

4. Procédé selon la revendication 1, après la réception, par un dispositif de réseau, d'une demande d'accès aléatoire envoyée par un dispositif terminal à un second niveau de couverture, et avant l'envoi, par le dispositif de réseau, d'informations concernant une première ressource de liaison montante au dispositif terminal au second niveau de couverture, le procédé comprenant en outre les étapes suivantes :

envoyer, par le dispositif de réseau, une réponse d'accès aléatoire au dispositif terminal au second niveau de couverture ; et
recevoir, par le dispositif de réseau au second niveau de couverture, un message de conflit envoyé par le dispositif terminal, dans lequel le message de conflit comprend des informations d'identification du dispositif terminal ; et
l'envoi, par le dispositif de réseau, d'informations concernant une première ressource de liaison montante au dispositif terminal au second niveau de couverture comprenant l'étape suivante :
envoyer, par le dispositif de réseau, un message de résolution de conflit au dispositif terminal au second niveau de couverture, dans lequel le message de résolution de conflit comprend les informations concernant la première ressource de liaison montante.

5. Procédé selon l'une quelconque des revendications 1 à 4, le procédé comprenant en outre les étapes suivantes :

après que le dispositif de réseau a envoyé des $(n-1)^{ièmes}$ informations de commande de retransmission au dispositif terminal, recevoir et démoduler, par le dispositif de réseau, un $n^{ième}$ signal dans une $n^{ième}$ ressource de liaison montante pour obtenir un $n^{ième}$ résultat de démodulation, dans lequel les $(n-1)^{ièmes}$ informations de commande de retransmission sont utilisées pour indiquer au dispositif terminal de renvoyer les données de liaison montante sur la $n^{ième}$ ressource de liaison montante, et n est un entier supérieur à 1 ; et
si le $n^{ième}$ résultat de démodulation est « incorrect », envoyer, par le dispositif de réseau, des $n^{ièmes}$ informations de commande de retransmission au dispositif terminal au premier niveau de couverture, dans lequel les $n^{ièmes}$ informations de commande de retransmission sont utilisées pour indiquer au dispositif terminal de renvoyer les données de liaison montante sur une $(n+1)^{ième}$ ressource de liaison montante.

6. Procédé selon l'une quelconque des revendications 1 à 4, le procédé comprenant en outre les étapes suivantes :

après que le dispositif de réseau a envoyé des (n-1)^{ièmes} informations de commande de retransmission au dispositif terminal, recevoir et démoduler, par le dispositif de réseau, un n^{ième} signal dans une n^{ième} ressource de liaison montante pour obtenir un n^{ième} résultat de démodulation, dans lequel les (n-1)^{ièmes} informations de commande de retransmission sont utilisées pour indiquer au dispositif terminal de renvoyer les données de liaison montante sur la n^{ième} ressource de liaison montante, et n est un entier supérieur à 1 ;
si le n^{ième} résultat de démodulation est « incorrect », déterminer, par le dispositif de réseau, si une (n-1)^{ième} ressource de liaison montante transporte les données de liaison montante ; et
si la (n-1)^{ième} ressource de liaison montante transporte les données de liaison montante, envoyer, par le dispositif de réseau, des n^{ièmes} informations de commande de retransmission au dispositif terminal au premier niveau de couverture, dans lequel les n^{ièmes} informations de commande de retransmission sont utilisées pour indiquer au dispositif terminal de renvoyer les données de liaison montante sur une (n+1)^{ième} ressource de liaison montante ; ou
si la (n-1)^{ième} ressource de liaison montante ne transporte pas les données de liaison montante, déterminer, par le dispositif de réseau, sur la base du n^{ième} résultat de démodulation, si la n^{ième} ressource de liaison montante transporte les données de liaison montante ; et
si la n^{ième} ressource de liaison montante transporte les données de liaison montante, envoyer, par le dispositif de réseau, des n^{ièmes} informations de commande de retransmission au dispositif terminal au premier niveau de couverture ; ou
si la n^{ième} ressource de liaison montante ne transporte pas les données de liaison montante, envoyer, par le dispositif de réseau, des n^{ièmes} informations de commande de retransmission au dispositif terminal au second niveau de couverture.

7. Appareil de planification de liaison montante, comprenant :

un module de réception, configuré pour recevoir une demande d'accès aléatoire envoyée par un dispositif terminal à un second niveau de couverture, dans lequel le dispositif terminal est dans un état connecté à un premier niveau de couverture ;
un module d'envoi, configuré pour envoyer des informations concernant une première ressource de liaison montante au dispositif terminal au second niveau de couverture, pour indiquer au dispositif terminal d'envoyer des données de liaison montante sur la première ressource de liaison montante,
le module de réception étant en outre configuré pour recevoir un premier signal dans la première ressource de liaison montante ;
un module de démodulation, configuré pour démoduler le premier signal qui est dans la première ressource de liaison montante et qui est reçu par le module de réception, pour obtenir un premier résultat de démodulation ; et
un module de détermination, configuré pour : lorsque le premier résultat de démodulation obtenu par le module de démodulation est « incorrect », déterminer, sur la base du premier résultat de démodulation, si la première ressource de liaison montante transporte les données de liaison montante,
le module d'envoi étant en outre configuré pour : lorsque le module de détermination détermine que la première ressource de liaison montante transporte les données de liaison montante, envoyer des premières informations de commande de retransmission au dispositif terminal au premier niveau de couverture, dans lequel les premières informations de commande de retransmission sont utilisées pour indiquer au dispositif terminal de renvoyer les données de liaison montante sur une deuxième ressource de liaison montante ; ou
le module d'envoi étant en outre configuré pour : lorsque le module de détermination détermine que la première ressource de liaison montante ne transporte pas les données de liaison montante, envoyer des premières informations de commande de retransmission au dispositif terminal au second niveau de couverture.

8. Appareil selon la revendication 7, dans lequel le module de détermination est en outre configuré pour : déterminer si la qualité de signal du premier signal est supérieure à un seuil, et lorsque la qualité de signal du premier signal est supérieure au seuil, déterminer que la première ressource de liaison montante transporte les données de liaison montante, ou lorsque la qualité de signal du premier signal est inférieure au seuil, déterminer que la première ressource de liaison montante ne transporte pas les données de liaison montante.

9. Appareil selon la revendication 7, dans lequel le premier niveau de couverture correspond à une couverture normale, et le second niveau de couverture correspond à une couverture améliorée.

10. Appareil selon la revendication 7, dans lequel le module d'envoi est en outre configuré pour : après que le module

de réception a reçu la demande d'accès aléatoire envoyée par le dispositif terminal au second niveau de couverture, envoyer une réponse d'accès aléatoire au dispositif terminal au second niveau de couverture ;

le module de réception est en outre configuré pour recevoir, au second niveau de couverture, un message de conflit envoyé par le dispositif terminal, dans lequel le message de conflit comprend des informations d'identification du dispositif terminal ; et
le module d'envoi est en outre configuré pour : après que le module de réception a reçu, au second niveau de couverture, le message de conflit envoyé par le dispositif terminal, envoyer un message de résolution de conflit au dispositif terminal au second niveau de couverture, dans lequel le message de résolution de conflit comprend les informations concernant la première ressource de liaison montante.

11. Appareil selon l'une quelconque des revendications 7 à 10, dans lequel le module de réception est en outre configuré pour : après que le module d'envoi a envoyé des $(n-1)^{ièmes}$ informations de commande de retransmission au dispositif terminal, recevoir un $n^{ième}$ signal dans une $n^{ième}$ ressource de liaison montante, dans lequel les $(n-1)^{ièmes}$ informations de commande de retransmission sont utilisées pour indiquer au dispositif terminal de renvoyer les données de liaison montante sur la $n^{ième}$ ressource de liaison montante, et n est un entier supérieur à 1 ;

le module de démodulation est en outre configuré pour : après que le module de réception a reçu le $n^{ième}$ signal, démoduler le $n^{ième}$ signal pour obtenir un $n^{ième}$ résultat de démodulation ; et
le module d'envoi est en outre configuré pour : lorsque le $n^{ième}$ résultat de démodulation obtenu par le module de démodulation est « incorrect », envoyer des $n^{ièmes}$ informations de commande de retransmission au dispositif terminal au premier niveau de couverture, dans lequel les $n^{ièmes}$ informations de commande de retransmission sont utilisées pour indiquer au dispositif terminal de renvoyer les données de liaison montante sur une $(n+1)^{ième}$ ressource de liaison montante.

12. Appareil selon l'une quelconque des revendications 7 à 10, dans lequel le module de réception est en outre configuré pour : après que le module d'envoi a envoyé des $(n-1)^{ièmes}$ informations de commande de retransmission au dispositif terminal, recevoir un $n^{ième}$ signal dans une $n^{ième}$ ressource de liaison montante, dans lequel les $(n-1)^{ièmes}$ informations de commande de retransmission sont utilisées pour indiquer au dispositif terminal de renvoyer les données de liaison montante sur la $n^{ième}$ ressource de liaison montante, et n est un entier supérieur à 1 ;

le module de démodulation est en outre configuré pour : après que le module de réception a reçu le $n^{ième}$ signal, démoduler le $n^{ième}$ signal pour obtenir un $n^{ième}$ résultat de démodulation ;
le module de détermination est en outre configuré pour : lorsque le $n^{ième}$ résultat de démodulation obtenu par le module de démodulation est « incorrect », déterminer si une $(n-1)^{ième}$ ressource de liaison montante transporte les données de liaison montante ; et
le module d'envoi est en outre configuré pour : lorsque le module de détermination détermine que la $(n-1)^{ième}$ ressource de liaison montante transporte les données de liaison montante, envoyer des $n^{ièmes}$ informations de commande de retransmission au dispositif terminal au premier niveau de couverture, dans lequel les $n^{ièmes}$ informations de commande de retransmission sont utilisées pour indiquer au dispositif terminal de renvoyer les données de liaison montante sur une $(n+1)^{ième}$ ressource de liaison montante ; ou
le module de détermination est en outre configuré pour : lorsque la $(n-1)^{ième}$ ressource de liaison montante ne transporte pas les données de liaison montante, déterminer, sur la base du $n^{ième}$ résultat de démodulation, si la $n^{ième}$ ressource de liaison montante transporte les données de liaison montante ; et
le module d'envoi est en outre configuré pour : lorsque le module de détermination détermine que la $n^{ième}$ ressource de liaison montante transporte les données de liaison montante, envoyer des $n^{ièmes}$ informations de commande de retransmission au dispositif terminal au premier niveau de couverture, ou lorsque le module de détermination détermine que la $n^{ième}$ ressource de liaison montante ne transporte pas les données de liaison montante, envoyer les $n^{ièmes}$ informations de commande de retransmission au dispositif terminal au second niveau de couverture.

13. Support de stockage lisible par ordinateur stockant une ou plusieurs instructions exécutables par ordinateur, dans lequel lorsque les instructions exécutables par ordinateur sont exécutées par un processeur, le processeur exécute le procédé selon l'une quelconque des revendications 1 à 6.

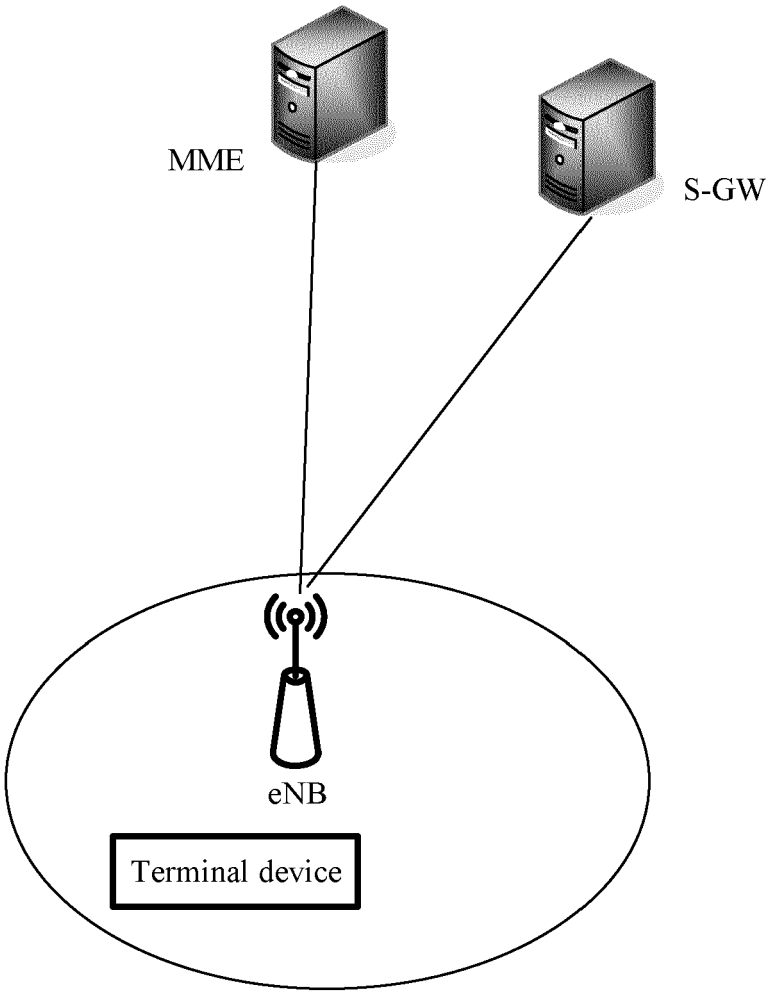

FIG. 1

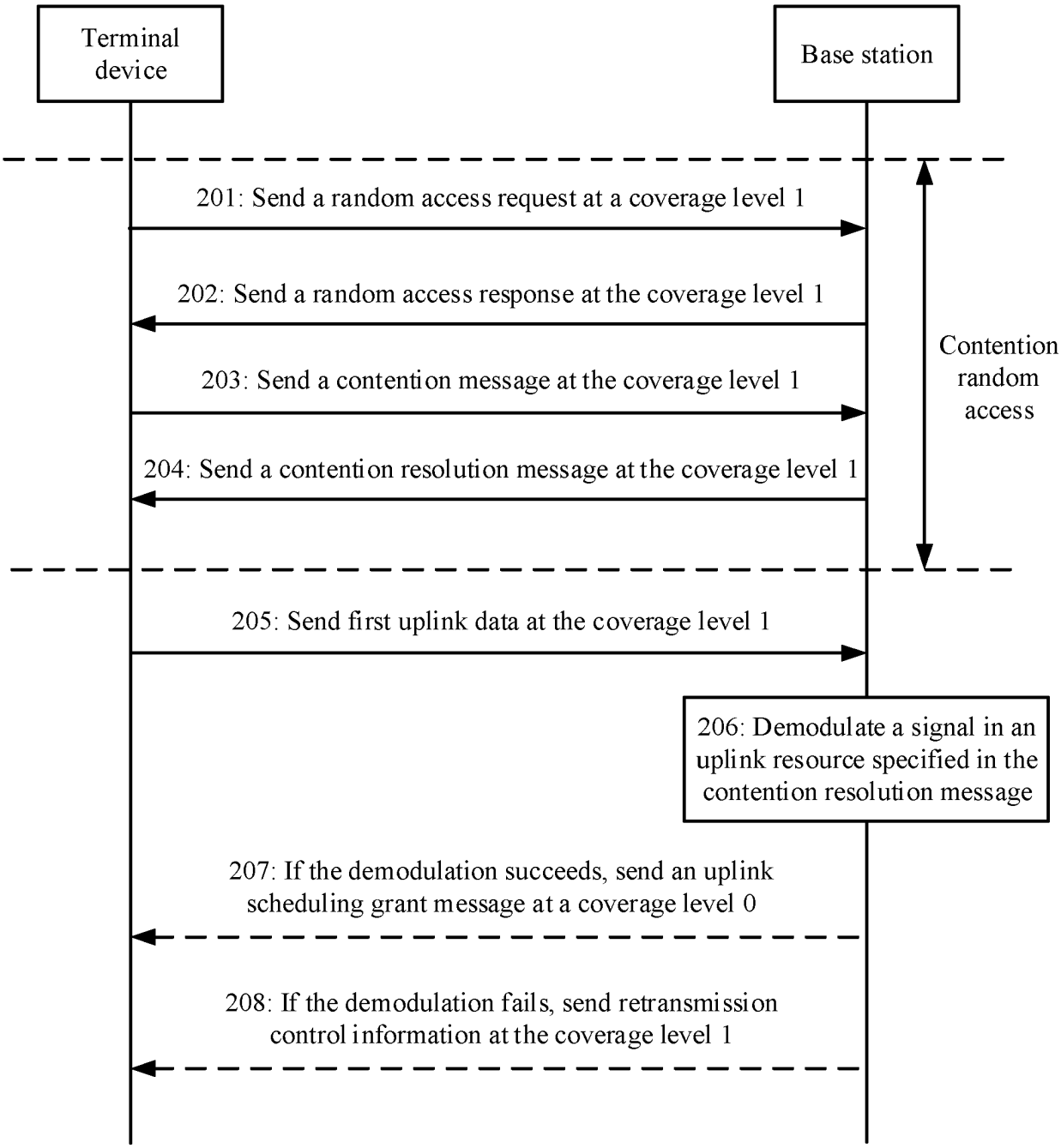
Terminal device
Base station
201: Send a random access request at a coverage level 1
202: Send a random access response at the coverage level 1
203: Send a contention message at the coverage level 1
204: Send a contention resolution message at the coverage level 1
Contention random access
205: Send first uplink data at the coverage level 1
206: Demodulate a signal in an uplink resource specified in the contention resolution message
207: If the demodulation succeeds, send an uplink scheduling grant message at a coverage level 0
208: If the demodulation fails, send retransmission control information at the coverage level 1

FIG. 2

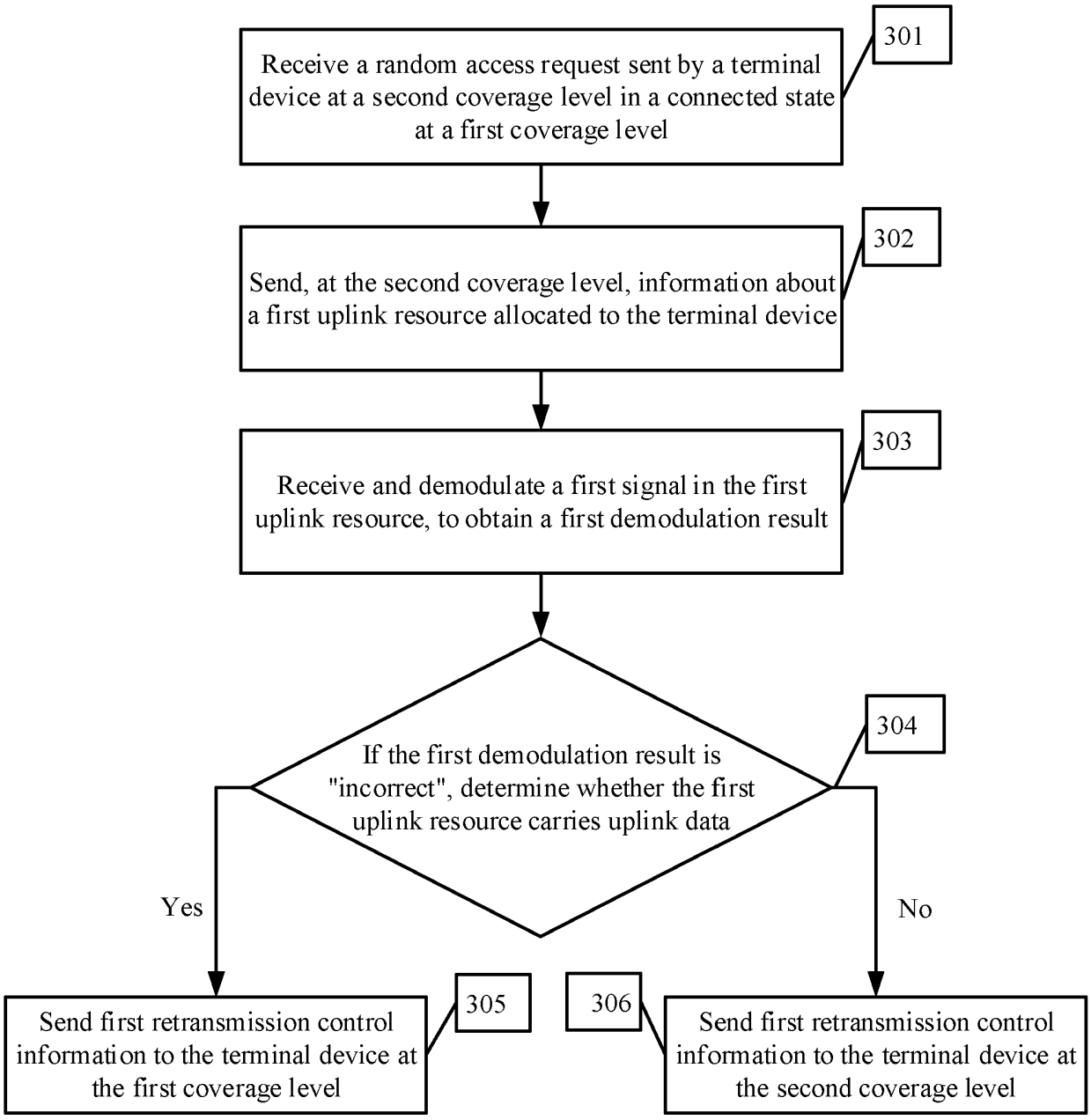
Receive a random access request sent by a terminal device at a second coverage level in a connected state at a first coverage level
301
Send, at the second coverage level, information about a first uplink resource allocated to the terminal device
302
Receive and demodulate a first signal in the first uplink resource, to obtain a first demodulation result
303
If the first demodulation result is "incorrect", determine whether the first uplink resource carries uplink data
304
Yes
No
Send first retransmission control information to the terminal device at the first coverage level
305
306
Send first retransmission control information to the terminal device at the second coverage level

FIG. 3

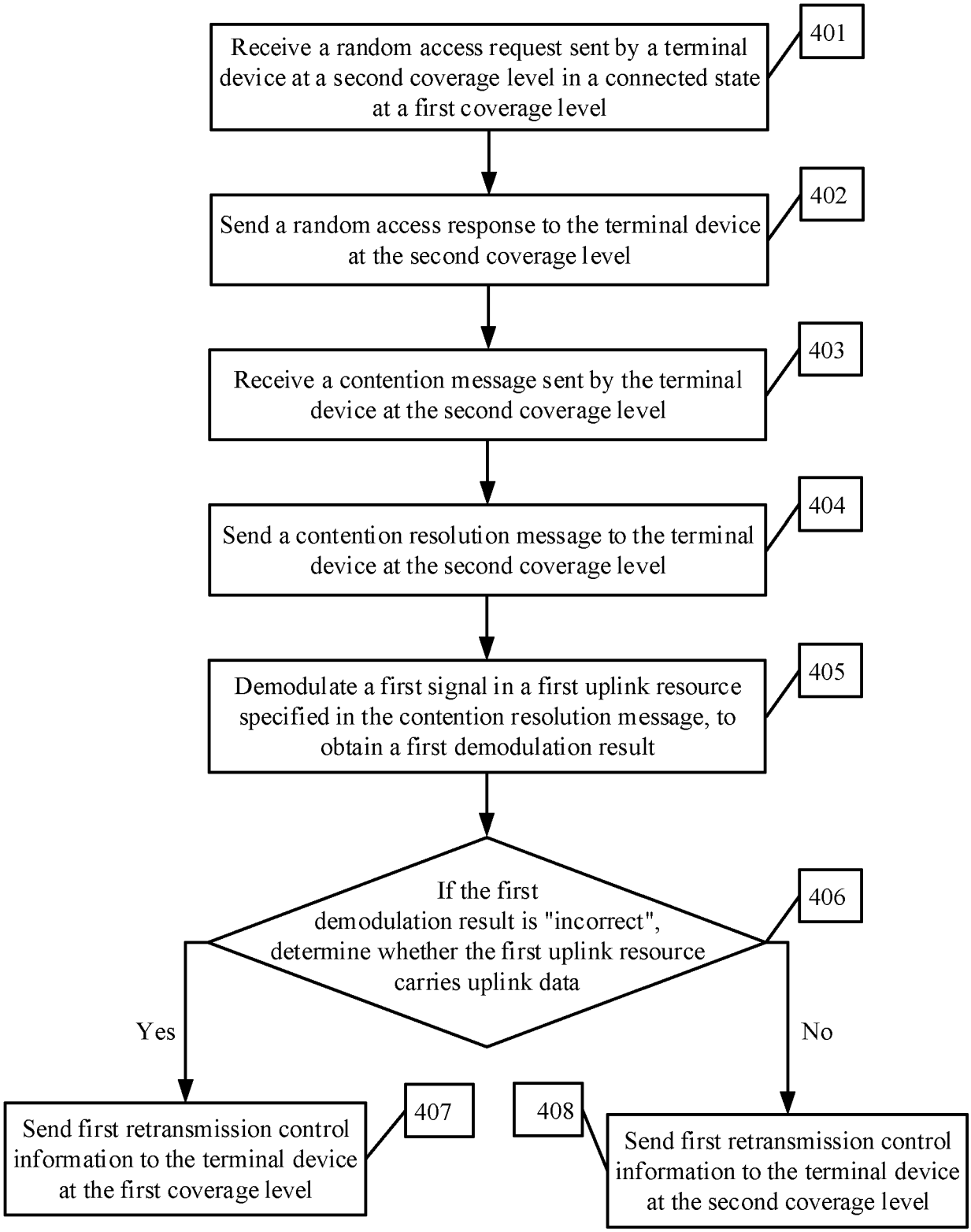
Receive a random access request sent by a terminal device at a second coverage level in a connected state at a first coverage level
401
Send a random access response to the terminal device at the second coverage level
402
Receive a contention message sent by the terminal device at the second coverage level
403
Send a contention resolution message to the terminal device at the second coverage level
404
Demodulate a first signal in a first uplink resource specified in the contention resolution message, to obtain a first demodulation result
405
If the first demodulation result is "incorrect", determine whether the first uplink resource carries uplink data
406
Yes
No
Send first retransmission control information to the terminal device at the first coverage level
407
408
Send first retransmission control information to the terminal device at the second coverage level

FIG. 4

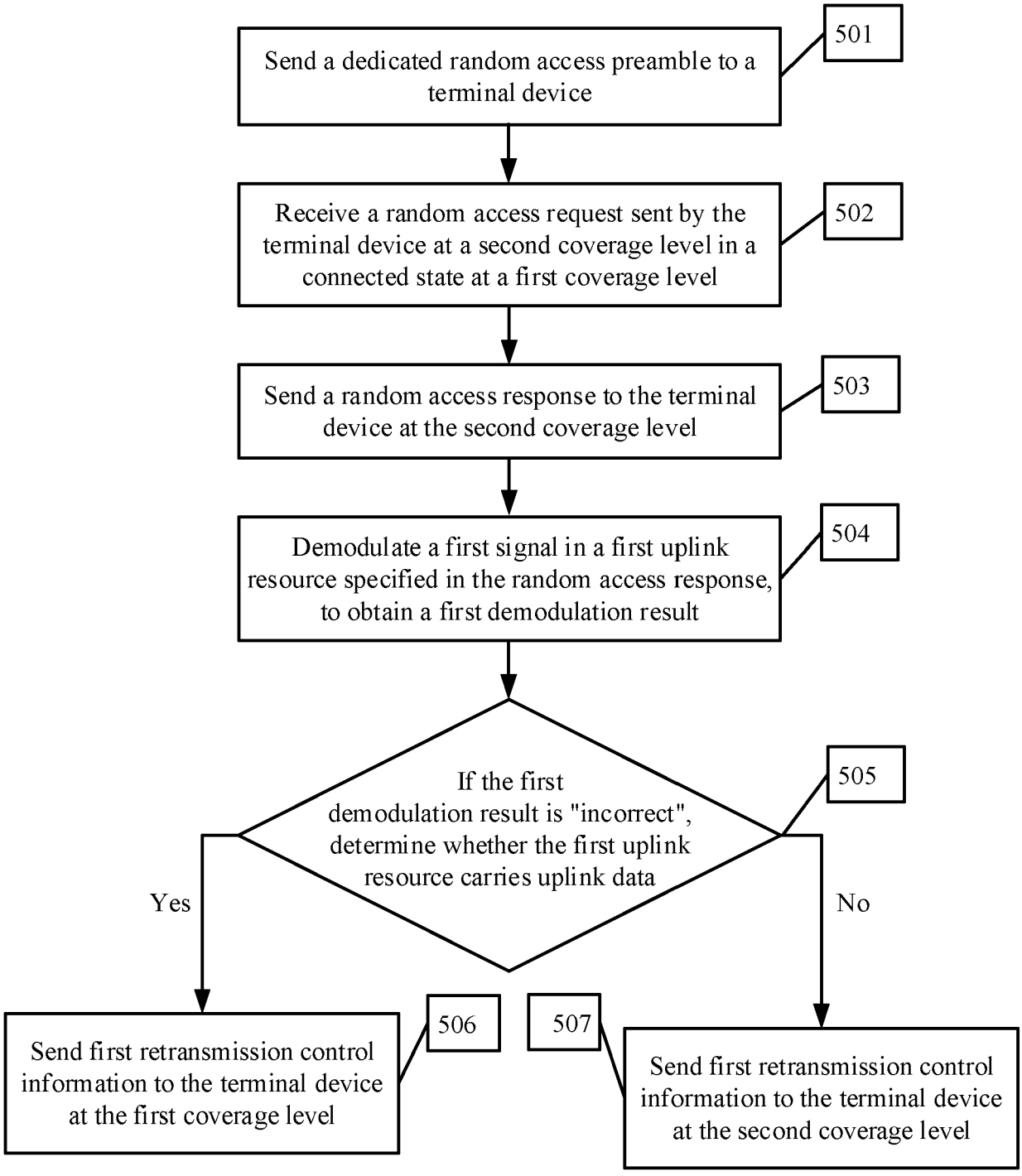
Send a dedicated random access preamble to a terminal device
501
Receive a random access request sent by the terminal device at a second coverage level in a connected state at a first coverage level
502
Send a random access response to the terminal device at the second coverage level
503
Demodulate a first signal in a first uplink resource specified in the random access response, to obtain a first demodulation result
504
If the first demodulation result is "incorrect", determine whether the first uplink resource carries uplink data
505
Yes
No
Send first retransmission control information to the terminal device at the first coverage level
506
507
Send first retransmission control information to the terminal device at the second coverage level

FIG. 5

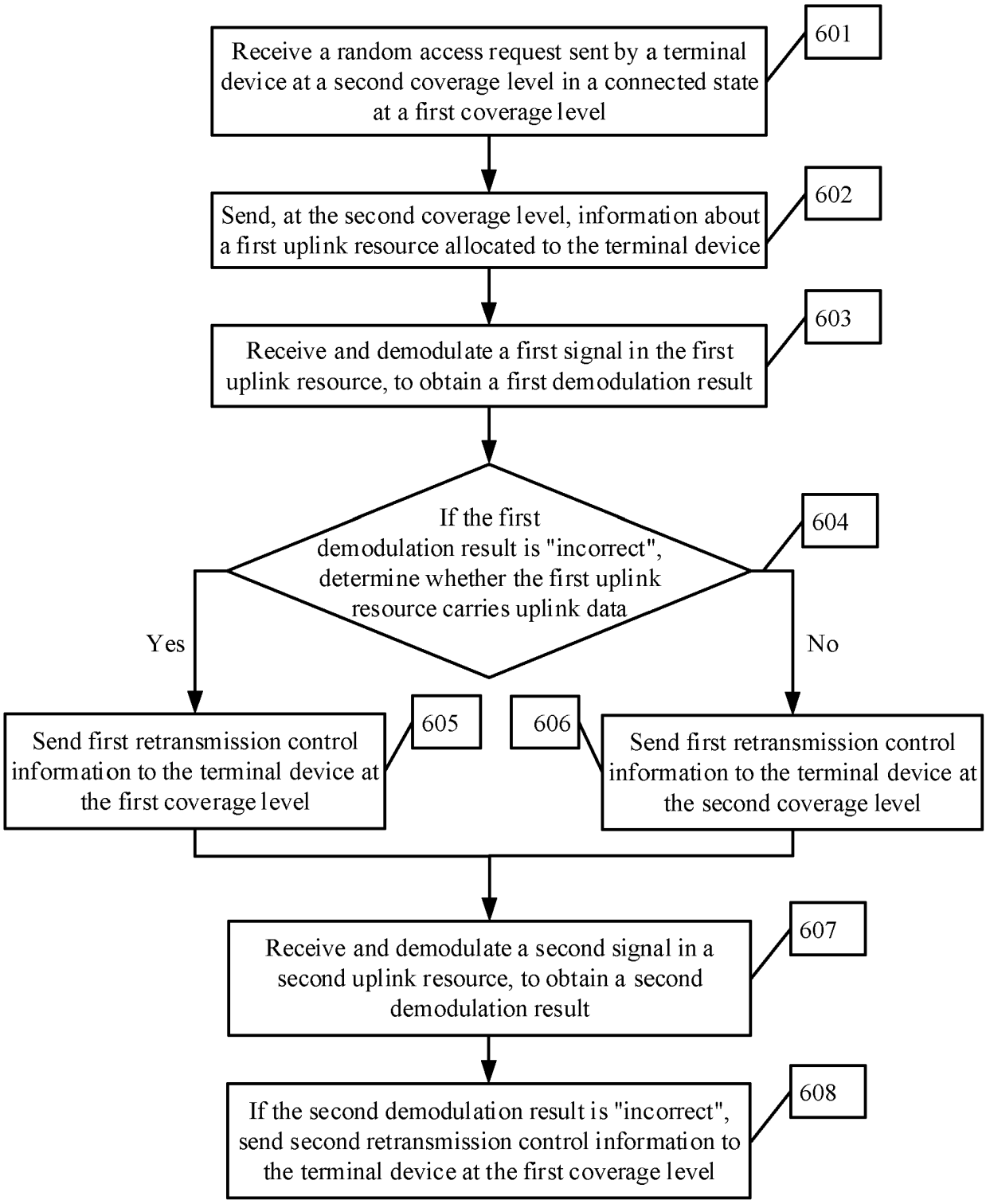
Receive a random access request sent by a terminal device at a second coverage level in a connected state at a first coverage level
601
Send, at the second coverage level, information about a first uplink resource allocated to the terminal device
602
Receive and demodulate a first signal in the first uplink resource, to obtain a first demodulation result
603
If the first demodulation result is "incorrect", determine whether the first uplink resource carries uplink data
604
Yes
No
Send first retransmission control information to the terminal device at the first coverage level
605
606
Send first retransmission control information to the terminal device at the second coverage level
Receive and demodulate a second signal in a second uplink resource, to obtain a second demodulation result
607
If the second demodulation result is "incorrect", send second retransmission control information to the terminal device at the first coverage level
608

FIG. 6

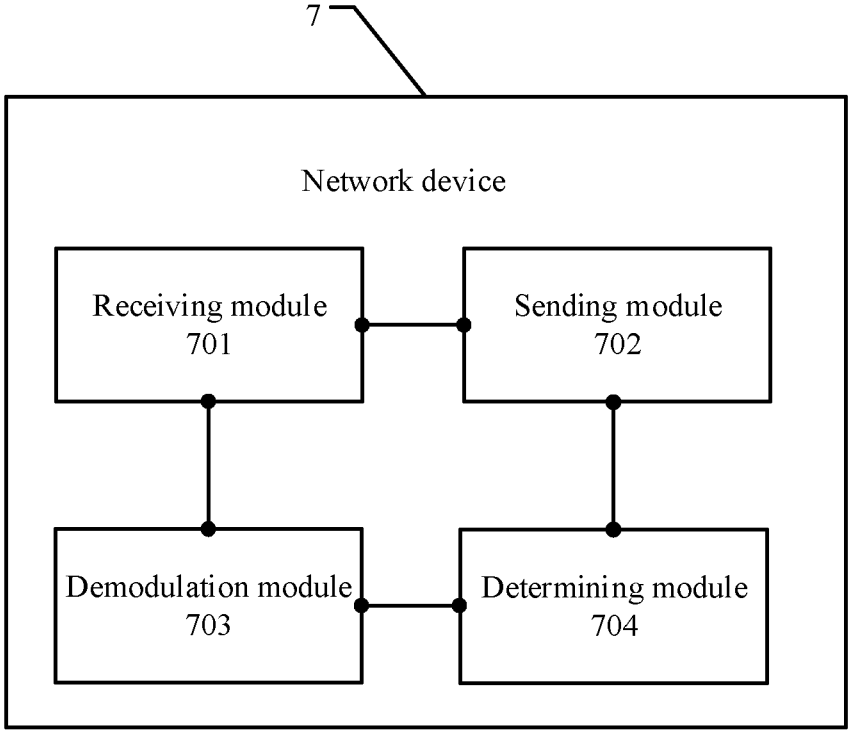
7
Network device
Receiving module
701
Sending module
702
Demodulation module
703
Determining module
704

FIG. 7

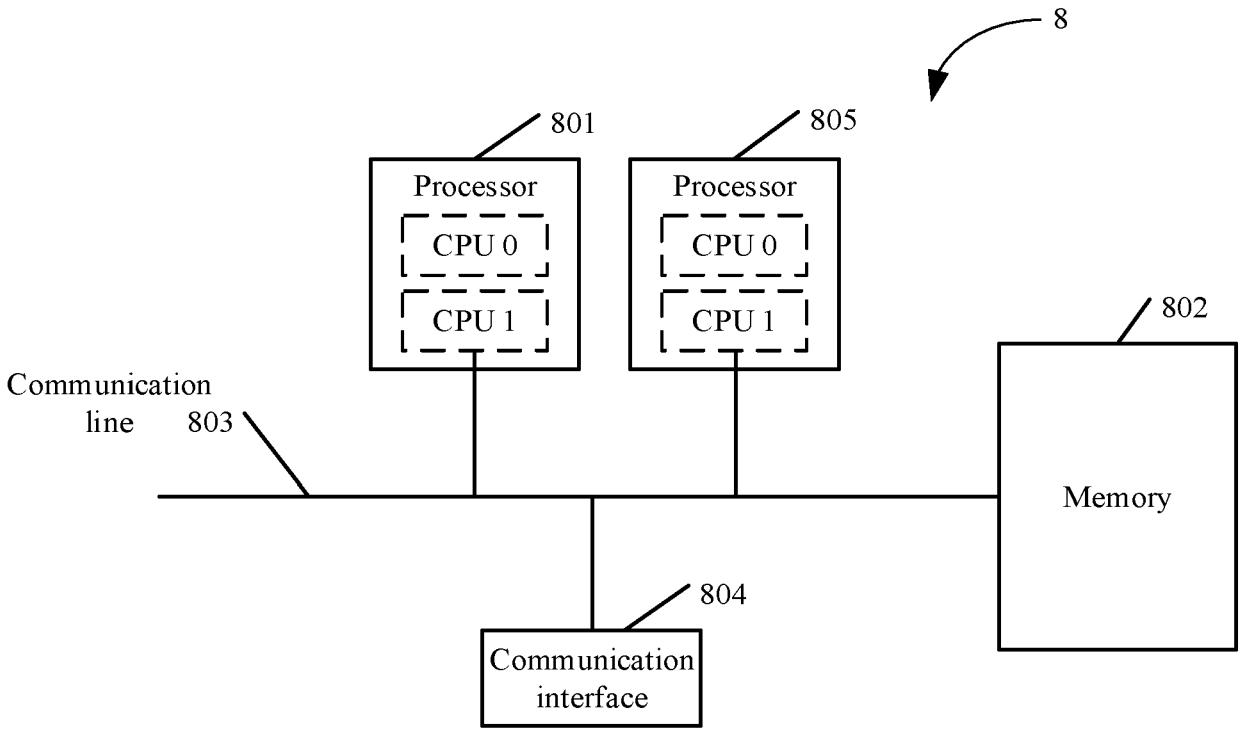
8
801
805
Processor
CPU 0
CPU 1
Processor
CPU 0
CPU 1
802
Communication
line
803
Memory
804
Communication
interface

FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 201910470190 **[0001]**
- US 2018176847 A **[0006]**
- WO 2019029747 A1 **[0006]**