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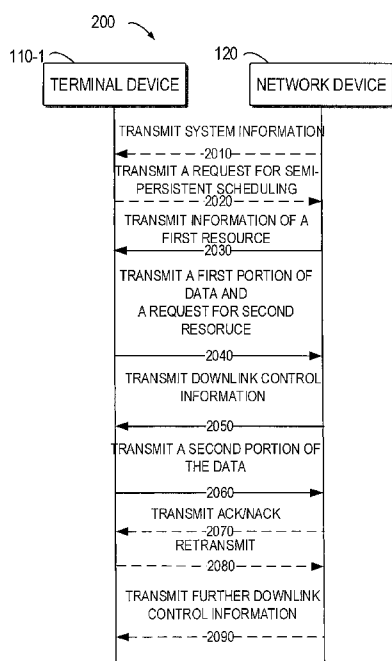


FIG. 2

(57) Abstract: Embodiments of the disclosure provide a method, device and computer readable medium for data transmission without RRC connections. According to embodiments of the present disclosure, the segments of data packet may be transmitted without the establishment of the RRC connection by introducing semi-persistent scheduling into the early transmission, thereby saving the consumption of signaling.

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METHODS, DEVICES AND COMPUTER READABLE MEDIUM FOR DATA TRANSMISSION WITHOUT RRC CONNECTIONS

FIELD

- 5 [0001] Embodiments of the present disclosure generally relate to communication techniques, and more particularly, to methods, devices and computer readable medium for data transmission without RRC connections.

BACKGROUND

- 10 [0002] In communication systems, it usually needs to establish a Radio Resource Control (RRC) connection between the terminal device and the network device. For example, in the third generation wireless communication (3G) system or Long Term Evolved (LTE) communication system, the terminal device usually establishes a RRC connection with the network device before transmitting data to the network device.
- 15 In the fifth generation wireless communication system (5G), small amount of data can be transmitted to the network device before the RRC connection is established. However, the RRC connection is still needed if the terminal device transmits a large data packet.

20 SUMMARY

[0003] In general, embodiments of the present disclosure relate to a method for authenticating terminal devices and the corresponding network device and terminal device.

- [0004] In a first aspect, embodiments of the present disclosure provide a method
- 25 implemented at a terminal device for communication. The method comprises: receiving, from a network device, information of a first resource that is allocated for transmission in absence of establishment of radio resource control (RRC) connection between the terminal device and the network device. The method also comprises transmitting, using the first resource, a first portion of data and a request for
- 30 semi-persistent scheduling a second resource to the network device. The method further comprises: in response to receiving downlink information indicating allocation

of the second resource, transmitting a second portion of the data to the network device using the second resource.

[0005] In a second aspect, embodiments of the present disclosure provide a method implemented at a network device for communication. The method comprises: transmitting, to a terminal device, information of a first resource that is allocated for transmission in absence of establishment of radio resource control (RRC) connection between the terminal device and the network device. The method also comprises in responses to receiving a first portion of data and a request for semi-persistent scheduling a second resource from the terminal device using the first resource, transmitting downlink information indicating allocation of the second resource to the terminal device. The method further comprises receiving a second portion of the data from the terminal device using the second resource.

[0006] In a third aspect, embodiments of the disclosure provide a terminal device. The terminal device comprises: at least one processor; and at least one memory including computer program codes. The at least one memory and the computer codes are configured to, with the at least one processor, cause the terminal device to perform: receiving, from a network device, information of a first resource that is allocated for transmission in absence of establishment of radio resource control (RRC) connection between the terminal device and the network device; transmitting, using the first resource, a first portion of data and a request for semi-persistent scheduling a second resource to the network device; and in response to receiving downlink information indicating allocation of the second resource, transmitting a second portion of the data to the network device using the second resource.

[0007] In a fourth aspect, embodiments of the disclosure provide a network device. The network device comprises: at least one processor; and at least one memory including computer program codes. The at least one memory and the computer program codes are configured to, with the at least one processor, cause the network device to perform: transmitting, to a terminal device, information of a first resource that is allocated for transmission in absence of establishment of radio resource control (RRC) connection between the terminal device and the network device; in responses to receiving a first portion of data and a request for semi-persistent scheduling a second resource from the terminal device using the first resource, transmitting

downlink information indicating allocation of the second resource to the terminal device; and receiving a second portion of the data from the terminal device using the second resource.

5 [0008] In a fifth aspect, embodiments of the disclosure provide a computer readable medium. The computer readable medium stores instructions thereon, the instructions, when executed by at least one processing unit of a machine, causing the machine to implement the method according to the first aspect of the present disclosure.

10 [0009] In a sixth aspect, embodiments of the disclosure provide a further computer readable medium. The further computer readable medium stores instructions thereon, the instructions, when executed by at least one processing unit of a machine, causing the machine to implement the method according to the second aspect of the present disclosure.

15 [0010] In a seventh aspect, embodiments of the disclosure provide an apparatus for communication. The apparatus comprises means for receiving, from a network device, information of a first resource that is allocated for transmission in absence of establishment of radio resource control (RRC) connection between the terminal device and the network device. The apparatus also comprises means for transmitting, using the first resource, a first portion of data and a request for semi-persistent scheduling a second resource to the network device. The apparatus further
20 comprises means for in response to receiving downlink information indicating allocation of the second resource, transmitting a second portion of the data to the network device using the second resource.

25 [0011] In an eighth aspect, embodiments of the disclosure provide a further apparatus for communication. The apparatus comprises means for transmitting, to a terminal device, information of a first resource that is allocated for transmission in absence of establishment of radio resource control (RRC) connection between the terminal device and the network device. The apparatus also comprises means for in response to receiving a first portion of data and a request for semi-persistent scheduling a
30 second resource from the terminal device using the first resource, transmitting downlink information indicating allocation of the second resource to the terminal device. The apparatus further comprises means for receiving a second portion of the

data from the terminal device using the second resource.

[0012] Other features and advantages of the embodiments of the present disclosure will also be apparent from the following description of specific embodiments when read in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of embodiments of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Some example embodiments will now be described with reference to the accompanying drawings, where

10 [0014] FIG. 1 illustrates a schematic diagram of a communication system according to embodiments of the present disclosure;

[0015] FIG. 2 is a schematic diagram illustrating interactions among terminal devices and network devices according to embodiments of the present disclosure;

15 [0016] FIG. 3 illustrates a flowchart of a method implemented at a terminal device for communication according to embodiments of the present disclosure;

[0017] FIG. 4 illustrates a flowchart of a method implemented at a network device for communication according to embodiments of the present disclosure; and

[0018] FIG. 5 illustrates a schematic diagram of a device according to embodiments of the present disclosure.

20 [0019] Throughout the figures, same or similar reference numbers indicate same or similar elements.

DETAILED DESCRIPTION

25 [0020] The subject matter described herein will now be discussed with reference to several example embodiments. It should be understood these embodiments are discussed only for the purpose of enabling those skilled persons in the art to better understand and thus implement the subject matter described herein, rather than suggesting any limitations on the scope of the subject matter.

30 [0021] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of example embodiments. As

used herein, the singular forms “a,” “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises,” “comprising,” “includes” and/or “including,” when used herein, specify the presence of stated features, integers, steps, operations, elements and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components and/or groups thereof.

[0022] It should also be noted that in some alternative implementations, the functions/acts noted may occur out of the order noted in the figures. For example, two functions or acts shown in succession may in fact be executed concurrently or may sometimes be executed in the reverse order, depending upon the functionality/acts involved.

[0023] As used herein, the term “communication network” refers to a network following any suitable communication standards, such as Long Term Evolution (LTE), LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), High-Speed Packet Access (HSPA), and so on. Furthermore, the communications between a terminal device and a network device in the communication network may be performed according to any suitable generation communication protocols, including, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the future fifth generation (5G) communication protocols, and/or any other protocols either currently known or to be developed in the future.

[0024] Embodiments of the present disclosure may be applied in various communication systems. Given the rapid development in communications, there will of course also be future type communication technologies and systems with which the present disclosure may be embodied. It should not be seen as limiting the scope of the present disclosure to only the aforementioned system.

[0025] The term “network device” includes, but not limited to, a base station (BS), a gateway, a management entity, and other suitable device in a communication system. The term “base station” or “BS” represents a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a Remote Radio Unit (RRU), a radio header (RH), a remote radio head (RRH), a relay, a low power node such as a femto, a pico, and so forth.

[0026] The term “terminal device” includes, but not limited to, “user equipment (UE)” and other suitable end device capable of communicating with the network device. By way of example, the “terminal device” may refer to a terminal, a Mobile Terminal (MT), a Subscriber Station (SS), a Portable Subscriber Station, a Mobile Station (MS),
5 or an Access Terminal (AT).

[0027] The term “circuitry” used herein may refer to one or more or all of the following:

[0028] (a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and

10 [0029] (b) combinations of hardware circuits and software, such as (as applicable):

[0030] (i) a combination of analog and/or digital hardware circuit(s) with

[0031] software/firmware and

[0032] (ii) any portions of hardware processor(s) with software (including digital signal processor(s)), software, and memory(ies) that work together to cause an
15 apparatus, such as a mobile phone or server, to perform various functions) and

[0033] (c) hardware circuit(s) and or processor(s), such as a microprocessor(s) or a portion of a microprocessor(s), that requires software (e.g., firmware) for operation, but the software may not be present when it is not needed for operation.”

[0034] This definition of circuitry applies to all uses of this term in this application,
20 including in any claims. As a further example, as used in this application, the term circuitry also covers an implementation of merely a hardware circuit or processor (or multiple processors) or portion of a hardware circuit or processor and its (or their) accompanying software and/or firmware. The term circuitry also covers, for example and if applicable to the particular claim element, a baseband integrated circuit or
25 processor integrated circuit for a mobile device or a similar integrated circuit in server, a cellular network device, or other computing or network device.

[0035] As described above, in communication systems, it usually needs to establish a RRC connection between the terminal device and the network device before data packets are transmitted to the terminal device. The establishment of the RRC
30 connection consumes quite lots of signaling. Recently, early data transmission (EDT)

has been proposed. In EDT, a small amount of data can be transmitted without the establishment. However, if the segment of the data packet is larger than the transport block size (TBS) of the EDT, the terminal device still needs to use legacy RRC connection. In particular, the terminal device needs to establish RRC connection and starts transmission of multiple segments of the data packet through separated allocation of narrowband physical uplink shared channel (NPUSCH) via narrowband physical data control channel (NPDCCH). The consumption of signaling varies depending on the number of segments to be transmitted. Thus, it needs to save the consumption of signaling.

10 [0036] Now some example embodiments of the present disclosure are described below with reference to the figures. Those skilled in the art would readily appreciate that the detailed description given herein with respect to these figures is for explanatory purpose as the present disclosure extends beyond theses limited embodiments.

15 [0037] FIG. 1 illustrates a schematic diagram of a communication system in which embodiments of the present disclosure can be implemented. The communication system 100, which is a part of a communication network, comprises a network device 120 and terminal devices 110-1, 110-2, . . . , and 110-N, which can be collectively referred to as “terminal device(s)” 110. It is to be understood that the number of network devices and terminal devices shown in FIG. 1 is given for the purpose of illustration without suggesting any limitations. The communication system 100 may comprise any suitable number of network devices and terminal devices. It should be noted that the communication system 100 may also comprise other elements which are omitted for the purpose of clarity. The network device 120 may communicate with the terminal devices 110.

25 [0038] Communications in the communication system 100 may be implemented according to any proper communication protocol(s), comprising, but not limited to, cellular communication protocols of the first generation (1G), the second generation (2G), the third generation (3G), the fourth generation (4G) and the fifth generation (5G) and on the like, wireless local network communication protocols such as Institute for Electrical and Electronics Engineers (IEEE) 802.11 and the like, and/or any other protocols currently known or to be developed in the future. Moreover, the

communication may utilize any proper wireless communication technology, comprising but not limited to: Code Divided Multiple Address (CDMA), Frequency Divided Multiple Address (FDMA), Time Divided Multiple Address (TDMA), Frequency Divided Duplexer (FDD), Time Divided Duplexer (TDD), Multiple-Input
5 Multiple-Output (MIMO), Orthogonal Frequency Divided Multiple Access (OFDMA) and/or any other technologies currently known or to be developed in the future.

[0039] According to embodiments of the present disclosure, the segments of data packet may be transmitted without the establishment of the RRC connection, by introducing semi-persistent scheduling during random access procedure as part of
10 early data transmission, thereby saving the consumption of signaling.

[0040] FIG. 2 is a schematic diagram 200 illustrating interactions among terminal devices and network devices according to embodiments of the present disclosure. For the purpose of illustrations, FIG. 2 is described with the reference to the interactions between the terminal device 110-1 and the network device 120.

[0041] In some embodiments, the network device 120 may transmit 2010 system information to the terminal device 110-1. The system information may indicate that the transmission of data prior to the RRC connection is supported in the communication system. For the purpose of illustrations, the term “early data transmission (EDT)” is used hereinafter as an example of the transmission prior to the
15 RRC connection. It should be note that the transmission of data prior to the RRC connection may also include any other suitable types of transmissions. The system information may also indicate that the semi-persistent scheduling for the EDT is supported. In this way, if the terminal device 110-1 needs to transmit a large amount of data (for example, larger than the TBS of the EDT), the terminal device 110-1 can
20 still transmit a portion of the data to the network device 120.

[0042] If the terminal device 110-1 needs to the semi-persistent scheduling for the EDT, the terminal device 110-1 may transmit 2020 a request for the EDT. For example, the terminal device 110-1 may transmit an EDT preamble to indicate that the semi-persistent scheduling for the EDT is required.

[0043] The network device 120 transmits 2030 information of a resource that is allocated for the EDT. For example, the network device 120 may transmit an uplink grant for the EDT. The uplink grant may include the maximum TBS size for the
30

EDT. The network device 120 may also transmit the number of subcarriers that can be used for the EDT. Alternatively, or in addition, the network device 120 may send a random access response (RAR) to the terminal device 110-1.

[0044] The terminal device 110-1 transmits 2040 a first portion of the data and a request for semi-persistent scheduling a resource (referred to as “second resource”) to the network device. As described, the terminal device 110-1 may divide the data to be transmitted into portions. The terminal device 110-1 may transmit the first portion of the data as the EDT. Since the data is larger than the TBS of the EDT, the terminal device 110-1 needs to request more resources to transmit the remaining data.

[0045] In some embodiments, the request for the second resource sent by the terminal device 110-1 may include an identity of the terminal device 110-1. For example, the terminal device 110-1 may generate a random identifier and transmit the random identifier to the network device 120. In another example, the terminal device 110-1 may use its International Mobile Equipment Identity or a portion thereof as its identity and transmit this to the network device 120. In other embodiments, the terminal device 110-1 may indicate that the bits of its identifier can be used as a part of semi-persistent scheduling radio network temporary identity (SPS-RNTI).

[0046] In a further embodiment, the request may also include the one or more parameters for the RRC connection. For example, the RRC parameters may include at least one of UE identity, establishment cause, resume identity and resume cause. In other embodiments, the request may include the size of the remaining data. For example, the terminal device 110-1 may transmit buffer status report (BSR) in the request to indicate the number of segments of the remaining portion of data.

[0047] If the network device 120 determines to allocate the second resource to the terminal device 110-1, the network device 120 transmits 2050 downlink information to the terminal device 110-1. The downlink information may be scrambled with the SPS-RNTI so that only the terminal device 110-1 can decode the DCI. In some embodiments, the SPS-RNTI may be dynamically generated using SPS-RNTI prefix and the bits of the identifier of the terminal device 110-1. The network device 120 may also transmit the downlink information to indicate that the second resource should be released after the transmission of the second portion is completed.

[0048] In an example embodiment, the downlink information may be transmitted on a

narrowband physical downlink shared channel (NPDSCH). In other embodiments, the downlink information may be transmitted on a narrowband physical downlink control channel (NPDCCH). If the downlink information is transmitted on the NPDCCH, the downlink information may be referred to downlink control information (DCI).

[0049] In some embodiments, the downlink information may comprise the number of resource blocks allocated in the second resource. The resource block allocation may be done in a semi-persistent manner. The term “resource block” used herein refers to a block of time-frequency resource. In other embodiments, the downlink information may indicate the starting subframe of the second resource. For example, the downlink information may indicate the start time of the first resource block in the second resource. Alternatively, or in addition, the downlink information may indicate the time interval between two adjacent resource blocks. In some embodiments, the time interval may be longer than the duration of one resource block.

[0050] In a further embodiment, the downlink information may also include the size of each resource block. For example, the downlink information may include the time duration of each resource block. The downlink information may also comprise the number of subcarriers included in each resource block. In an example embodiment, the downlink information may also indicate that the resource block size in the second resource is the same as the resource block in the first resource. In this way, the SPS for the EDT can be implemented.

[0051] The terminal device 110-1 transmits the second portion of data using the second resource. For example, the terminal device 110-1 may transmit a segment of the second portion of data using the resource block allocated by the network device 120. In this way, the terminal device 110-1 may transmit a large amount of data to the network device 120 without the establishment of the RRC connection.

[0052] In some embodiments, if the network device 120 receives a segment the second portion of the data, the network device 120 may transmit an ACK to the terminal device 110-1. The ACK may be scrambled with temporary cell-RNTI (C-RNTI). The C-RNTI may be pre-configured to the network device 120 and the terminal device 110-1.

[0053] In a further embodiment, if the network device 120 does not receive the

segment the second portion of the data, the network device 120 may transmit 2070 a NACK to the terminal device 110-1. The network device may also transmit an indication of a third resource to the terminal device 110-1 for retransmitting the segment. If the terminal device 110-1 receives a NACK and the indication of the
5 third resource, the terminal device 110-1 may retransmit the segment using the third resource. As described above, the time interval between two adjacent resource blocks may be larger than the duration of the resource block, the terminal device 110-1 may retransmit the segment in the time interval before the following segment is transmitted.

10 [0054] In some embodiments, after the terminal device 110-1 transmits the second portion to the network device 120, the terminal device 110 may wait for further downlink information. In some embodiments, the network device 120 may transmit 2090 the further downlink information including an indication that one or more segments are not received successfully. In this case, the further downlink
15 information may also include information of a fourth resource for retransmitting the one or more segments. The further control information may include at least one of: the number of resource blocks, the start time of the fourth resource, the time interval of the resource blocks and the like.

[0055] If the network device 120 determines that the second portion of the data have
20 been received successfully, the network device 120 may transmit the downlink information to indicate that the second resource should be released.

[0056] FIG. 3 illustrates a flowchart of method 300 in accordance with an example of the present disclosure. The method 300 may be implemented at the terminal device 110-1.

25 [0057] At block 310, the terminal device 110-1 receives, from the network device 120, information of a first resource that is allocated for transmission without establishment of radio resource control (RRC) connection between the terminal device and the network device.

[0058] In some embodiments, the terminal device 110-1 may receive from the
30 network device 120, system information indicating that semi persistent scheduling for the transmission before establishment of RRC is allowed. In a further embodiment, the terminal device 110-1 may transmitting to the network device a request for the

transmission before establishment of RRC, in response to receiving the system information. In another embodiment, the terminal device 110-1 may receive, from the network device 120, an uplink grant for the transmission before establishment of RRC connection.

- 5 [0059] At block 320, the terminal device 110-1 transmits, using the first resource, a first portion of data and a request for semi-persistent scheduling a second resource to the network device. In some embodiments, the request for the second resource may indicate an identity of the terminal device. In a further embodiment, the request for the second resource may indicate at least one parameter for the RRC connection.
- 10 Alternatively, or in addition, the request for the second resource may indicate a size of the second portion of the data.

- [0060] At block 330, the terminal device 110-1 transmits a second portion of the data to the network device 120 using the second resource in response to receiving the downlink information. The downlink information may indicate the number of
- 15 resource blocks in the second resource. The downlink information may also indicate a starting subframe of the second resource. In some embodiments, the downlink information indicates an interval between adjacent resource blocks in the second resource. In a further embodiment, the downlink information may indicate size of each of resource blocks in the second resource.

- 20 [0061] In some embodiments, the terminal device 110-1 may receive an indication of allocation of a third resource between adjacent resource blocks in the second resource, in response to receiving a NACK concerning a segment in the second portion of the data. The terminal device 110-1 may retransmit the segment using the third resource.

- 25 [0062] In some embodiments, the terminal device 110-1 may receive receiving an indication of allocation of a fourth resource, in response to receiving a NACK concerning at least one segment in the second portion of the data. The terminal device 110-1 may retransmit the segment using the fourth resource.

- [0063] In a further embodiment, the terminal device 110-1 may release the second
- 30 resource, in response to an ACK concerning the transmission of the second portion of the data. In other embodiments, the terminal device 110-1 may release, based on the downlink information, the second resource upon completion of the transmission of the

second portion.

[0064] In some embodiments, an apparatus for performing the method 300 (for example, the terminal device 110-1) may comprise respective means for performing the corresponding steps in the method 300. These means may be implemented in any suitable manners. For example, it can be implemented by circuitry or software modules.

[0065] In some embodiments, the apparatus comprises: means for receiving, from a network device, information of a first resource that is allocated for transmission in absence of establishment of radio resource control (RRC) connection between the terminal device and the network device; means for transmitting, using the first resource, a first portion of data and a request for semi-persistent scheduling a second resource to the network device; and means for in response to receiving downlink information indicating allocation of the second resource, transmitting a second portion of the data to the network device using the second resource.

[0066] In some embodiments, the means for receiving the information of the first resource comprises: means for receiving, from the network device, system information indicating that semi persistent scheduling for the transmission before establishment of RRC is allowed; means for in response to receiving the system information, transmitting to the network device a request for the transmission before establishment of RRC; and means for receiving, from the network device, a uplink grant for the transmission before establishment of RRC connection.

[0067] In some embodiments, the apparatus further comprise: means for in response to receiving a NACK concerning a segment in the second portion of the data, receiving an indication of allocation of a third resource between adjacent resources blocks in the second resource; and means for retransmitting the segment using the third resource.

[0068] In some embodiments, the apparatus further comprises: means for in response to receiving a NACK concerning at least one segment in the second portion of the data, receiving an indication of allocation of a fourth resource; and means for retransmitting the at least one segment using the fourth resource.

[0069] In some embodiments, the apparatus further comprises: means for in response

to an ACK concerning the transmission of the second portion of the data, releasing the second resource.

5 [0070] In some embodiments, the apparatus further comprises: means for releasing, based on the downlink information, the second resource upon completion of the transmission of the second portion.

[0071] In some embodiments, the means for receiving the downlink information comprises means for receiving the downlink information via a narrowband physical downlink control channel (NPDCCH). In some embodiments, the means for receiving the downlink information comprises means for receiving the downlink
10 information via a narrowband physical downlink shared channel (NPDSCH).

[0072] FIG. 4 illustrates a flowchart of method 400 in accordance with an example of the present disclosure. The method 400 may be implemented at the network device
120.

15 [0073] At block 410, the network device 120 transmits, to a terminal device 110-1, information of a first resource that is allocated for transmission in absence of establishment of radio resource control (RRC) connection between the terminal device 110-1 and the network device 120.

[0074] In some embodiments, the network device 120 may transmit to the terminal device 110-10, system information indicating that semi persistent scheduling for the
20 transmission before establishment of RRC is allowed. In a further embodiment, the network device 120 may receive from the terminal device 110-1 a request for semi-persistent scheduling the transmission before establishment of RRC. In another embodiment, the network device 120 may transmit an uplink grant for the transmission before establishment of RRC connection.

25 [0075] At block 420, the network device 120 transmits downlink information indicating allocation of the second resource to the terminal device 110-1, in responses to receiving a first portion of data and a request for a second resource from the terminal device 110-1 using the first resource. In some embodiments, the request for the second resource may indicate an identity of the terminal device. In a further
30 embodiment, the request for the second resource may indicate at least one parameter for the RRC connection. Alternatively, or in addition, the request for the second

resource may indicate a size of the second portion of the data.

[0076] The downlink information may indicate the number of resource blocks in the second resource. The downlink information may also indicate a starting subframe of the second resource. In some embodiments, the downlink information indicates an interval between adjacent resource blocks in the second resource. In a further embodiment, the downlink information may indicate size of each of resource blocks in the second resource.

[0077] At block 430, the network device 120 receives a second portion of the data from the terminal device 110-1 using the second resource.

[0078] In some embodiments, if the network device 120 fails to receive a segment in the second portion of the data, it may transmit a NACK concerning the segment in the second portion of the data. The network device 120 may also transmit an indication of allocation of a third resource between adjacent resource blocks in the second resource for retransmitting the segment.

[0079] In some embodiments, if the network device 120 fails to receive at least one segment in the second portion of the data, it may transmit a NACK concerning the at least one segment. The network device 120 may also transmit an indication of allocation of a fourth resource for retransmitting the at least one segment.

[0080] In some embodiments, the network device 120 may transmit the downlink information indicating releasing the second resource upon completion of the transmission of the second portion.

[0081] In some embodiments, an apparatus for performing the method 400 (for example, the network device 120) may comprise respective means for performing the corresponding steps in the method 400. These means may be implemented in any suitable manners. For example, it can be implemented by circuitry or software modules.

[0082] In some embodiments, the apparatus comprises: means for transmitting, to a terminal device, information of a first resource that is allocated for transmission before establishment of radio resource control (RRC) connection between the terminal device and the network device; means for in responses to receiving a first portion of data and a request for a second resource from the terminal device using the first

resource, transmitting downlink information indicating allocation of the second resource to the terminal device; and means for receiving a second portion of the data from the terminal device using the second resource.

5 [0083] In some embodiments, the means for transmitting the information of the first resource comprises: means for transmitting, to the terminal device, system information indicating that semi persistent scheduling for the transmission before establishment of RRC is allowed; means for in response to receiving a request for the transmission before establishment of RRC, transmitting to the terminal device a uplink grant for the transmission before establishment of RRC connection.

10 [0084] In some embodiments, the apparatus further comprises: means for in response to failing to receive a segment in the second portion of the data, transmitting a NACK concerning the segment in the second portion of the data; and means for transmitting an indication of allocation of a third resource between adjacent resource blocks in the second resource for retransmitting the segment.

15 [0085] In some embodiments, the apparatus further comprises: means for in response to failing to receive at least one segment in the second portion of the data, transmitting a NACK concerning the at least one segment in the second portion of the data; and means for transmitting an indication of allocation of a fourth resource for retransmitting the at least one segment.

20 [0086] In some embodiments, the apparatus further comprises means for transmitting the downlink information indicating releasing the second resource upon completion of the transmission of the second portion.

[0087] In some embodiments, the means for transmitting the downlink information comprises means for transmitting the downlink information via a narrowband physical
25 downlink control channel (NPDCCH). In some embodiments, the means for transmitting the downlink information comprises means for transmitting the downlink information via a narrowband physical downlink shared channel (NPDSCH).

[0088] FIG. 5 is a simplified block diagram of a device 500 that is suitable for implementing embodiments of the present disclosure. The device 500 may be
30 implemented at the network device 120. The device 500 may also be implemented at the terminal device 110-1. As shown, the device 500 comprises one or more

processors 510, one or more memories 520 coupled to the processor(s) 510, one or more transmitters and/or receivers (TX/RX) 540 coupled to the processor 510.

5 [0089] The processor 510 may be of any type suitable to the local technical network, and may comprise one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multicore processor architecture, as non-limiting examples. The device 500 may have multiple processors, such as an application specific integrated circuit chip that is slaved in time to a clock which synchronizes the main processor.

10 [0090] The memory 520 may be of any type suitable to the local technical network and may be implemented using any suitable data storage technology, such as a non-transitory computer readable storage medium, semiconductor based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory, as non-limiting examples.

15 [0091] The memory 520 stores at least a part of a program 530. The TX/RX 540 is for bidirectional communications. The TX/RX 540 has at least one antenna to facilitate communication, though in practice an Access Node mentioned in this application may have several ones. The communication interface may represent any interface that is necessary for communication with other network elements.

20 [0092] The program 530 is assumed to comprise program instructions that, when executed by the associated processor 510, enable the device 500 to operate in accordance with the embodiments of the present disclosure, as discussed herein with reference to Figs. 2 to 4. That is, embodiments of the present disclosure can be implemented by computer software executable by the processor 510 of the device 500, or by hardware, or by a combination of software and hardware.

25 [0093] In the context of the present disclosure, the computer program code or related data may be carried by any suitable carrier to enable the device, apparatus, or processor to perform the various processes and operations described above. Examples of carriers include signals, computer readable media and the like.

30 [0094] While this specification contains many specific implementation details, these should not be construed as limitations on the scope of any disclosure or of what may be claimed, but rather as descriptions of features that may be specific to particular

embodiments of particular disclosures. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple
5 embodiments separately or in any suitable sub-combination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a sub-combination or variation of a sub-combination.

10 [0095] Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Moreover, the separation of various
15 system components in the embodiments described above should not be understood as requiring such separation in all embodiments, and it should be understood that the described program components and systems can generally be integrated together in a single software product or packaged into multiple software products.

[0096] Various modifications, adaptations to the foregoing exemplary embodiments of
20 this disclosure may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings. Any and all modifications will still fall within the scope of the non-limiting and exemplary embodiments of this disclosure. Furthermore, other embodiments of the disclosures set forth herein will come to mind to one skilled in the art to which these
25 embodiments of the disclosure pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings.

[0097] Therefore, it is to be understood that the embodiments of the disclosure are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be comprised within the scope of the appended claims.
30 Although specific terms are used herein, they are used in a generic and descriptive sense only and not for purpose of limitation.

WHAT IS CLAIMED IS:

1. A method implemented at a terminal device, comprising:
receiving, from a network device, information of a first resource that is
5 allocated for transmission in absence of establishment of radio resource control (RRC)
connection between the terminal device and the network device;
transmitting, using the first resource, a first portion of data and a request for
semi-persistent scheduling a second resource to the network device; and
in response to receiving downlink information indicating allocation of the
10 second resource, transmitting a second portion of the data to the network device using
the second resource.

2. The method of claim 1, wherein receiving the information of the first
resource comprises:
15 receiving, from the network device, system information indicating that
semi-persistent scheduling for the transmission in absence of establishment of RRC is
allowed;
in response to receiving the system information, transmitting to the network
device a request for the transmission in absence of establishment of RRC; and
20 receiving, from the network device, an uplink grant for the transmission in
absence of establishment of RRC connection.

3. The method of claim 1, wherein the request for the second resource
indicates at least one of the following:
25 an identity of the terminal device,
at least one parameter for the RRC connection, and
a size of the second portion of the data.

4. The method of claim 1, wherein the downlink information indicates at
30 least one of the following:
the number of resource blocks in the second resource,
starting subframe of the second resource,
an interval between adjacent resource blocks in the second resource, and

a size of each of resource blocks in the second resource.

5. The method of claim 1, further comprising:

5 in response to receiving a NACK concerning a segment in the second portion of the data, receiving an indication of allocation of a third resource between adjacent resource blocks in the second resource; and
retransmitting the segment using the third resource.

6. The method of claim 1, further comprising:

10 in response to receiving a NACK concerning at least one segment in the second portion of the data, receiving an indication of allocation of a fourth resource; and
retransmitting the at least one segment using the fourth resource.

7. The method of claim 1, further comprising:

15 in response to an ACK concerning the transmission of the second portion of the data, releasing the second resource.

8. The method of claim 1, further comprising:

20 releasing, based on the downlink information, the second resource upon completion of the transmission of the second portion.

9. The method of claim 1, wherein receiving the downlink information indicating allocation of the second resource comprises:

25 receiving the downlink information via a narrowband physical downlink control channel (NPDCCH).

10. The method of claim 1, wherein receiving the downlink information indicating allocation of the second resource comprises:

30 receiving the downlink information via a narrowband physical downlink shared channel (NPDSCH).

11. A method implemented at a network device, comprising:

transmitting, to a terminal device, information of a first resource that is allocated for transmission in absence of establishment of radio resource control (RRC) connection between the terminal device and the network device;

in responses to receiving a first portion of data and a request for
5 semi-persistent scheduling a second resource from the terminal device using the first resource, transmitting downlink information indicating allocation of the second resource to the terminal device; and

receiving a second portion of the data from the terminal device using the
10 second resource.

12. The method of claim 11, wherein transmitting the information of the first resource comprises:

transmitting, to the terminal device, system information indicating that
15 semi-persistent scheduling for the transmission in absence of establishment of RRC is allowed;

in response to receiving a request for the transmission before establishment of RRC, transmitting to the terminal device a uplink grant for the transmission in absence of establishment of RRC connection.

20 13. The method of claim 11, wherein the request for the second resource indicates at least one of the following:

an identity of the terminal device,
at least one parameter for the RRC connection, and
a size of the second portion of the data.

25 14. The method of claim 11, wherein the downlink information indicates at least one of the following:

the number of resource blocks in the second resource,
a starting subframe of the second resource,
30 an interval between adjacent resource blocks in the second resource, and
a size of each of resource blocks in the second resource.

15. The method of claim 11, further comprising:

in response to failing to receive a segment in the second portion of the data,
transmitting a NACK concerning the segment in the second portion of the data; and
transmitting an indication of allocation of a third resource between adjacent
resource blocks in the second resource for retransmitting the segment.

5

16. The method of claim 11, further comprising:

in response to failing to receive at least one segment in the second portion of
the data, transmitting a NACK concerning the at least one segment in the second
portion of the data; and

10

transmitting an indication of allocation of a fourth resource for retransmitting
the at least one segment.

17. The method of claim 11, further comprising:

15

transmitting the downlink information indicating releasing the second
resource upon completion of the transmission of the second portion.

18. The method of claim 11, wherein transmitting the downlink information
indicating allocation of the second resource comprises:

20

transmitting the downlink information via a narrowband physical downlink
control channel (NPDCCH).

19. The method of claim 11, wherein transmitting the downlink information
indicating allocation of the second resource comprises:

25

transmitting the downlink information via a narrowband physical downlink
shared channel (NPDSCH).

20. A terminal device, comprising:

at least one processor; and

at least one memory including computer program codes;

30

the at least one memory and the computer program codes configured to, with
the at least one processor, cause the terminal device to perform:

receiving, from a network device, information of a first resource that is allocated for transmission in absence of establishment of radio resource control (RRC) connection between the terminal device and the network device;

transmitting, using the first resource, a first portion of data and a request for semi-persistent scheduling a second resource to the network device; and

in response to receiving downlink information indicating allocation of the second resource, transmitting a second portion of the data to the network device using the second resource.

21. The terminal device of claim 20, wherein receiving the information of the first resource comprises:

receiving, from the network device, system information indicating that semi-persistent scheduling for the transmission in absence of establishment of RRC is allowed;

in response to receiving the system information, transmitting to the network device a request for the transmission in absence of establishment of RRC; and

receiving, from the network device, a uplink grant for the transmission in absence of establishment of RRC connection.

22. The terminal device of claim 20, wherein the request for the second resource indicates at least one of the following:

an identity of the terminal device,
at least one parameter for the RRC connection, and
a size of the second portion of the data.

23. The terminal device of claim 20, wherein the downlink information indicates at least one of the following:

the number of resource blocks in the second resource,
a starting subframe of the second resource,
an interval between adjacent resource blocks in the second resource, and
a size of each of resource blocks in the second resource.

24. The terminal device of claim 20, further performing:

in response to receiving a NACK concerning a segment in the second portion of the data, receiving an indication of allocation of a third resource between adjacent resource blocks in the second resource; and

5 retransmitting the segment using the third resource.

25. The terminal device of claim 20, further performing:

in response to receiving a NACK concerning at least one segment in the second portion of the data, receiving an indication of allocation of a fourth resource; and

10

retransmitting the at least one segment using the fourth resource.

26. The terminal device of claim 20, further performing:

in response to an ACK concerning the transmission of the second portion of the data, releasing the second resource.

15

27. The terminal device of claim 20, further performing:

releasing, based on the downlink information, the second resource upon completion of the transmission of the second portion.

20

28. The terminal device of claim 20, wherein receiving the downlink information indicating allocation of the second resource comprises:

receiving the downlink information via a narrowband physical downlink control channel (NPDCCH).

25

29. The terminal device of claim 20, wherein receiving the downlink information indicating allocation of the second resource comprises:

receiving the downlink information via a narrowband physical downlink shared channel (NPDSCH).

30

30. A network device, comprising:

at least one processor; and

at least one memory including computer program codes;

the at least one memory and the computer program codes configured to, with the at least one processor, cause the network device to perform:

5 transmitting, to a terminal device, information of a first resource that is allocated for transmission in absence of establishment of radio resource control (RRC) connection between the terminal device and the network device;

in responses to receiving a first portion of data and a request for semi-persistent scheduling a second resource from the terminal device using the first resource, transmitting downlink information indicating allocation of the second resource to the terminal device; and

10 receiving a second portion of the data from the terminal device using the second resource.

31. The network device of claim 30, wherein transmitting the information of the first resource comprises:

15 transmitting, to the terminal device, system information indicating that semi-persistent scheduling for the transmission in absence of establishment of RRC is allowed;

in response to receiving a request for the transmission before establishment of RRC, transmitting to the terminal device a uplink grant for the transmission in
20 absence of establishment of RRC connection.

32. The network device of claim 30, wherein the request for the second resource indicates at least one of the following:

25 an identity of the terminal device,
at least one parameter for the RRC connection, and
a size of the second portion of the data.

33. The network device of claim 30, wherein the downlink information indicates at least one of the following:

30 the number of resource blocks in the second resource,
a starting subframe of the second resource,
an interval between adjacent resource blocks in the second resource, and
a size of each of resource blocks in the second resource.

34. The network device of claim 30, further performing:

in response to failing to receive a segment in the second portion of the data,
transmitting a NACK concerning the segment in the second portion of the data; and

5 transmitting an indication of allocation of a third resource between adjacent
resource blocks in the second resource for retransmitting the segment.

35. The network device of claim 30, further performing:

10 in response to failing to receive at least one segment in the second portion of
the data, transmitting a NACK concerning the at least one segment in the second
portion of the data; and

transmitting an indication of allocation of a fourth resource for retransmitting
the at least one segment.

15 36. The network device of claim 30, further performing:

transmitting the downlink information indicating releasing the second
resource upon completion of the transmission of the second portion.

20 37. The network device of claim 30, wherein transmitting the downlink
information indicating allocation of the second resource comprises:

transmitting the downlink information via a narrowband physical downlink
control channel (NPDCCH).

25 38. The network device of claim 30, wherein transmitting the downlink
information indicating allocation of the second resource comprises:

transmitting the downlink information via a narrowband physical downlink
shared channel (NPDSCH).

30 39. A computer readable medium storing instructions thereon, the
instructions, when executed by at least one processing unit of a machine, causing the
machine to perform the method according to any one of claims 1-10.

40. A computer readable medium storing instructions thereon, the instructions, when executed by at least one processing unit of a machine, causing the machine to perform the method according to any one of claims 11-19.

5 41. An apparatus for communication, comprising:

 means for receiving, from a network device, information of a first resource that is allocated for transmission in absence of establishment of radio resource control (RRC) connection between the terminal device and the network device;

 means for transmitting, using the first resource, a first portion of data and a request for semi-persistent scheduling a second resource to the network device; and

 means for in response to receiving downlink information indicating allocation of the second resource, transmitting a second portion of the data to the network device using the second resource.

15 42. The apparatus of claim 41, wherein the means for receiving the information of the first resource comprises:

 means for receiving, from the network device, system information indicating that semi-persistent scheduling for the transmission in absence of establishment of RRC is allowed;

20 means for in response to receiving the system information, transmitting to the network device a request for the transmission in absence of establishment of RRC; and

 means for receiving, from the network device, a uplink grant for the transmission in absence of establishment of RRC connection.

25 43. The apparatus of claim 41, wherein the request for the second resource indicates at least one of the following:

 an identity of the terminal device,

 at least one parameter for the RRC connection, and

30 a size of the second portion of the data.

 44. The apparatus of claim 41, wherein the downlink information indicates at least one of the following:

the number of resource blocks in the second resource,
a starting subframe of the second resource,
an interval between adjacent resource blocks in the second resource, and
a size of each of resource blocks in the second resource.

5

45. The apparatus of claim 41, further comprising:

means for in response to receiving a NACK concerning a segment in the
second portion of the data, receiving an indication of allocation of a third resource
between adjacent resource blocks in the second resource; and

10

means for retransmitting the segment using the third resource.

46. The apparatus of claim 41, further comprising:

means for in response to receiving a NACK concerning at least one segment
in the second portion of the data, receiving an indication of allocation of a fourth
resource; and

15

means for retransmitting the at least one segment using the fourth resource.

47. The apparatus of claim 41, further comprising:

means for in response to an ACK concerning the transmission of the second
portion of the data, releasing the second resource.

20

48. The apparatus of claim 41, further comprising:

means for releasing, based on the downlink information, the second
resource upon completion of the transmission of the second portion.

25

49. The apparatus of claim 41, wherein the means for receiving the downlink
information indicating allocation of the second resource comprises:

means for receiving the downlink information via a narrowband physical
downlink control channel (NPDCCH).

30

50. The apparatus of claim 41, wherein the means for receiving the downlink
information indicating allocation of the second resource comprises:

means for receiving the downlink information via a narrowband physical downlink shared channel (NPDSCH).

51. An apparatus for communication, comprising:

5 means for transmitting, to a terminal device, information of a first resource that is allocated for transmission in absence of establishment of radio resource control (RRC) connection between the terminal device and the network device;

means for in responses to receiving a first portion of data and a request for semi-persistent scheduling a second resource from the terminal device using the first
10 resource, transmitting downlink information indicating allocation of the second resource to the terminal device; and

means for receiving a second portion of the data from the terminal device using the second resource.

15 52. The apparatus of claim 51, wherein the means for transmitting the information of the first resource comprises:

means for transmitting, to the terminal device, system information indicating that semi-persistent scheduling for the transmission in absence of establishment of RRC is allowed;

20 means for in response to receiving a request for the transmission before establishment of RRC, transmitting to the terminal device a uplink grant for the transmission in absence of establishment of RRC connection.

53. The apparatus of claim 51, wherein the request for the second resource
25 indicates at least one of the following:

an identity of the terminal device,
at least one parameter for the RRC connection, and
a size of the second portion of the data.

30 54. The apparatus of claim 51, wherein the downlink information indicates at least one of the following:

the number of resource blocks in the second resource,
a starting subframe of the second resource,

an interval between adjacent resource blocks in the second resource, and
a size of each of resource blocks in the second resource.

55. The apparatus of claim 51, further comprising:

5 means for in response to failing to receive a segment in the second portion of
the data, transmitting a NACK concerning the segment in the second portion of the
data; and

means for transmitting an indication of allocation of a third resource between
adjacent resource blocks in the second resource for retransmitting the segment.

10

56. The apparatus of claim 51, further comprising:

means for in response to failing to receive at least one segment in the second
portion of the data, transmitting a NACK concerning the at least one segment in the
second portion of the data; and

15

means for transmitting an indication of allocation of a fourth resource for
retransmitting the at least one segment.

57. The apparatus of claim 51, further comprising:

20 means for transmitting the downlink information indicating releasing the
second resource upon completion of the transmission of the second portion.

20

58. The apparatus of claim 51, wherein the means for transmitting the
downlink information indicating allocation of the second resource comprises:

25 means for transmitting the downlink information via a narrowband physical
downlink control channel (NPDCCH).

25

59. The method of claim 51, wherein the means for transmitting the downlink
information indicating allocation of the second resource comprises:

30 means for receiving the downlink information via a narrowband physical
downlink shared channel (NPDSCH).

30

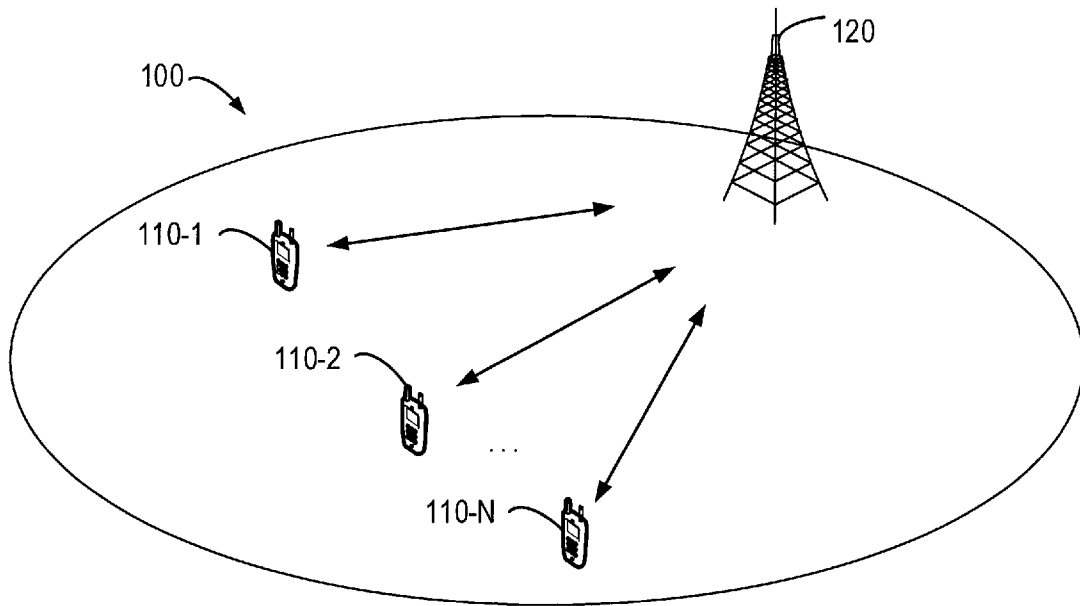


FIG. 1

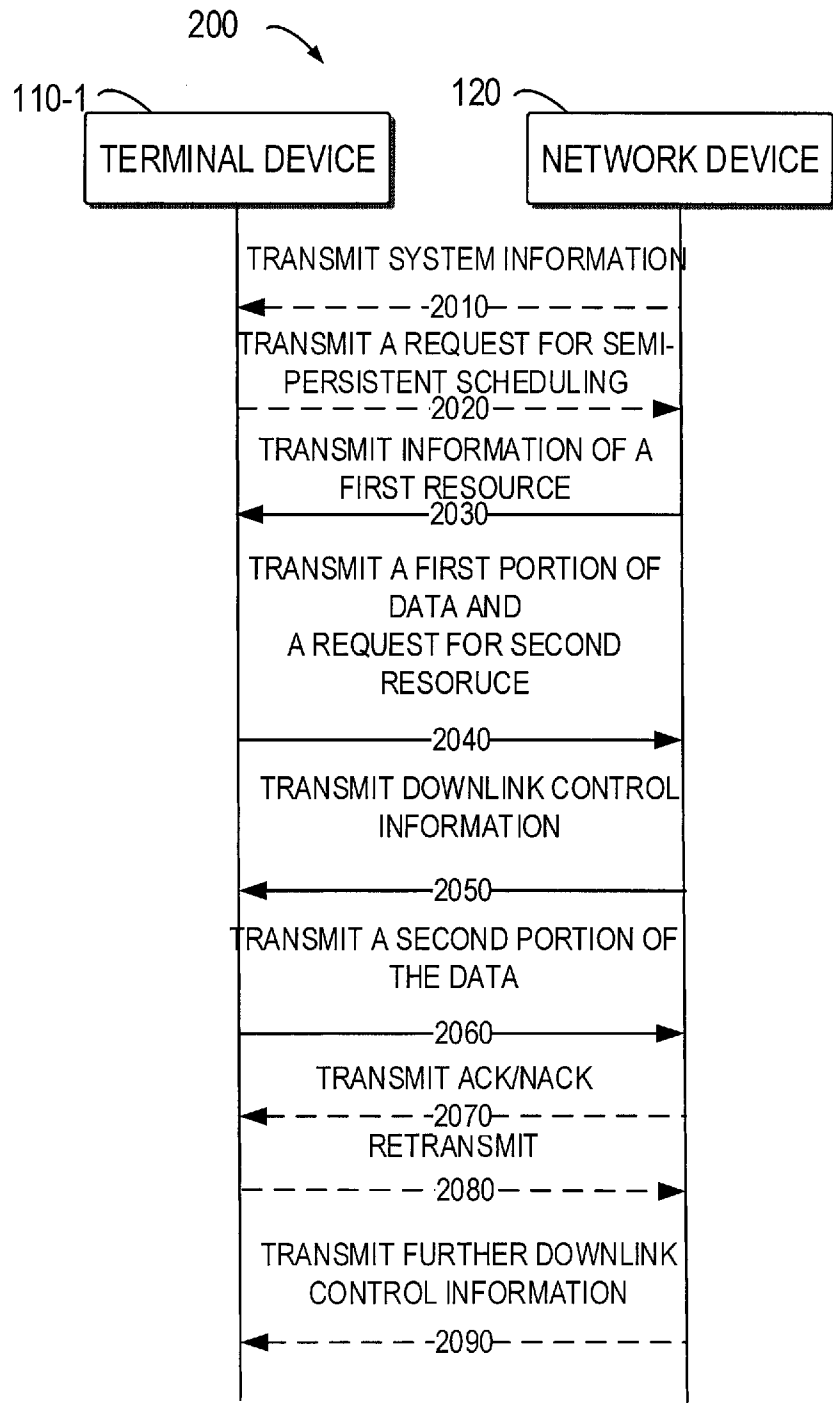


FIG. 2

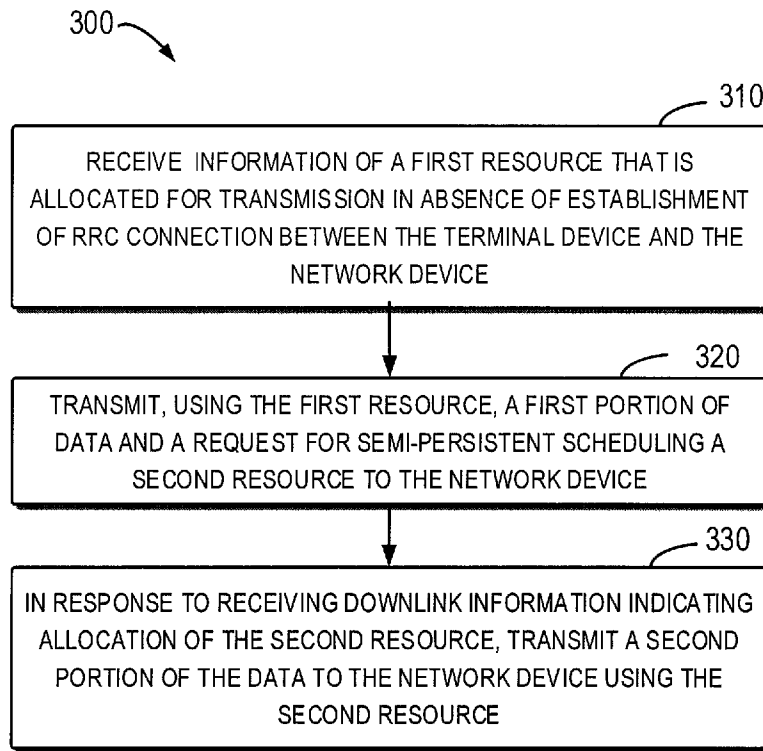


FIG. 3

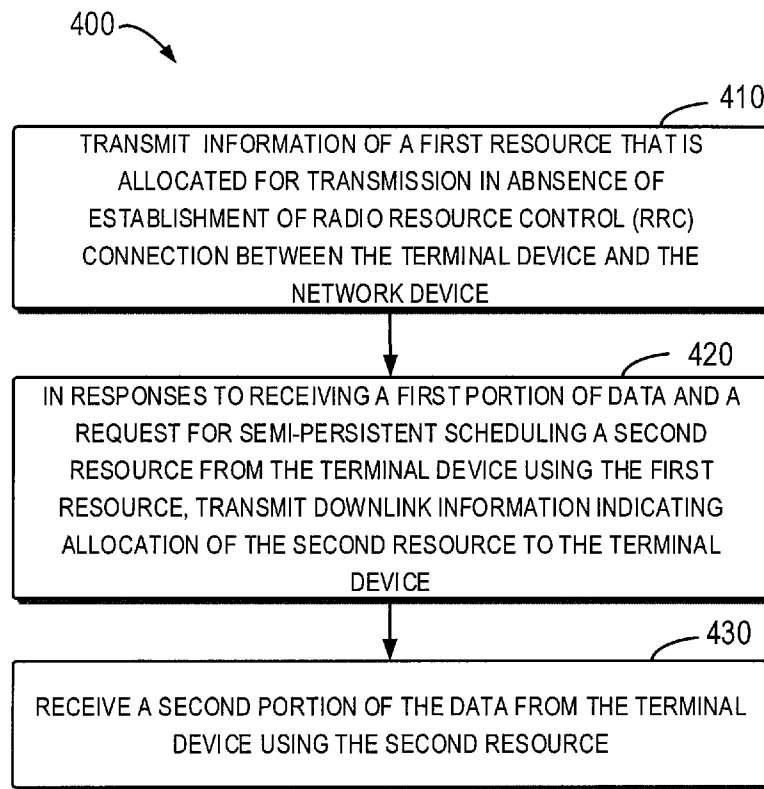


FIG. 4

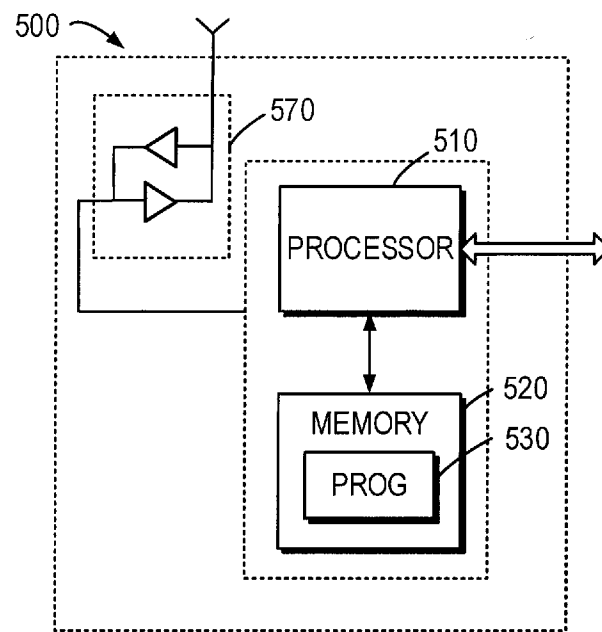


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2018/083788

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/12(2009.01)i; H04W 24/10(2009.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W; H04L

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

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

CNPAT, CNKI, WPI, EPODOC, 3GPP: semi-persistent scheduling, allocation, resource, early, transmission, small, data, uplink, grant-free, without, no, RRC, connection, request

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	QUALCOMM INCORPORATED. "Early data transmission and SPS" 3GPP TSG RAN WG1 Meeting #90 R1-1712808, 25 August 2017 (2017-08-25), sections 2, 4, 6	1-59
A	CN 104284340 A (HUAWEI TECHNOLOGIES CO., LTD.) 14 January 2015 (2015-01-14) the whole document	1-59
A	CN 101765146 A (DATANG MOBILE COMMUNICATION EQUIPMENT CO., LTD.) 30 June 2010 (2010-06-30) the whole document	1-59
A	WO 2017116132 A1 (LG ELECTRONICS INC.) 06 July 2017 (2017-07-06) the whole document	1-59



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

13 December 2018

Date of mailing of the international search report

04 January 2019

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2018/083788

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	104284340	A	14 January 2015	None			
CN	101765146	A	30 June 2010	None			
WO	2017116132	A1	06 July 2017	EP	3399822	A1	07 November 2018
				CN	108370582	A	03 August 2018