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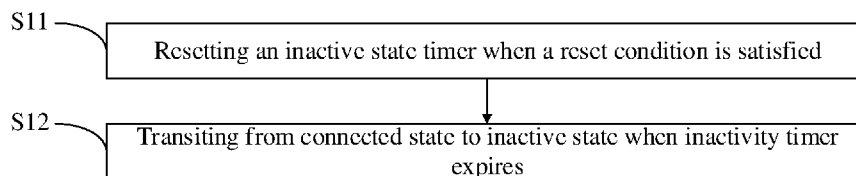


FIG. 1

(57) Abstract: A communication state transition method is disclosed, the method including: resetting an inactivity timer when a reset condition is satisfied, wherein the reset condition includes receiving first information from a base station and/or successfully transmitting second information to a base station, the first information includes positive feedback information in response to the new uplink data, and the second information includes the new uplink data and/or the positive feedback information in response to the new downlink data; and transiting from the connected state to the inactive state, when the inactivity timer expires. A communication state transition apparatus is also disclosed.



COMMUNICATION STATE TRANSITION METHOD AND

APPARATUS

TECHNICAL FIELD

[0001] Embodiments of the present disclosure generally relate to communication technology, and in particular relate to a communication state transition method and apparatus.

BACKGROUND

[0002] In new radio (NR), a user equipment (UE) has three states of radio resource control (RRC) connected (RRC_CONNECTED) state, RRC_INACTIVE state, and RRC_IDLE state.

[0003] The UE in the RRC_INACTIVE state still has a core network (CN)-radio access network (RAN) connection. A base station which keeps the CN-RAN connection of the UE and stores the UE context can be referred to as an anchor base station, and the anchor base station is responsible for configuring a notification area (NA) for the UE.

[0004] There are two methods, i.e., an explicit method and an implicit method, to perform a state transition from RRC_CONNECTED to RRC_INACTIVE. The explicit method means that the base station transmits explicit RRC signaling to the UE to perform state transition. The implicit method refers to use a timer to perform state transitions.

[0005] In the implicit state transition, each of the UE in the RRC_CONNECTED state and the base station is configured with a timer, and the durations of the two timers are identical. When the timer expires, the UE and the base station perform state transition to transit from RRC_CONNECTED to RRC_INACTIVE. Since the timer of the UE is independent from the timer of the base station, the two timers may not be synchronized, and thus the RRC state of the UE may be in a state mismatch at the UE side and the base station side.

[0006] In addition, in the implicit state transition, the base station needs to

pre-transmit the transition related parameters to the UE in the RRC_CONNECTED state (while in the explicit mode, it can be carried by the RRC signaling indicating the state transition). Transmitting the transition related parameters before each state transition may cause large signaling overhead.

SUMMARY

[0007] The technical problem that the present disclosure mainly resolves is to provide a communication state transition method and apparatus, which can solve the problem in the prior art of state mismatch of implicit state transition and large signaling overhead caused by transmitting the transition related parameters.

[0008] In order to solve the above-mentioned technical problem, the present disclosure provides a communication state transition method, the method including: resetting an inactivity timer when a reset condition is satisfied, wherein the reset condition includes receiving first information from a base station, and/or successfully transmitting second information to the base station; and when the inactivity timer expires, the transition state transiting from a connected state to an inactive state.

[0009] In order to solve the above-mentioned technical problem, the present disclosure provides another communication state transition method, the method including: resetting an inactivity timer when a reset condition is satisfied, the reset condition including successfully transmitting first information to a UE, and/or receiving second information from the UE; and transiting the UE from a connected state to an inactive state when the inactivity timer expires.

[0010] In order to solve the above-mentioned technical problem, the present disclosure provides another communication state transition method, the method including: resetting an inactivity timer when a reset condition is satisfied; when the inactivity timer expires, using transition related parameters to transit from a connected state to an inactive state, wherein the transition related parameters are received only when the transition related parameters change, and the situations that the transition related parameters change includes entering a new notification area.

[0011] In order to solve the above-mentioned technical problem, the present

disclosure provides another communication state transition method, the method including: transmitting transition related parameters to a UE only when the transition related parameters change, the transition related parameters being configured to assist the UE to transit from a connected state to an inactive state when the inactivity timer expires, and the situation that transition related parameters change comprising the UE entering a new notification area.

[0012] In order to solve the above-mentioned technical problem, the present disclosure provides a communication state transition apparatus. The apparatus includes a processor and a communication circuit, in which the processor is coupled to the communication circuit, and the processor is configured to execute instructions to implement the method of any of the first to the fourth aspect of the present disclosure.

[0013] In order to solve the above-mentioned technical problem, the present disclosure provides readable storage medium, the readable storage medium stored with instructions, in which the method of any of the first to the fourth aspect of the present disclosure is implemented when the instructions are executed.

[0014] The present disclosure may have the advantages that, the UE/base station resets the inactivity timer when the second/first information is successfully transmitted, avoiding the inactivity timer of the UE and the inactivity timer of the base station getting out of sync due to the mis-resetting of the inactivity timer at a single side when the second/first information fails to be transmitted. Thus the inactivity timer of the UE and the inactivity timer of the base station keep synchronized, thereby avoiding the state mismatch between the UE and the base station in an implicit state transition.

[0015] Furthermore, the transmission of the transition related parameters can be performed only when the transition related parameters change, and the number of transmitting the transition related parameters is reduced, thereby reducing the signaling overhead caused by the transmission of the transition related parameters.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG.1 is a schematic flowchart of a first embodiment of a communication state transition method according to the present disclosure.

[0017] FIG. 2 is a schematic diagram of a state mismatch in downlink data transmission in a related art.

[0018] FIG. 3 is a schematic diagram of a state mismatch in uplink data transmission in a related art.

[0019] FIG. 4 is a schematic flowchart of a third embodiment of a communication state transition method according to the present disclosure.

[0020] FIG. 5 is a schematic flowchart of a fourth embodiment of a communication state transition method according to the present disclosure.

[0021] FIG. 6 is a schematic flowchart of a sixth embodiment of a communication state transition method according to the present disclosure.

[0022] FIG. 7 is a schematic flowchart of a seventh embodiment of a communication state transition method according to the present disclosure.

[0023] FIG. 8 is a schematic flowchart of an eighth embodiment of a communication state transition method according to the present disclosure.

[0024] FIG. 9 is a schematic flowchart of a ninth embodiment of the communication state transition method of the present disclosure;

[0025] FIG. 10 is a schematic flowchart of a tenth embodiment of a communication state transition method according to the present disclosure.

[0026] FIG. 11 is a schematic flowchart of the eleventh embodiment of the communication state transition method of the present disclosure;

[0027] FIG. 12 is a schematic flowchart of a twelfth embodiment of a communication state transition method according to the present disclosure.

[0028] FIG. 13 is a structural diagram of a first embodiment of a readable storage medium of the present disclosure.

[0029] FIG. 14 is a structural diagram of a second embodiment of the communication state transition apparatus of the present disclosure;

[0030] FIG. 15 is s structural diagram of a third embodiment of the communication state transition apparatus of the present disclosure.

DETAILED DESCRIPTION

[0031] The present disclosure will now be described in detail with the accompanied drawings and embodiments. In the following embodiments, the non-conflicting ones may be combined with each other.

[0032] In a first embodiment of the communication state transition method of the present disclosure, a user equipment (UE) is the executing subject, and the UE may be fixed or mobile, may be a cellular phone, a personal digital assistant (PDA), or a wireless modem, tablets, laptops, cordless phones, etc. As shown in FIG. 1, the embodiment includes following blocks.

[0033] In S11, the method includes resetting an inactivity timer when a reset condition is satisfied.

[0034] In a downlink data transmission, the base station firstly transmits downlink data to the UE, and the UE attempts to perform decoding after receiving the downlink data. If the decoding is successful, positive feedback information (such as ACKnowledgment, ACK) may be transmitted to the base station. If the decoding fails, then, negative feedback information (for example, Negative ACKnowledgment, NACK) may be transmitted to the base station. The positive feedback information and negative feedback information may be collectively referred as feedback information. If the base station receives the positive feedback information, the downlink data transmission is successfully completed. If the base station receives the negative feedback information or does not receive the feedback information within a specified duration, it means that the downlink data or the feedback information fails to be transmitted, and the base station retransmits the downlink data. After receiving the retransmitted downlink data, the UE attempts to perform decoding, and if the decoding succeeds, the UE transmits positive feedback information, and if the decoding fails, it transmits negative feedback information. Once the downlink data is transmitted, the base station typically transmits downlink control information (DCI) first, and the DCI (hereinafter referred as downlink DCI) can include resource information allocated for the downlink data, and then uses the allocated resources to

transmit downlink data.

[0035] In the uplink data transmission, the base station firstly transmits downlink control information (DCI), and the DCI (referred as uplink DCI) includes uplink resource information allocated for the UE. After receiving the DCI, the UE can use the allocated uplink resource to transmit uplink data to the base station. After receiving the uplink data, the base station attempts to perform decoding. If the decoding succeeds, the uplink data transmission may be directly completed or the positive feedback information may be transmitted to the UE. If the decoding fails, the UE transmits negative feedback information or DCI to indicate the UE to retransmit the uplink data.

[0036] As shown in FIG. 2, in the downlink data transmission of the related art, the reset condition of the inactivity timer of the UE and the base station may include the new downlink data or the transmission/ reception of positive feedback information in the downlink data transmission. When the transmission of the downlink data/positive feedback information fails, the inactivity timer is only reset on the transmitting side, and the receiving side does not reset the inactivity timer since it does not receive the downlink data/positive feedback information, resulting in a state mismatch. As shown in FIG. 3, in the uplink data transmission of the related art, the reset condition of the inactivity timers of the UE and the base station may include transmission/reception of uplink data/DCI in uplink data transmission. When the uplink data/DCI transmission fails, the inactivity timer is only reset on the transmitting side, and the receiving side does not reset the inactivity timer because the uplink data/DCI is not received, resulting in a state mismatch.

[0037] The reset condition in the present embodiment may include receiving first information from a base station and/or successfully transmitting second information to a base station. The reset condition can include successfully transmitting the second information to the base station instead of transmitting the second information to the base station, which means that the UE, as the transmitting side, can reset the inactivity timer when determining that the second information has been successfully transmitted instead of directly resetting the inactivity timer when transmitting the second

information. When the reset condition includes receiving the first information from the base station, the UE, as the receiving side, can reset the inactivity timer to an initial duration upon receiving the first information.

[0038] To ensure that the first information and the second information has been successfully transmitted without any indeterminate situation, the first information and the second information can include final information. The successful transmission of the final information means that the uplink/downlink data transmission ends successfully without receiving any direct feedback about the final information from the UE/base station, and the receiver of the final information will request the transmitter of the final information to retransmit the final information when the final information is not successfully transmitted. The final information can be the last information in a successful data transmission.

[0039] After the UE/base station transmits non-final information, the UE/base station can wait for feedback information from the base station/UE (i.e., direct feedback for non-final information). If the feedback information is received, it means that the non-final information and the feedback information are transmitted successfully. If the feedback information is not received, the non-final information may fail to be transmitted, or the feedback information may fail to be transmitted, and the UE/base station cannot determine whether the non-final information has been transmitted successfully or not. Therefore, the reset condition may only include successful transmission/reception of the final information, or include successful transmission/reception of the final information and non-final information, and may not merely include successful transmission/reception of non-final information.

[0040] The first information may include positive feedback information in response to the new uplink data, and the second information may include positive feedback information in response to new uplink data and/or the new downlink data. The positive feedback information, transmitted by the UE to the base station in response to the new downlink data, belongs to the final information in the downlink data transmission. In the uplink transmission, if the base station needs to transmit positive feedback information to the UE after successfully decoding the uplink data,

the positive feedback information transmitted by the base station to the UE in response to the new uplink data belongs to the final information in the uplink data transmission. If the base station does not need to transmit positive feedback information to the UE after the base station successfully decoding the uplink data, the new uplink data belongs to the final information in the uplink data transmission.

[0041] In the uplink/downlink data transmission, the new uplink/downlink data will be retransmitted after the transmission failed. After the retransmission of the uplink/downlink data fails, if the number of the uplink/downlink data retransmission times does not reach a maximum number of retransmission times, the uplink/downlink data will be retransmitted, and if the number of retransmission times reaches the maximum number of retransmission times, the uplink/downlink data will not be retransmitted. The retransmitted uplink/downlink data, which reach the maximum number of retransmission times when transmitted, may be referred to as the final retransmitted uplink/downlink data. The final retransmitted uplink/downlink data will not be retransmitted again no matter whether its transmission is successful or not. Other retransmitted uplink/downlink data except for the final retransmitted uplink/downlink data may be referred to as non-final retransmitted uplink/downlink data. The final retransmitted uplink data and the positive feedback information in response to the final retransmitted uplink/downlink data is not the final information, and the non-final uplink data and the positive feedback information in response to the non-final retransmitted uplink/downlink data is the final information. Alternatively, the first information may further include feedback information in response to the non-final retransmitted uplink data, and the second information may further include non-final retransmitted uplink data and/or feedback information in response to the non-final retransmitted downlink data.

[0042] The initial duration of the inactivity timer of the UE and initial duration of the inactivity timer of the base station can be the same, and the reset conditions of the two inactivity timers can match with each other, that is, the information involved in the reset conditions of the two inactivity timers are the same. The resetting of inactivity timer may be resetting the current duration of the inactivity timer to an

initial duration or duration less than the initial duration. Resetting the inactivity timer can include creating a new timer and resetting its previous duration to the initial duration, i.e., activating the inactivity timer.

[0043] The UE in the RRC_CONNECTED state may perform one or more data transmissions, and one or more first/second information may be generated during each data transmission. The UE may determine whether the reset condition is satisfied for part of or all the first and second information.

[0044] In S12, the method includes transiting from the connected state to the inactive state when the inactivity timer expires.

[0045] After the inactivity timer is activated, the timer continuously performs timing, and during the timing (also referred as the validity period), if the reset condition is satisfied, the inactivity timer is reset until the inactivity timer stops timing, that is, expires. When the inactivity timer expires, the UE can automatically transit from the connected state (i.e. RRC_CONNECTED state) to the inactive state (i.e. RRC_INACTIVE state) by using the pre-configured transition related parameters, without receiving RRC signaling from the base station.

[0046] The transition related parameters may refer to parameters required for the UE to enter RRC_INACTIVE, such as UE context, discontinuous reception (DRX) period configured by RAN, RAN notification area configuration information, RAN update period, etc..

[0047] The transition related parameters need to be allocated to the UE before the state transition. The transition related parameters might be carried by RRC signaling, such as RRCConnectionReconfiguration.

[0048] With the implementation of the present embodiment, the reset condition of the UE-side inactivity timer includes receiving the first information from the base station and/or successfully transmitting the second information to the base station. The UE as the transmitting side does not directly resets the inactivity timer when transmitting the second information but resets the inactivity timer when it is confirmed that the second information has been successfully transmitted, so as to avoid the situation that the inactivity timer of the UE is mis-reset when the second

information transmission fails while the inactivity timer of the base station is not reset, so that the inactivity timer of the UE and the inactivity timer of the base station are kept synchronized, thereby avoiding a state mismatch between the UE and the base station in the implicit state transition.

[0049] Based on the first embodiment of the communication state transition method of the present disclosure, the second embodiment of the communication state transition method of the present disclosure uses the pending timer to determine whether the second information is successfully transmitted or not.

[0050] The pending timer is in one-to-one correspondence with the second information, and is configured to determine whether the second information is successfully transmitted. The number of pending timers that are working at the same time may be one or more. The pending timer is reset to the initial duration when the UE transmits the second information to the base station. The initial duration of the pending timer is the same with the initial duration of the inactivity timer.

[0051] The correspondence between the operation of the pending timer on the UE side and the triggering condition of the operation is shown in Table 1.

Operation	Triggering condition
Resetting	Transmitting second information to the base station
Upgrading to the inactivity timer (the second information is transmitted successfully)	(1) The retransmission indication is not received within the specified duration; or (2) The HARQ process number corresponding to the pending timer is used for the new transmission.
Stopping (the second information fails to be transmitted)	(3) Receiving a retransmission indication within the specified duration or (4) The second information corresponding to another pending timer with reset time later than the pending timer has been successfully transmitted.

Table 1

[0052] The uplink/downlink data transmission may apply a hybrid automatic repeat request (HARQ) mechanism. HARQ is a technique that combines forward error correction (FEC) and automatic repeat request (ARQ) methods. By adding redundant information, FEC enables the receiver to correct a portion of the error, thereby reducing the number of retransmission times. For errors that FEC cannot correct, the receiver requests the transmitter to retransmit the data through the ARQ mechanism.

[0053] HARQ uses a stop-and-wait protocol to transmit data. In the stop-and-wait protocol, after the transmitter transmits a transport block (TB), it stops and waits for feedback information (positive/negative). However, after each transmission, the transmitter stops and waits for feedback, which results in low throughput. Therefore, multiple concurrent HARQ processes are used. When one HARQ process is waiting for feedback information, the transmitter can use another HARQ process to transmit data. Each one of second information corresponds to one HARQ process. The HARQ process number and the New Data Indicator (NDI) can also be included in the DCI (including the allocated downlink/uplink resource information) received by the UE, before the second information is transmitted. The HARQ process number can also be referred as a HARQ process ID, and be configured to uniquely specify a HARQ process, while the NDI can be configured to indicate whether the uplink/downlink data scheduled to be transmitted is to be newly transmitted or retransmitted.

[0054] The condition for determining through the pending timer that the second information is successfully transmitted may include: (1) not receiving the retransmission indication in a specified duration; and (2) the HARQ process number corresponding to the pending timer being used for the new transmission. Conditions (1) and (2) implicitly indicates that the second information has been successfully received by the base station. When the pending timer is in the working state, with any one of the conditions (1) and (2) being satisfied, it can be determined that the second information is successfully transmitted, and the inactivity timer is reset to the

remaining duration of the pending timer. For convenience of description, resetting the inactivity timer to the remaining duration of the pending timer is referred as upgrading the pending timer to the inactivity timer, and the validity period of the upgraded inactivity timer is counted from the moment when corresponding pending timer is reset.

[0055] In condition (1), the retransmission indication is configured to indicate the UE to retransmit the second information, and the retransmission indication is not received within the specified duration, which means that the base station may have successfully received the second information. In the downlink data transmission, if the second information includes positive feedback information in response to the new transmission/non-final retransmitted downlink data, the retransmission indication includes the retransmitted downlink data. In the uplink data transmission, if the second information includes the new transmission/non-final uplink data, the retransmission indication includes negative feedback information from the base station and/or DCI indicating retransmission. The specified duration can be the validity duration of the drx-RetransmissionTimer.

[0056] In the HARQ mechanism, one HARQ process is not used for transmission of other TBs before successfully completing/abandoning the transmission of one TB. In condition (2), the HARQ process number received by the UE in the DCI after transmitting the second information, is the same with the HARQ process number corresponding to the second information/pending timer, and the NDI indicates that the DCI is used for new transmission, meaning that the second information has been successfully received by the base station.

[0057] It is assumed that at a first moment, the UE determines that the second information A corresponding to a certain pending timer a is successfully transmitted, and the pending timer a is upgraded to an inactivity timer. There is an older one, that is, another pending timer b with reset time earlier than the pending timer a, is still counting. At a second moment after the first moment, the UE determines the second information B corresponding to the other pending timer b is successfully transmitted, the pending timer b may be upgraded to the inactivity timer. In this case,

the UE firstly confirms that the second information A is successfully transmitted, and then confirms that the second information B is successfully transmitted. The validity period of the UE side inactivity timer is counted from when the pending timer b is reset, that is, when the second information B is transmitted. The reset time of the pending timer b is earlier than the pending timer a, that is, the transmitting time of the second information B is earlier than the second information A. Accordingly, the base station firstly receives the second information B and then receives the second information A. The validity period of the inactivity timer on the base station side is calculated from the time when the second information A is received, and the inactivity timers on both sides are out of synchronization.

[0058] To avoid the occurrence of the above-mentioned out-of-synchronization, in one example, when determining through the current pending timer that the second information has been successfully transmitted, the UE may firstly determine whether the inactivity timer has been reset by a pending timer which is younger than the current pending timer (i.e., pending timer with reset time later than reset time of the current pending timer), if the result is positive, the resetting of the inactivity timer is abandoned, and if the result is negative, the inactive state is reset to the remaining duration of the current pending timer. In another example, the pending timer older than the current pending timer may be stopped when reset time that the second information has been successfully transmitted. The stopped pending timer will not continue to work, and will not be upgraded to the inactivity timer even if the corresponding second information is successfully transmitted. Alternatively, the UE may delete these older pending timers that are stopped.

[0059] The condition for determining through the pending timer that the second information transmission fails may include: (3) receiving a retransmission indication within a specified duration; and (4) successfully transmitting a second information corresponding to another pending timer with reset time later than the pending timer. When the pending timer is in the working state, as long as any one of the conditions (3) and (4) is satisfied, the second information transmission failure is determined, and the inactivity timer is stopped.

[0060] The retransmission indication in condition (3) is the same with that in the condition (1), and the UE receiving the retransmission indication means that the base station fails to receive the second information, and the second information transmission fails. In the case that the condition (4) is satisfied, it does not necessarily mean that the second information fails to be transmitted, but it is treated as a transmission failure to avoid the non-synchronization of the inactivity timer of the UE and the inactivity timer of the base station. For details, reference may be made to the foregoing related content. If the second information only includes the new uplink data and/or the positive feedback information in response to the new downlink data, during the same uplink/downlink data transmission process, the pending timer will not be reset once it is stopped. In this case, the stopped pending timer can be deleted.

[0061] As shown in FIG. 4, the third embodiment of the communication state transition method of the present disclosure limits the number of transmission times of the transition related parameters, on the basis of the first embodiment of the communication state transition method of the present disclosure. The present embodiment is a further extension of the first embodiment of the communication state transition method of the present disclosure, and the same portions are not repeated. The present embodiment includes following blocks.

[0062] In S110, the method includes receiving the transition related parameters only when the transition related parameters change.

[0063] The transition related parameters can be related to RRC_INACTIVE. The UE in the RRC_INACTIVE state can camp on the NA. The case that the transition related parameters change may include the UE entering a new notification area, and the change of the notification area causes the transition related parameters to change. The case that the transition related parameters change may further include the update of the transition related parameters in the case where the notification area is unchanged. When the transition related parameters have not changed, the UE can inherit the configured transition related parameters.

[0064] In S120, the method includes resetting the inactivity timer when a reset

condition is satisfied.

[0065] Herein, the reset condition includes receiving first information from the base station and/or successfully transmitting second information to the base station.

[0066] The executing order between this step and S110 is merely illustrative.

[0067] In S130, the method includes using transition related parameters to transit from the connected state to the inactive state, when the inactivity timer expires.

[0068] Through the implementation of the embodiment, the transmission of the transition related parameters is performed only when the transition related parameters change. Compared with transmitting the transition related parameters before each state transition, the number of transmission times of the transition related parameters is reduced, thereby reducing signaling overhead caused by the transmission of the transition related parameters.

[0069] The executing subject of the fourth embodiment of the communication state transition method of the present disclosure is a base station, which is a base station of a currently connected cell in the present embodiment. The base station connects to a core network and performs wireless communication with the UE to provide communication coverage for the corresponding geographic area. The base station may be a macro base station, a micro base station, a pico base station, or a femtocell. In some embodiments, a base station may also be referred to as a radio base station, an access point, a Node B, an eNodeB (eNB), gNB, or other suitable terminology. As shown in FIG. 5, the present embodiment includes following blocks.

[0070] In S21, the method includes resetting an inactivity timer when a reset condition is satisfied.

[0071] The reset condition may include successfully transmitting first information to the UE and/or receiving second information from the UE. The initial duration of the inactivity timer of the UE and initial duration of the inactivity timer the base station can be the same, and the reset conditions of the two inactivity timers can match with each other, that is, the information involved in the reset conditions of the two inactivity timers are the same. The resetting of inactivity timer may be resetting the current duration of the inactivity timer to an initial duration or duration less than the

initial duration. Resetting the inactivity timer can include creating a new timer and resetting its previous duration to the initial duration, i.e., activating the inactivity timer.

[0072] The reset condition includes successfully transmitting the first information to the UE instead of transmitting the first information to the UE, which means that the base station, as the transmitting side, can reset the inactivity timer when determining that the first information has been successfully transmitted instead of directly reset the inactivity timer when transmitting the first information when transmitting the first information. When the reset condition includes receiving the second information from the UE, the base station, as the receiving side, can reset the inactivity timer to the initial duration upon receiving the second information.

[0073] The specific description of the first information and the second information may refer to related content in the first embodiment of the communication state transition method of the present disclosure, and is not repeated herein again.

[0074] The UE in the RRC_CONNECTED state may perform one or more data transmissions, and one or more first/second information may be generated during each data transmission. The base station may determine whether the reset condition is satisfied for part of or all the first and second information.

[0075] In S22, the method includes transiting the UE from a connected state to an inactive state when the inactivity timer expires.

[0076] After the inactivity timer gets activated, the timing is continuously performed, and during the timing (also referred as the validity period), if the reset condition is satisfied, the inactivity timer is reset until the inactivity timer expires, that is, expires. When the inactivity timer expires, the base station automatically transits the state of the UE of the network side from RRC_CONNECTED state to RRC_INACTIVE state, without transmitting RRC signaling to the UE.

[0077] With the implementation of the present embodiment, the reset condition of the base station side inactivity timer includes receiving the second information from the UE and/or successfully transmitting the first information to the base station. The base station as the transmitting side does not directly resets the inactivity timer when

transmitting the first information, but resets the inactivity timer when it is confirmed that the first information has been successfully transmitted, so as to avoid the situation that the inactivity timer of the base station is mis-reset when the first information transmission fails, while the inactivity timer of the UE is not reset, so that the inactivity timer of the UE and the inactivity timer of the base station are kept synchronized, thereby avoiding a state mismatch between the UE and the base station in the implicit state transition.

[0078] Based on the fourth embodiment of the communication state transition method of the present disclosure, the fifth embodiment of the communication state transition method of the present disclosure uses the pending timer to determine whether the first information is successfully transmitted or not.

[0079] The pending timer is in one-to-one correspondence with the first information, and is configured to determine whether the first information is successfully transmitted. The number of pending timers that are working at the same time may be one or more. The pending timer is reset to the initial duration when the UE transmits the first information to the base station. The initial duration of the pending timer is the same with the initial duration of the inactivity timer.

[0080] The correspondence between the operation of the pending timer on the base station side and the triggering condition of the operation is as shown in Table 2.

Operation	Triggering condition
Resetting	Transmitting the first information to the base station
Upgrading to the inactivity timer (the first information is transmitted successfully)	(5) The retransmission indication is not received within the specified duration.
Stopping (the first information failed to be transmitted)	(6) Receiving a retransmission indication within the specified time; or (7) The first information corresponding to another pending timer with reset time later than the pending timer has been successfully transmitted.

Table 2

[0081] The condition for determining through the pending timer that the first

information is successfully transmitted may include: (5) not receiving the retransmission indication within a specified duration. In condition (5), the retransmission indication is typically the retransmitted uplink data.

[0082] When the pending timer is in the working state, as long as the condition (5) is satisfied, it can be determined that the first information is successfully transmitted, and the inactivity timer is reset to the remaining duration of the pending timer. Resetting the inactivity timer to the remaining duration of the pending timer may also be referred to as upgrading the pending timer to the inactivity timer, and the validity period of the upgraded inactivity timer is counted from the moment when corresponding pending timer is reset.

[0083] In order to avoid that the inactivity timer of the UE and the inactivity timer of the base station are out of synchronization, when determining through the current pending timer that the first information has been successfully transmitted, the pending timer older than the current pending timer may be stopped and the first information corresponding to the older pending timer is regarded as a transmission failure. Alternatively, the base station can delete these older pending timers that are stopped.

[0084] The condition for determining through the pending timer that the first information transmission fails includes: (6) receiving a retransmission indication within a specified duration, and (7) successfully transmitting first information corresponding to another pending timer with reset time later than the pending timer. When the pending timer is in the working state, as long as any one of the conditions (6) and (7) is satisfied, the first information transmission failure is determined, and the inactivity timer is stopped. In the case that the condition (7) is satisfied, the first information does not necessarily fail to be transmitted, but it is treated as a transmission failure to avoid the non-synchronization between the inactivity timer of the UE and the inactivity timer of the base station. For details, reference may be made to the foregoing related content. If the first information only includes the positive feedback information in response to the new uplink data, during the same uplink data transmission process, pending timer will not be reset again once it is stopped. In this case, the stopped pending timer can be deleted.

[0085] As shown in FIG. 6, the sixth embodiment of the communication state transition method of the present disclosure limits the number of transmission times of the transition related parameters, on the basis of the fourth embodiment of the communication state transition method of the present disclosure. The present embodiment is a further extension of the fourth embodiment of the communication state transition method of the present disclosure, and the same portions are not repeated. The present embodiment includes following blocks.

[0086] In S210, the method includes transmitting the transition related parameters to the UE only when the transition related parameters change.

[0087] The transition related parameters can be configured to assist the UE to transit from the connected state to the inactive state when the inactivity timer expires. The transition related parameters are related to RRC_INACTIVE, and the UE in the RRC_INACTIVE state can camp on the NA. The case that the transition related parameters change may include the UE entering a new notification area, and the change of the notification area causes the transition related parameters to change. The case that the transition related parameters change might further include the update of the transition related parameters in the case where the notification area is unchanged. When the transition related parameters have not changed, there is no need to configure the transition related parameters for the UE again.

[0088] In S220, the method includes resetting the inactivity timer when a reset condition is satisfied.

[0089] Herein, the reset condition includes successfully transmitting the first information to the UE and/or receiving the second information from the UE.

[0090] The executing order between this step and S120 is merely illustrative.

[0091] In S230, the method includes transiting the UE from the connected state to the inactive state when the inactivity timer expires.

[0092] Through the implementation of the embodiment, the transmission of the transition related parameters is performed only when the transition related parameters change. Compared with transmitting the transition related parameters before each state transition, the number of transmission times of the transition related parameters

is reduced, thereby reducing signaling overhead caused by the transmission of the transition related parameters.

[0093] The following description illustrates how the inactivity timer of the UE and the inactivity timer of the base station keep synchronized when working in different situations, with reference to the accompanying drawings, wherein the parts the same with the foregoing embodiments are not repeated herein.

[0094] As shown in FIG. 7, the seventh embodiment of the communication state transition of the present disclosure describes a case that downlink data transmission fails in downlink data transmission. The present embodiment includes following blocks.

[0095] In S301, the gNB may transmit new downlink data 1 to the UE.

[0096] In S302, the UE may transmit ACK1 to the gNB, and resetting a UE pending timer 1.

[0097] The transmission of the downlink data 1 is successfully completed.

[0098] In S303, the gNB may reset the gNB inactivity timer when the ACK 1 is received.

[0099] In S304, through a specified duration after resetting the UE pending timer 1, the UE may upgrade the UE pending timer 1 to the UE inactivity timer.

[00100] The validity period of the UE inactivity timer is counted from the time when the UE pending timer 1 to be reset, that is, when the ACK 1 is transmitted, the same with the starting time of the gNB inactivity timer.

[00101] In S305, the gNB may transmit the new downlink data 2 to the UE but the transmission fails.

[00102] In S306, the gNB may transmit the retransmitted downlink data 2 to the UE but the transmission fails.

[00103] In S307, the gNB may transmit the retransmitted downlink data 2 to the UE but the transmission fails.

[00104] In S308, the UE may perform state transition when the UE inactivity timer expires.

[00105] The UE does not receive new downlink data and does not reset the new

pending timer.

[00106] In S309, the gNB may perform state transition when the gNB inactivity timer expires.

[00107] The UE inactivity timer and the gNB inactivity timer have the same starting time and the same validity period, so both of them expire at the same time.

[00108] As shown in FIG. 8, the eighth embodiment of the communication state transition method of the present disclosure describes a case where the ACK transmission in response to the new downlink data fails in the downlink data transmission. The present embodiment includes following blocks.

[00109] In S321, the gNB may transmit the new downlink data 1 to the UE.

[00110] In S322, the UE may transmit ACK1 to the gNB and resets the UE pending timer 1.

[00111] The transmission of the downlink data 1 is successfully completed.

[00112] In S323, the gNB may reset the gNB inactivity timer when the ACK 1 is received.

[00113] In S324, through a specified duration since resetting the UE pending timer 1, the UE may upgrade the UE pending timer 1 to the UE inactivity timer.

[00114] The validity period of the UE inactivity timer is counted from the time when the UE pending timer 1 is reset, that is, when the ACK 1 is transmitted, the same as the starting time of the gNB inactivity timer.

[00115] In S325, the gNB may transmit the new downlink data 2 to the UE.

[00116] In S326, the UE may transmit ACK2 to the gNB and reset the UE pending timer 2, and the ACK2 transmission fails.

[00117] In S327, the UE may receive the retransmitted downlink data 2 transmitted by the gNB and stop the UE pending timer 2.

[00118] The second information in the present embodiment only includes the ACK in response to new downlink data.

[00119] In S328, the UE may transmit ACK2 to the gNB, and the ACK2 transmission fails.

[00120] In S329, the UE may receive the retransmitted downlink data 2 transmitted

by the gNB.

[00121] In S330, the UE may transmit ACK2 to the gNB, and the ACK2 transmission fails.

[00122] In S331, the UE may receive the retransmitted downlink data 2 transmitted by the gNB.

[00123] In S332, the UE may perform state transition when the UE inactivity timer expires.

[00124] In S333, the gNB may perform state transition when the gNB inactivity timer expires.

[00125] The UE pending timer 2 has not yet been successfully upgraded, and the gNB does not receive the ACK2 and will not reset the gNB inactivity timer again. The starting time of the UE inactivity timer and the starting time of the gNB inactivity timer is still the transmission/reception time of ACK1, with the same validity period, therefore both of them expires at the same time.

[00126] As shown in FIG. 9, the ninth embodiment of the communication state transition method of the present disclosure describes the case where the continuous transmission of downlink data is successful. The present embodiment includes following blocks.

[00127] In S341, the gNB may transmit the new downlink data 1 to the UE.

[00128] In S342, the gNB may transmit the new downlink data 2 to the UE.

[00129] In S343, the gNB may transmit the new downlink data 3 to the UE.

[00130] In S344, the UE may transmit ACK1 to the gNB and resets the UE pending timer 1.

[00131] The transmission of the downlink data 1 is successfully completed.

[00132] In S345, the gNB may reset the gNB inactivity timer when the ACK 1 is received.

[00133] In S346, the UE may transmit an ACK 2 to the gNB, and resets the UE pending timer 2.

[00134] The transmission of downlink data 2 is successfully completed.

[00135] In S347, the gNB may reset the gNB inactivity timer when the ACK 2 is

received.

[00136] In S348, the UE may transmit an ACK 3 to the gNB, and resets the UE pending timer 3.

[00137] The transmission of downlink data 3 is successfully completed.

[00138] In S349, the gNB may reset the gNB inactivity timer when the ACK 3 is received.

[00139] In S350, through a specified duration since resetting UE pending timer 1, the UE may upgrade the UE pending timer 1 to the UE inactivity timer.

[00140] The validity period of the UE inactivity timer is counted from the time when the UE pending timer 1 is reset, that is, when the ACK 1 is transmitted.

[00141] In S351, through a specified duration since resetting UE pending timer 2, the UE may upgrade the UE pending timer 2 to the UE inactivity timer.

[00142] The validity period of the UE inactivity timer is counted from the time when the UE pending timer 2 is reset, that is, when the ACK 2 is transmitted. The UE pending timer 1 is stopped.

[00143] In S352, through a specified duration since resetting UE pending timer 3, the UE may upgrade the UE pending timer 3 to the UE inactivity timer.

[00144] The validity period of the UE inactivity timer is counted from the time when the UE pending timer 3 is reset, that is, when the ACK 3 is transmitted. The UE pending timer 2 is stopped.

[00145] In S353, the UE may perform state transition when the UE inactivity timer expires.

[00146] In S354, the gNB may perform state transition when the gNB inactivity timer expires.

[00147] The starting time of the UE inactivity timer and the starting time of the gNB inactivity timer are both the transmission/reception time of the ACK3, and the validity periods are the same, so both of them expire at the same time.

[00148] As shown in FIG. 10, the tenth embodiment of the communication state transition method of the present disclosure describes a case where a HARQ number is used for a new transmission. The present embodiment includes following blocks.

[00149] In S361, the gNB may transmit the new downlink data 1 (HARQ process number: 0001) to the UE.

[00150] In S362, the gNB may transmit the new downlink data 2 (HARQ process number: 0010) to the UE.

[00151] In S363, the gNB may transmit the new downlink data 3 (HARQ process number: 0011) to the UE.

[00152] In S364, the UE may transmit ACK1 to the gNB and resets the UE pending timer 1.

[00153] The transmission of the downlink data 1 is successfully completed.

[00154] In S365, the gNB may reset the gNB inactivity timer when the ACK 1 is received.

[00155] In S366, the UE may transmit an ACK 2 to the gNB, and resets the UE pending timer 2.

[00156] The transmission of downlink data 2 is successfully completed.

[00157] In S367, the gNB may reset the gNB inactivity timer when the ACK 2 is received.

[00158] In S368, the UE may transmit an ACK 3 to the gNB, and resets the UE pending timer 3.

[00159] The transmission of downlink data 3 was successfully completed.

[00160] In S369, the gNB may reset the gNB inactivity timer when the ACK 3 is received.

[00161] In S370, the UE may receive the new downlink data 4 (HARQ process number: 0010) from the gNB, and upgrade the UE pending timer 2 to the UE inactivity timer.

[00162] The validity period of the UE inactivity timer is counted from the time when the UE pending timer 2 is reset, that is, when the ACK 2 is transmitted. The UE pending timer 1 is stopped.

[00163] S371, the UE may transmit an ACK 4 to the gNB, and reset the UE pending timer 4.

[00164] The transmission of the downlink data 4 is successfully completed.

[00165] In S372, the gNB may reset the gNB inactivity timer when the ACK4 is received.

[00166] In S373, through a specified duration since resetting UE pending timer 3, the UE may upgrade the UE pending timer 3 to the UE inactivity timer.

[00167] The validity period of the UE inactivity timer is counted from the time when the UE pending timer 3 is reset, that is, when the ACK 3 is transmitted. The UE pending timer 2 is stopped.

[00168] In S374, through a specified duration since resetting UE pending timer 4, the UE may upgrade the UE pending timer 4 to the UE inactivity timer.

[00169] The validity period of the UE inactivity timer is counted from the time when the UE pending timer 4 is reset, that is, when the ACK 3 is transmitted. The UE pending timer 3 is stopped.

[00170] In S375, the UE may perform state transition when the UE inactivity timer expires.

[00171] In S376, the gNB may perform state transition when the gNB inactivity timer expires.

[00172] The starting time of the UE inactivity timer and the gNB inactivity timer are both the transmission/reception time of the ACK4, and the validity periods are the same, so both of them expire at the same time.

[00173] In the seventh to tenth embodiments of the communication state transition method of the present disclosure, the resetting of the inactivity timer in the downlink data transmission is triggered by the successful transmission/reception of the ACK in response to the new downlink data. In the uplink data transmission process, if the base station does not transmit the positive feedback information to the UE after successfully receiving the uplink data from the UE, the triggering condition of resetting the inactivity timer may be that, after the uplink DCI is successfully transmitted, the uplink data transmitted by the UE is successfully transmitted/received. The operations of the inactivity timer of the base station and the inactivity timer of the UE are similar to that shown in Figures 7-10.

[00174] As shown in FIG. 11, the eleventh embodiment of the communication state

transition method of the present disclosure includes following blocks.

[00175] In S51, the method can include resetting the inactivity timer when the reset condition is satisfied.

[00176] The execution subject of the present embodiment is a UE. The reset condition in the present embodiment may be reset conditions in the foregoing embodiment, or may be other reset conditions.

[00177] In S52, the method can include transiting from the connected state to the inactive state by using the pre-configured transition related parameters when the inactivity timer expires.

[00178] After the inactivity timer gets activated, the timing is continuously performed, and during the timing (also referred as the validity period), if the reset condition is satisfied, the inactivity timer is reset until the inactivity timer expires, that is, expires. When the inactivity timer expires, the UE can automatically transit from RRC_CONNECTED state to RRC_INACTIVE state by using the pre-configured transition related parameters, without receiving RRC signaling from the base station

[00179] The transition related parameters can refer to parameters required for the UE to enter RRC_INACTIVE, such as UE context, DRX period configured by RAN, RAN notification area configuration information, RAN update period, etc.. The transition related parameters need to be allocated to the UE before the state transition. The transition related parameters might be carried by RRC signaling, such as RRCConnectionReconfiguration.

[00180] The transition related parameters can be received only when the transition related parameters change. The transition related parameters can be related to RRC_INACTIVE, and the UE in the RRC_INACTIVE state can camp on the NA. The case that the transition related parameters change may include the UE entering a new notification area, and the change of the notification area causes the transition related parameters to change. The case where the transition related parameters change may further include the update of the transition related parameters in the case where the notification area is unchanged. When the transition related parameters have not changed, the UE can inherit the configured transition related parameters.

The base station that transmits the transition related parameters to the UE is not necessarily the same as the base station to which the UE is connected during the operation of the state transition.

[00181] Through the implementation of the embodiment, the transmission of the transition related parameters is performed only when the transition related parameters change. Compared with transmitting the transition related parameters before each state transition, the number of transmission times of the transition related parameters is reduced, thereby reducing signaling overhead caused by the transmission of the transition related parameters.

[00182] As shown in FIG. 12, the twelfth embodiment of the communication state transition method of the present disclosure includes following blocks.

[00183] In S61, the method may include transmitting the transition related parameters to the UE only when the transition related parameters change.

[00184] The execution subject of the present embodiment is a base station. The transition related parameters may refer to parameters required for the UE to enter RRC_INACTIVE, and may be configured to assist the UE to transit from the connected state to the inactive state when the inactivity timer expires.

[00185] The case that the transition related parameters change may include the UE entering a new notification area. The case where the transition related parameters change may further include the update of the transition related parameters in the case where the notification area is unchanged.

[00186] Through the implementation of the embodiment, the transmission of the transition related parameters is performed only when the transition related parameters change. Compared with transmitting the transition related parameters before each state transition, the number of transmission times of the transition related parameters is reduced, thereby reducing signaling overhead caused by the transmission of the transition related parameters.

[00187] As shown in FIG. 13, the first embodiment of the communication state transition apparatus of the present disclosure includes a processor 110 and a communication circuit 120, and the processor 110 may be coupled to the

communication circuit 120.

[00188] The communication circuit 120 may be configured for transmitting and receiving data, which is an interface for communication between the communication state transition apparatus and other communication devices.

[00189] The processor 110 controls the operation of the communication state transition apparatus, which may also be referred to as a central processing unit (CPU). Processor 110 may be an integrated circuit chip with signal processing capabilities. The processor 110 can also be a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field-programmable gate array (FPGA) or other programmable logic device, a discrete gate or transistor logic device, and a discrete hardware component. The general purpose processor may be a microprocessor, or the processor may also be any conventional processor.

[00190] The processor 110 may be configured to execute instructions to implement the method provided by any one of the first to third embodiments and the eleventh embodiment of the communication state transition method of the present disclosure and any of their non-conflicting combination.

[00191] The communication state transition apparatus in the present embodiment may be a UE, or may be a separate component that can be integrated in the UE, such as a baseband chip.

[00192] As shown in FIG. 14, a second embodiment of the communication state transition apparatus of the present disclosure includes a processor 210 and a communication circuit 220, and the processor 210 may be coupled to the communication circuit 220.

[00193] The communication circuit 220 may be configured to transmit and receive user data, and is an interface for the communication state transition apparatus to communicate with other communication devices.

[00194] The processor 210 controls the operation of the communication state transition apparatus, which may also be referred to as a central processing unit (CPU). Processor 210 may be an integrated circuit chip with signal processing capabilities. The processor 210 can also be a general purpose processor, a digital signal processor

(DSP), an application specific integrated circuit (ASIC), an field-programmable gate array (FPGA) or other programmable logic device, a discrete gate or transistor logic device, a discrete hardware component. The general purpose processor may be a microprocessor, or the processor or any conventional processor.

[00195] The processor 210 is configured to execute instructions to implement the method provided by any one of the fourth to sixth embodiments and the twelfth embodiment of the communication state transition method of the present disclosure and any of their non-conflicting combination.

[00196] The communication state transition apparatus in the present embodiment may be a base station, or may be a separate component that can be integrated in the base station, such as a baseband board.

[00197] As shown in FIG. 15, a first embodiment of the readable storage medium of the present disclosure includes a storage 310 in which instructions are stored, and the methods provided by any of the embodiments of the first to twelfth embodiments of the communication state transition method of the present disclosure and their non-conflicting combination may be implemented when the instructions are executed.

[00198] The storage 310 may include a read-only memory (ROM), a random access memory (RAM), a flash memory, a hard disk, an optical disk, etc.

[00199] In the embodiments provided by the present disclosure, it is to be understood that the disclosed methods and apparatuses can be implemented in other ways. For example, the apparatus embodiments described above are merely illustrative; the division of the modules or units is merely a division of logical functions, and can be divided in other ways such as combining or integrating multiple units or components with another system when being implemented; and some features can be ignored or not executed. In another aspect, the coupling such as direct coupling and communication connection which may be shown or discussed can be implemented through some interfaces, and the indirect coupling and the communication connection between devices or units can be electrical, mechanical, or otherwise.

[00200] The units described as separated components can or cannot be physically separate, and the components shown as units can or cannot be physical units, that is,

can be located in one place or distributed over a plurality of network elements. It is possible to select some or all of the units in accordance with the actual needs to achieve the object of the embodiments.

[00201] In addition, each of the functional units in each of the embodiments of the present disclosure can be integrated in one processing unit. Each unit can be physically exists alone, or two or more units can be integrated in one unit. The above-mentioned integrated unit can be implemented either in the form of hardware, or in the form of software functional units.

[00202] The integrated unit can be stored in a computer-readable storage medium if it is implemented in the form of a software functional unit and sold or utilized as a separate product. Based on this understanding, the technical solution of the present disclosure, either essentially or in part, contributes to the prior art, or all or a part of the technical solution can be embodied in the form of a software product. The software product may be stored in a storage medium, which may include a number of instructions for enabling a computer device (which can be a personal computer, a server, a network device, etc.) or a processor to execute all or a part of the steps of the methods described in each of the embodiments of the present disclosure. The above-mentioned storage medium may include a variety of media such as a USB disk, a mobile hard disk, a read-only memory (ROM), a random access memory (RAM), a magnetic disk, and an optical disk which may be capable of storing program codes.

[00203] The foregoing is merely embodiments of the present disclosure, and is not intended to limit the scope of the present disclosure. Any equivalent structure or flow transformation made based on the specification and the accompanying drawings of the present disclosure, or any direct or indirect applications of the disclosure on other related fields, shall all be covered within the protection of the present disclosure.

Claims

What is claimed is:

1. A communication state transition method, comprising:
resetting an inactivity timer when a reset condition is satisfied, wherein the reset condition comprises at least one of receiving first information from a base station and successfully transmitting second information to the base station, the first information comprising positive feedback information in response to new uplink data, the second information comprising at least one of new uplink data and positive feedback information in response to new downlink data; and
transiting from a connected state to an inactive state when the inactivity timer expires.
2. The method of claim 1, wherein the reset condition comprises successfully transmitting the second information to the base station, and the resetting the inactivity timer when the reset condition is satisfied comprises:
when determining through a pending timer that the second information is successfully transmitted, resetting the inactivity timer to a remaining duration of the pending timer, wherein the pending timer is in one-to-one correspondence with the second information, and configured to determine whether the second information is successfully transmitted, the pending timer is reset to an initial duration when the second information is transmitted to the base station, and the initial duration of the pending timer is the same with an initial duration of the inactivity timer.
3. The method of claim 2, wherein the pending timer corresponds to a hybrid automatic repeat request (HARQ) process, and a condition that the second information is successfully transmitted comprises not receiving a retransmission indication within a specified duration or a HARQ process number corresponding to the pending timer is used for a new transmission.
4. The method of claim 3, further comprising:
stopping and deleting other pending timers with reset time earlier than the pending timer, when determining through the pending timer that the second information is successfully transmitted.
5. The method of claim 3, further comprising:

stopping the inactivity timer when it is determined that the second information transmission fails through a pending timer, wherein a condition that the second information transmission fails comprises receiving the retransmission indication within the specified duration or second information, corresponding to another pending timer with a reset time later than the pending timer, having been successfully transmitted.

6. The method of claim 1, wherein the reset condition comprises receiving the first information from the base station, and the resetting the inactivity timer when the reset condition is satisfied comprises:

resetting the inactivity timer to an initial duration when the first information from the base station is received.

7. The method of any of claims 1-6, wherein the first information further comprises positive feedback information in response to a non-final retransmitted uplink data, the second information further comprises at least one of a non-final retransmitted uplink data and positive feedback information in response to the non-final retransmitted downlink data.

8. The method of any of claims 1-6, wherein the transiting from the connected state to the inactive state when the inactivity timer expires comprises:

using pre-configured transition related parameters to transit from the connected state to the inactive state, when the inactivity timer expires.

9. The method of claim 8, wherein before the transiting from the connected state to the inactive state when the inactivity timer expires, the method further comprises:

receiving transition related parameters only when the transition related parameters change, and situations that the transition related parameters change comprises entering a new notification area.

10. A communication state transition method, comprising:

resetting an inactivity timer when a reset condition is satisfied, wherein the reset condition comprises at least one of successfully transmitting first information to a user equipment (UE) and receiving second information from the UE, the first information comprising positive feedback information in response to new uplink data, the second

information comprising at least one of new uplink data and positive feedback information in response to new downlink data; and
transiting the UE from a connected state to an inactive state when the inactivity timer expires.

11. The method of claim 10, wherein the reset condition comprises successfully transmitting the first information to the UE, and the resetting the inactivity timer when the reset condition is satisfied comprises:

when determining through a pending timer that the first information is successfully transmitted, resetting the inactivity timer to a remaining duration of the pending timer, wherein the pending timer is in one-to-one correspondence with the first information, and configured to determine whether the first information is successfully transmitted, the pending timer is reset to an initial duration when the first information is transmitted to the base station, and the initial duration of the pending timer is the same with an initial duration of the inactivity timer.

12. The method of claim 11, wherein the pending timer corresponds to a hybrid automatic repeat request HARQ process, and a condition that the first information is successfully transmitted comprises not receiving a retransmission indication within a specified duration or a HARQ process number corresponding to the pending timer is used for a new transmission.

13. The method of claim 12, further comprising:

stopping and deleting other pending timers with reset time earlier than the pending timer, when determining through the pending timer that the first information is successfully transmitted.

14. The method of claim 12, further comprising:

stopping the inactivity timer when it is determined that the first information transmission fails through a pending timer, wherein a condition that the first information transmission fails comprises receiving the retransmission indication within the specified duration or the first information, corresponding to another pending timer with a reset time later than the pending timer, having been successfully transmitted.

15. The method of claim 10, wherein the reset condition comprises receiving the second information from the UE, and the resetting the inactivity timer when the reset condition is satisfied comprises:

resetting the inactivity timer to an initial duration when the second information from the base station is received.

16. The method of any of claims 10-15, wherein the first information further comprises positive feedback information in response to a non-final retransmitted uplink data, the second information further comprises at least one of a non-final uplink data and positive feedback information in response to the non-final retransmitted downlink data.

17. The method of any of claims 10 to 15, wherein before transiting from the connected state to the inactive state when the inactivity timer expires, the method further comprises:

transmitting transition related parameters to the UE only when the transition related parameters change, wherein the transition related parameters are configured to assist the UE to transit from the connected state to the inactive state when the inactivity timer expires, and situations that the transition related parameters change comprises entering a new notification area.

18. A communication state transition method, comprising:

resetting an inactivity timer when a reset condition is satisfied; and

using transition related parameters to transit from a connected state to an inactive state when the inactivity timer expires, wherein the transition related parameters are only received when the transition related parameters change, and situations that the transition related parameters change comprises entering a new notification area.

19. A communication state transition method, comprising:

transmitting transition related parameters to a UE only when the transition related parameters change, the transition related parameters being configured to assist the UE to transit from a connected state to an inactive state when an inactivity timer expires, situation that the transition related parameters change comprising the UE entering a new notification area.

20. A communication state transition apparatus, comprising: a processor and a communication circuit, the processor coupled to the communication circuit; and the processor is configured to execute instructions to implement the method of any of claims 1-19.

21. A readable storage medium, having instructions stored therein, wherein the method of any of claims 1-19 is implemented when the instructions are executed.

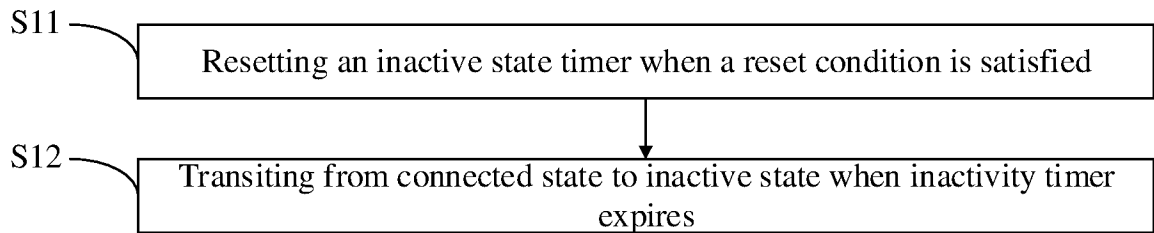


FIG. 1

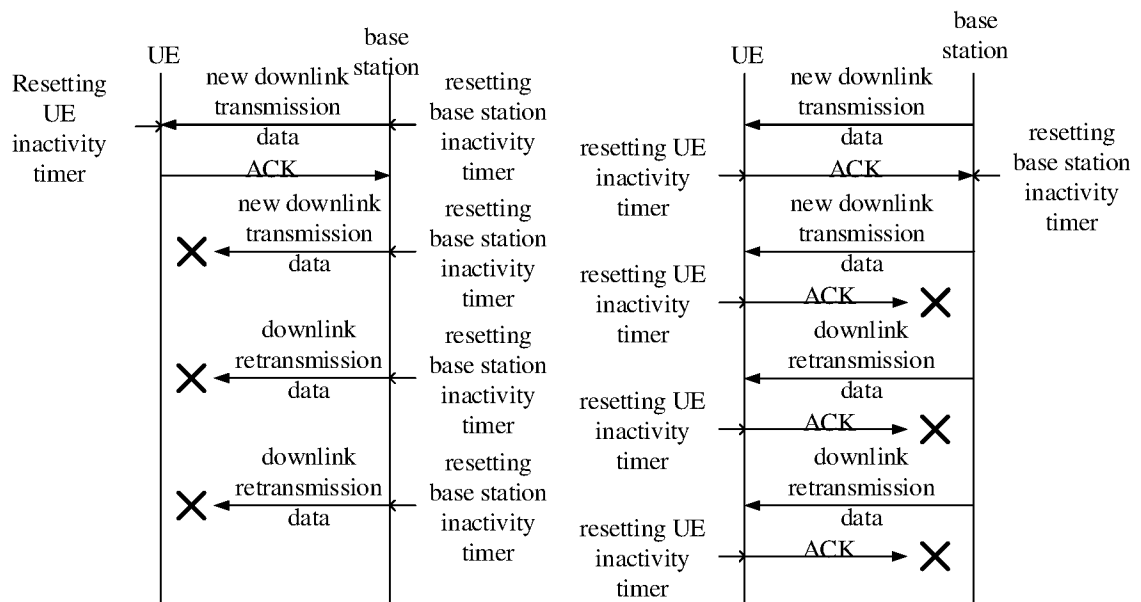


FIG. 2

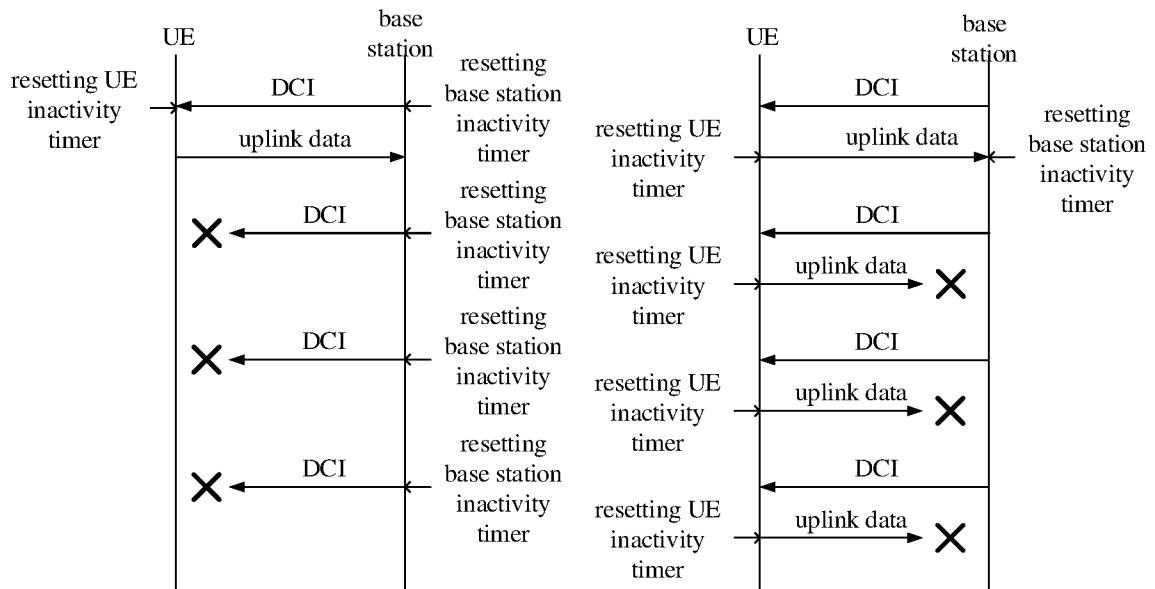


FIG. 3

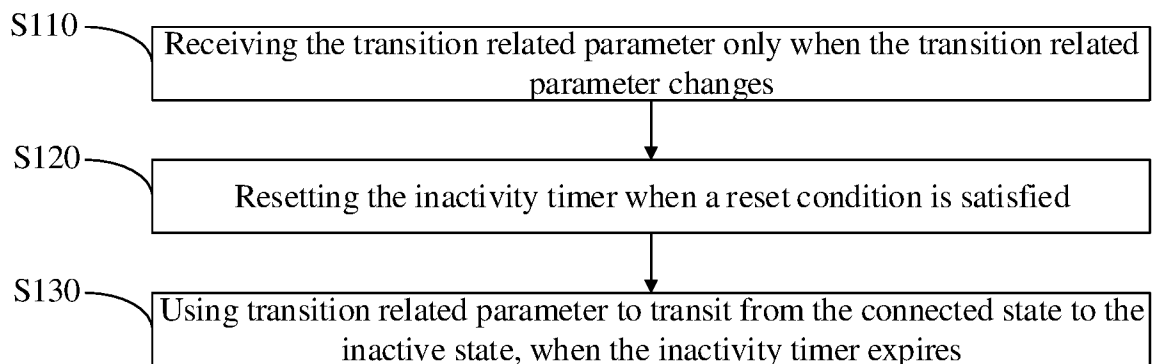


FIG. 4

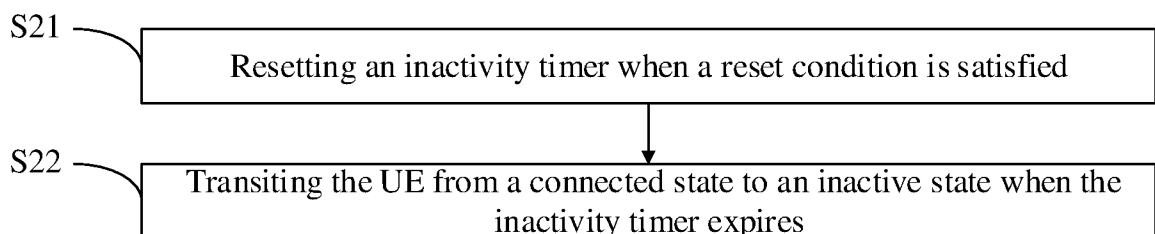


FIG. 5

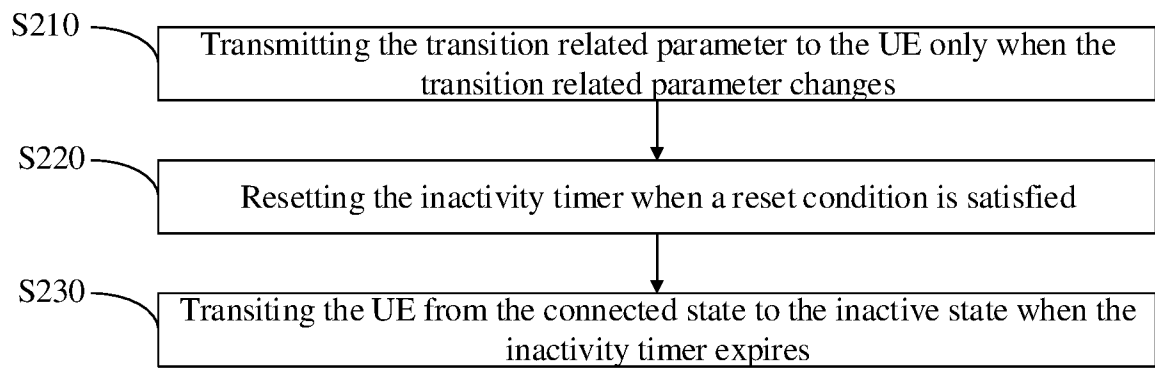


FIG. 6

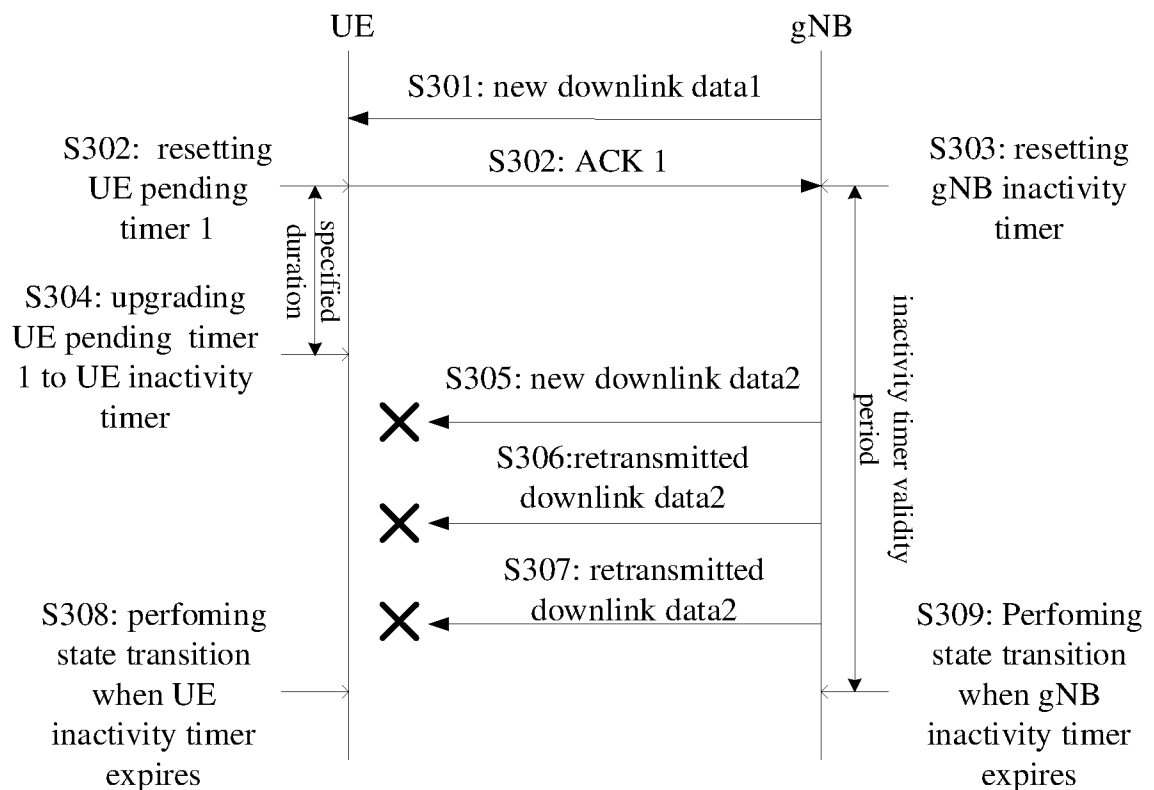


FIG. 7

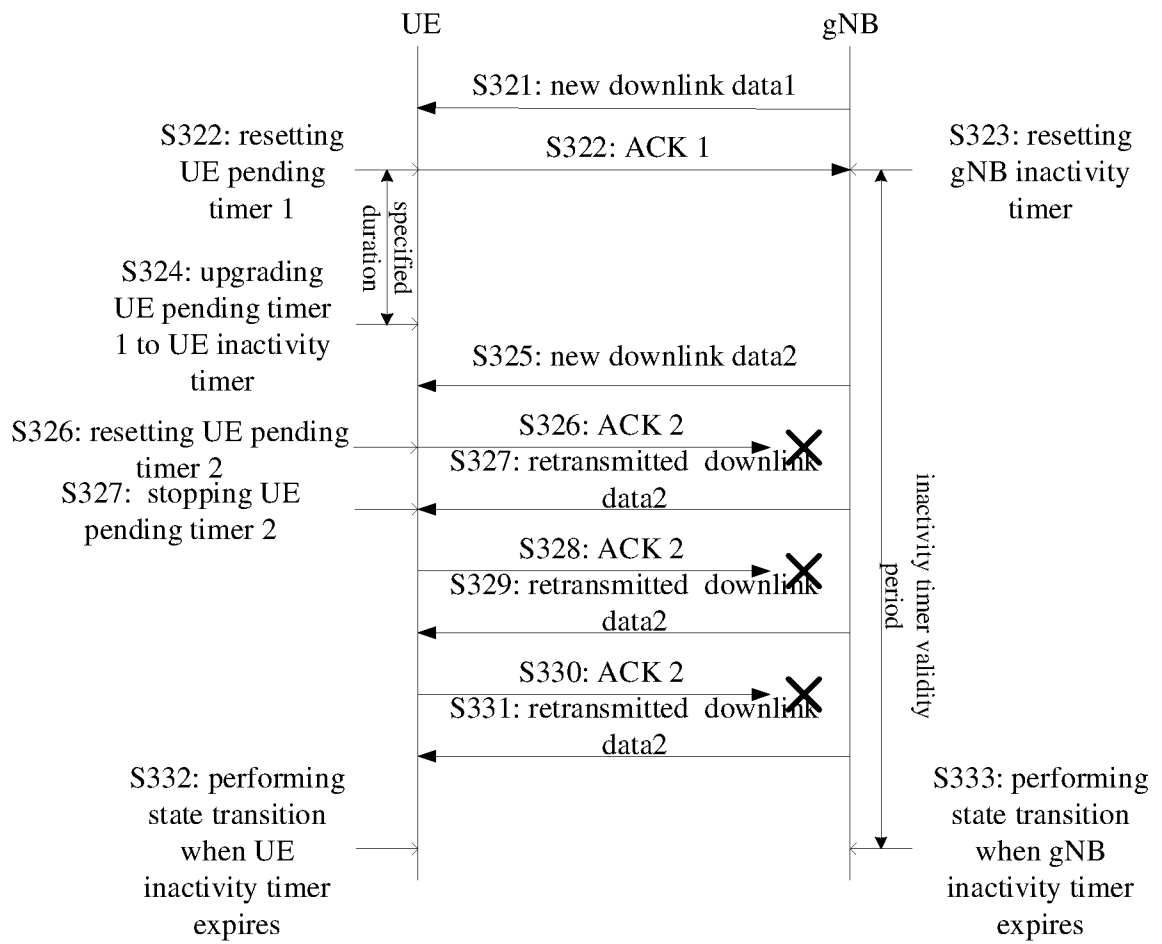


FIG. 8

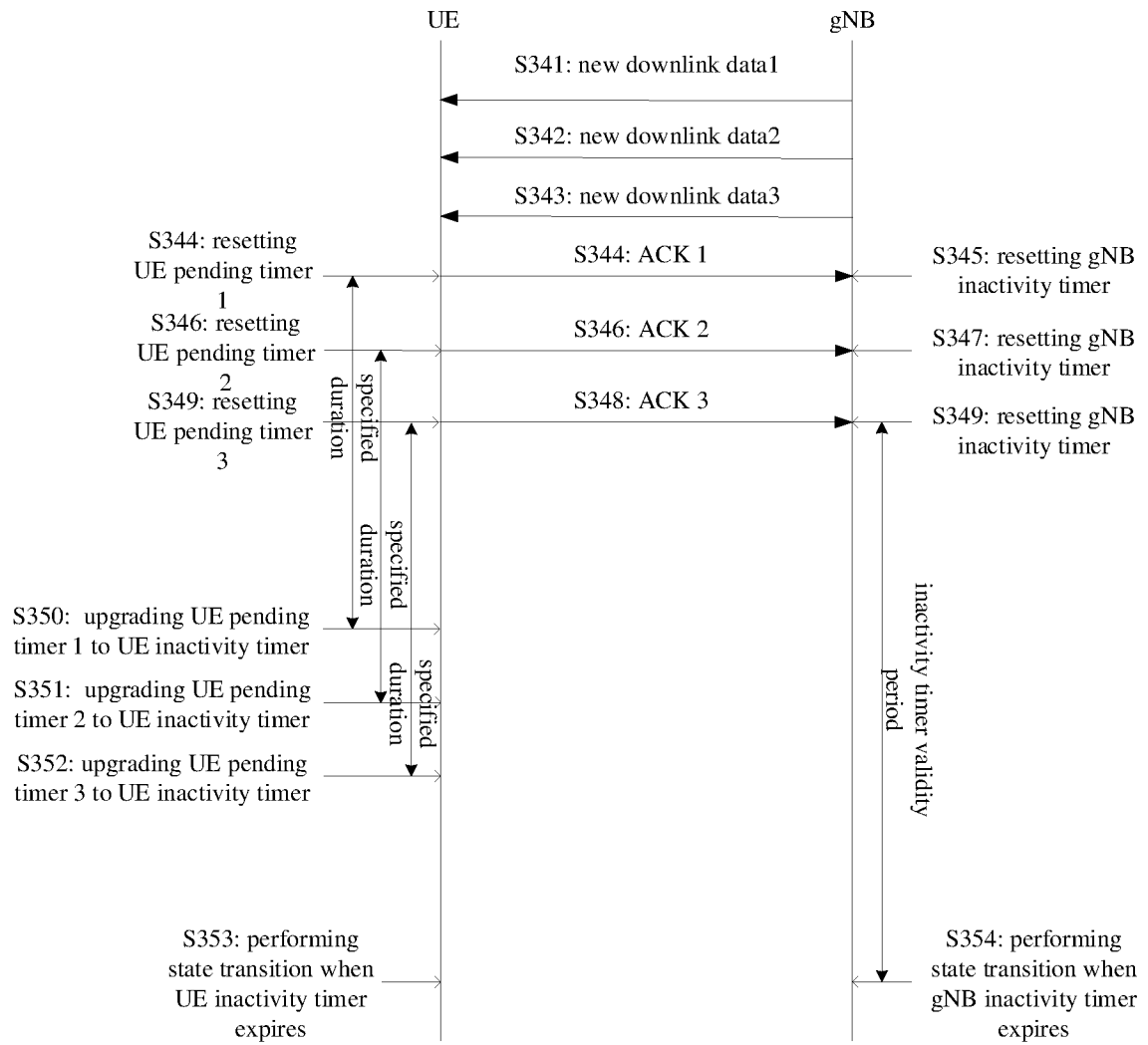


FIG. 9

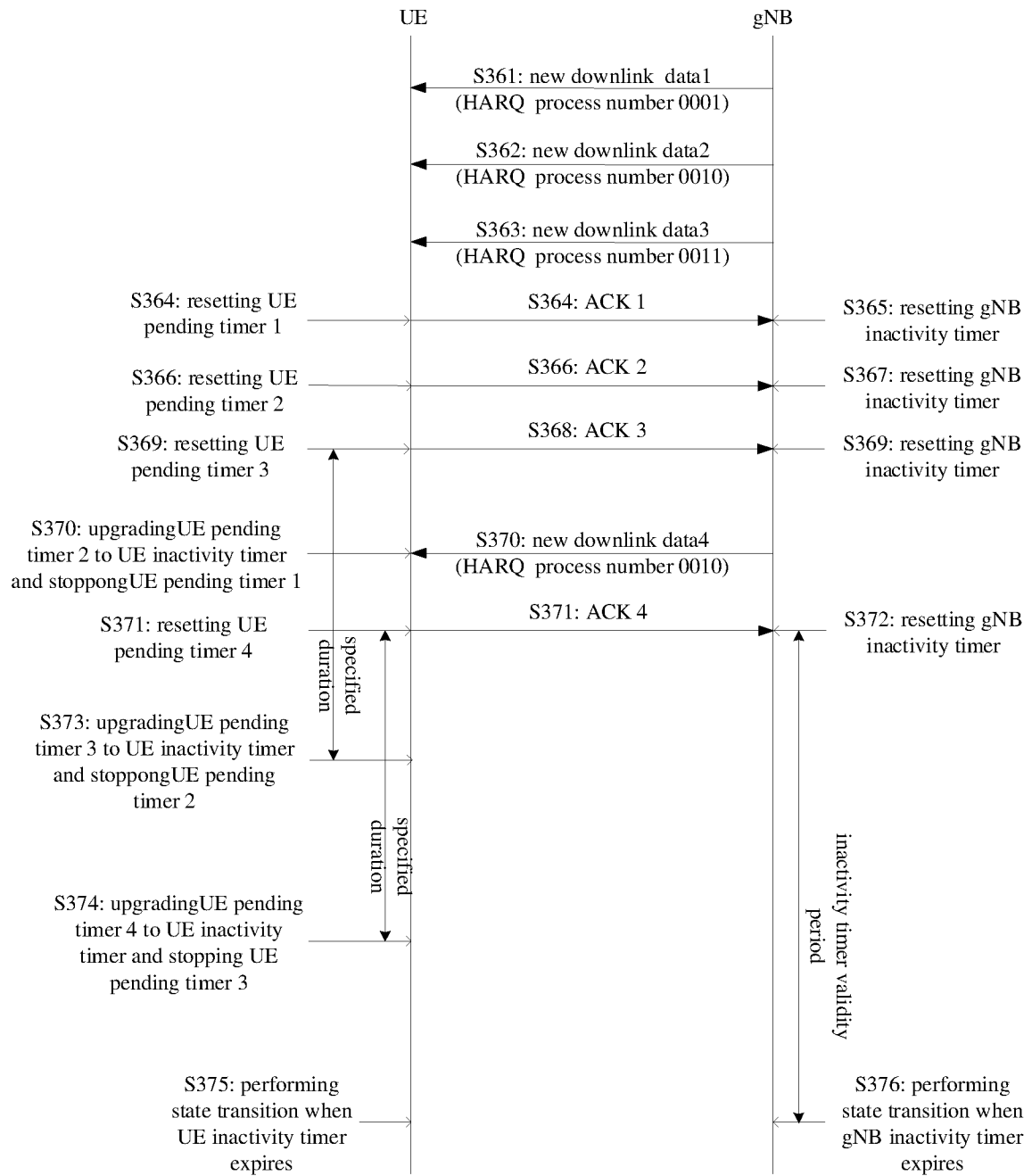


FIG. 10

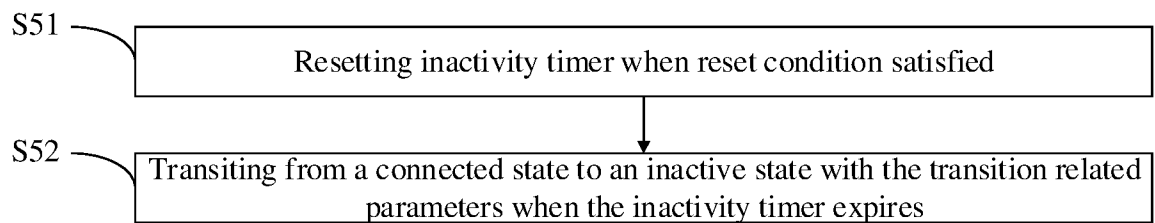


FIG. 11

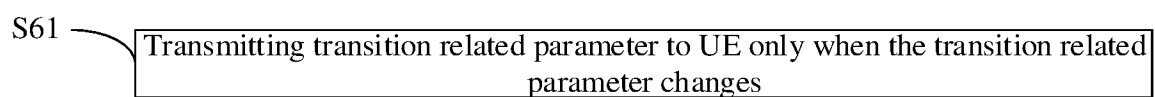


FIG. 12

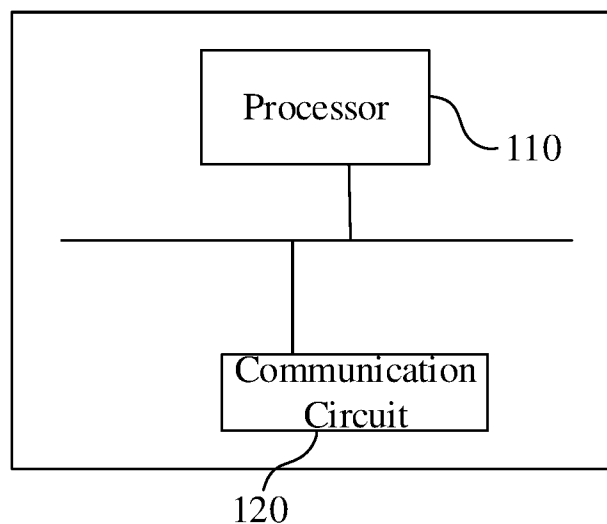


FIG. 13

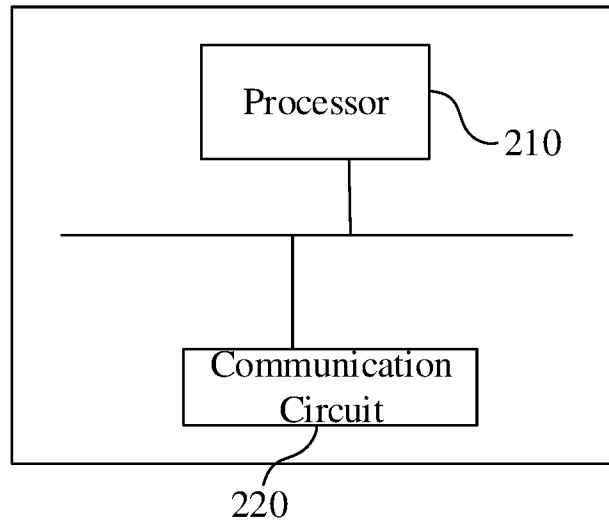


FIG. 14

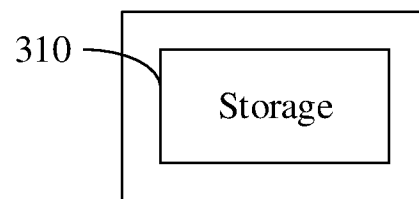


FIG. 15

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2018/116140

A. CLASSIFICATION OF SUBJECT MATTER

H04W 76/27(2018.01)i; H04L 5/00(2006.01)i; H04W 56/00(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, WPI, EPODOC, CNKI, 3GPP: timer, reset, success, ACK, NACK, feedback, response, connected, inactive, state, idle, RRC, positive, transit, parameter, synchron+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	INTEL. "Stage 3 RRC TP on RRC_INACTIVE state for E-UTRA connected to 5GC" <i>3GPP TSG-RAN2 Meeting #101bis, R2-1805051</i> , 20 April 2018 (2018-04-20), section 5.3.8	1-21
A	CN 107484260 A (WUHAN HONGXIN TELECOM TECHNOLOGIES CO., LTD.) 15 December 2017 (2017-12-15) the whole document	1-21
A	CN 107666691 A (CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY) 06 February 2018 (2018-02-06) the whole document	1-21
A	CN 107249221 A (WUHAN HONGXIN TELECOM TECHNOLOGIES CO., LTD.) 13 October 2017 (2017-10-13) the whole document	1-21
A	US 2016234877 A1 (BANGOLAE SANGEETHA L. ET AL.) 11 August 2016 (2016-08-11) the whole document	1-21

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

* Special categories of cited documents:

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

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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

29 April 2019

Date of mailing of the international search report

16 May 2019

Name and mailing address of the ISA/CN

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Facsimile No. (86-10)62019451

Telephone No. 86-(10)-53961733

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2018/116140

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	107484260	A	15 December 2017	None			
CN	107666691	A	06 February 2018	WO	2018019001	A1	01 February 2018
				KR	2019028550	A	18 March 2019
CN	107249221	A	13 October 2017	WO	2019024545	A1	07 February 2019
US	2016234877	A1	11 August 2016	KR	20170116018	A	18 October 2017
				EP	3402303	A1	14 November 2018
				JP	2018504854	A	15 February 2018
				CN	107431880	A	01 December 2017
				WO	2016130264	A1	18 August 2016
				EP	3257323	A1	20 December 2017
				HK	1247504	A0	21 September 2018