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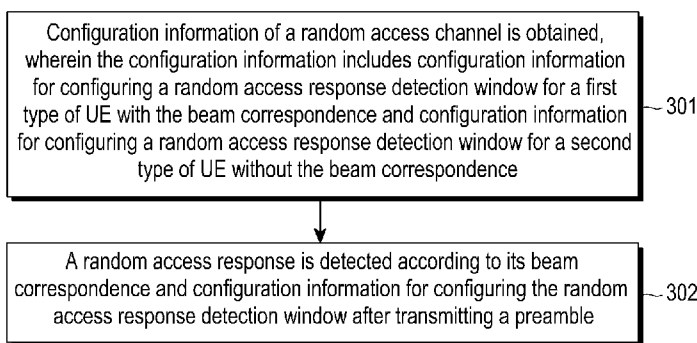
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(54) Title: METHOD, BASE STATION, AND USER EQUIPMENT FOR TRANSMITTING AND DETECTING A RANDOM ACCESS RESPONSE



(57) Abstract: The present disclosure relates to a pre-5th-Generation (5G) or 5G communication system to be provided for supporting higher data rates Beyond 4th-Generation (4G) communication system such as Long Term Evolution (LTE). The present disclosure discloses a method of transmission and detection of random access response, which comprises the following process. A UE obtains configuration information of a random access channel, which includes configuration information of a random access response detection window for a first type of UE and configuration information of a random access response detection window for a second type of UE. Wherein, the first type of UE has beam correspondence, the second type of UE does not have the beam correspondence. After transmitting a preamble, the UE detects a random access response according to its beam correspondence and the configuration of the random access response detection window. Compared with the prior art, in the present disclosure, according to different capabilities of the beam correspondence of the UE, the UE adopts different configurations of random access response detection and uses different methods for detecting the random access response, to avoid the decrease of the random access performance caused by improper resource allocations and improper detection mode configurations, and to improve the overall access performance of the communication system.



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Description

Title of Invention: METHOD, BASE STATION, AND USER EQUIPMENT FOR TRANSMITTING AND DETECTING A RANDOM ACCESS RESPONSE

Technical Field

- [1] The present disclosure relates to wireless communication technology, in particular to a method, a base station, and use equipment (UE) for transmitting and detecting a random access response.

Background Art

- [2] To meet the demand for wireless data traffic having increased since deployment of 4G (4th-Generation) communication systems, efforts have been made to develop an improved 5G (5th-Generation) or pre-5G communication system. Therefore, the 5G or pre-5G communication system is also called a 'beyond 4G network' or a 'post LTE system'.
- [3] The 5G communication system is considered to be implemented in higher frequency (mmWave) bands, e.g., 60GHz bands, so as to accomplish higher data rates. To decrease propagation loss of the radio waves and increase the transmission distance, the beamforming, massive multiple-inputmultiple-output (MIMO), fulldimensional MIMO (FD-MIMO), array antenna, an analog beam forming, large scale antenna techniques are discussed in 5G communication systems.
- [4] In addition, in 5G communication systems, development for system network improvement is under way based on advanced small cells, cloud radio access networks (RANs), ultra-dense networks, device-to-device (D2D) communication, wireless backhaul, moving network, cooperative communication, coordinated multi-points (CoMP), reception-end interference cancellation and the like.
- [5] In the 5G system, hybrid FSK and QAM modulation (FQAM) and sliding window superpositioncoding (SWSC) as an advanced coding modulation (ACM), and filter bank multicarrier (FBMC), non-orthogonal multipleaccess (NOMA), and sparse code multipleaccess (SCMA) as an advanced access technology have been developed.
- [6] Random Access (RA) process is an important step for establishing a communication link between the user side and the network side in a wireless communication system. RA is used to establish uplink synchronization between a UE and a base station, and is also used by the base station to assign an identification (ID) for the UE.
- [7] The performance of a random access directly affects the user's experience. In conventional wireless communication systems, suchas LTE and LTE-Advanced, the random access procedure is applied to a plurality of scenes suchas establishing an

initial link, a cell handover, re-establishing an uplink, re-establishing an RRC connection, and the like. And according to whether the user monopolizes the preamble resources, the random accesses are typified into Contention-based Random Access and Contention-free Random Access. As for the Contention-based Random Access, in the process of each user's attempting to establish the uplink, if a preamble is selected from the same preamble resources, there may be multiple users selecting the same preamble to transmit to the base station, so the conflict resolution mechanism is an important research direction in random access. How to reduce the probability of conflict and how to quickly resolve the conflicts occurred, are the key indicators to effect random access performance.

Disclosure of Invention

Technical Problem

[8] Contention-based random access process in LTE-A is divided into four steps, as shown in Figure 1. In the first step (101), a preamble is selected from the preamble resource pool by the user randomly and transmitted to a base station. The base station performs the correlation detecting for the receiving signals to identify the preamble transmitted by the user. In the second step (102), the base station transmits a random access response (RAR) to the user, which contains a random access preamble identifier, a timing advance instruction determined according to the time delay between the user and the base station, Cell-Radio Network Temporary Identifier (C-RNTI), and the time-frequency resources assigned for the next uplink transmission of the user. In the third step (103), a third message (Msg3) is transmitted by the user to the base station according to the information in the RAR. Msg3 contains information such as a user terminal identifier and a RRC link request, wherein, the user terminal identifier is unique to the user to resolve the conflict. In the fourth step (104), the base station transmits a collision resolution identifier to the user, which includes the user terminal identifier of the user who wins in the conflict. After the user terminal identifier is detected out by the user, the temporary C-RNTI is upgraded to a C-RNTI and an ACK signal is transmitted to the base station by the user to complete the random access procedure, and then the user waits for the scheduling of the base station. Otherwise, the user will start a new random access process after a delay.

[9] For a contention-free based random access procedure, a preamble may be assigned for the user because the base station has known the user identifier. So the user does not need to select the sequence randomly when transmitting the preamble, but uses the assigned preamble. After detecting the assigned preamble, the base station transmits a corresponding random access response, including timing advance and uplink resource assignment and so on. After receiving the random access response, the user considers

that the uplink synchronization has been completed and waits for further scheduling of the base station. Thus, the contention-free random access procedure consists of only two steps: the first step is to transmit a preamble; the second step is the transmission of the random access response.

[10] In LTE, the length of a detection window for detecting a random access response is configured by the high layer signaling, starting at the subframe that contains the end of a preamble transmission plus three subframes, the RA-RNTI corresponding to the time-frequency resources used for transmitting the preamble is used to monitor the physical downlink control channel in the random access response detection window configured by the high layer signaling.

[11] Figure 2 shows the monitoring pattern of a random access response in LTE. The physical downlink control channel is monitored in the random access response detection window configured by the high layer signaling, starting from the third subframe (202) after the subframe for completing the transmission of the preamble (201). Figure 2 shows a case that the length of a random access response detection window (203) is configured as three subframes.

[12] In the 5G, because a multi-beam operation is adopted by the high frequency section, and it is needed to distinguish between the terminal with the beam correspondence and the terminal without the beam correspondence in the network, so the detection mode of a random access response also is need to adjust according to the requirement to adapt the terminals with different abilities.

[13] The purpose of the present disclosure is relates to overcome the defects of the prior art, and to provide a method for detecting and transmitting a random access response, in order to support the terminal with beam correspondence and the terminal without beam correspondence at the same time in the cell.

Solution to Problem

[14] In order to achieve the purpose, the present disclosure provides a method for detecting a random access response, which includes the following steps:

[15] obtaining, configuration information of a random access channel; wherein the configuration information comprises configuration first information for configuring about a random access response detection window for a first type of UE and configuration second information for configuring about a random access response detection window for a second type of UE; wherein the first type of UE has beam correspondence, and the second type of UE does not have the beam correspondence;

[16] detecting the random access response according to its beam correspondence and configuration of a random access response detection window corresponding to its beam correspondence after transmitting a preamble.

- [17] Preferably, the configuration information for configuring about the random access response detection window for the first type of UE with the beam correspondence comprises: at least one of information of the length of the random access response detection window, and/or information of the start position of the random access response detection window;
- [18] the configuration information for configuring about the random access response detection window for the second type of UE without the beam correspondence comprises: at least one of information of the length of the random access response detection window, and/or information of the start position of the random access response detection window.
- [19] Preferably, the configuration information for configuring about the random access response detection window for the second type of UE comprises:
- [20] information of the start position and information of the length of each random access response detection window corresponding to each random access channel resource in a random access channel resource set.
- [21] Preferably, the information of the start position of the random access response detection window comprises: information of the start position of a random access response detection window corresponding to the first random access channel resource in the random access channel resource set and gap between two adjacent random access response detection windows.
- [22] Preferably, detecting the random access response according to its beam correspondence and the configuration of the random access response detection window comprises:
- [23] detecting, by the UE having the beam correspondence, the random access response according to the configuration of the random access response detection window of the first type of UE after transmitting the preamble; or
- [24] detecting, by the UE without the beam correspondence, the random access response according to the configuration of the random access response detection window of the second type of UE after the last random access channel resource in the random access channel resource set;
- [25] wherein, the random access channel resource set comprises one or more random access channel resources.
- [26] Preferably, when the UE transmitting the preamble does not have the beam correspondence, the method for detecting the random access response comprises:
- [27] determining, by the UE, a random access response detection window according to the configuration of the random access response detection window after every random access channel resource in the random access channel resource set; and
- [28] detecting and receiving the random access response according to the random access

response-radio network temporary identification (RA-RNTI) corresponding to the one or more random access channel resources used for transmitting the preamble.

- [29] Preferably, detecting and receiving the random access response according to the RA-RNTI corresponding to the one or more random access channel resources used for transmitting the preamble comprises:
- [30] terminating detecting and receiving the random access response, when the random access response is detected and received successfully according to the RA-RNTI corresponding to a random access channel resource in the random access channel resources used for transmitting the preamble.
- [31] Preferably, the random access response is detected and received successfully when a downlink control channel is detected and decoded successfully according to the RA-RNTI, the downlink resource assignment indicated by the downlink control channel is decoded successfully, and a preamble identifier matched with the transmitted preamble is detected in the random access response carried in time-frequency resource indicated by the downlink resource assignment in the downlink control channel.
- [32] Preferably, detecting and receiving the random access response according to the RA-RNTI corresponding to the one or more random access channel resources used for transmitting the preamble comprises:
- [33] detecting and receiving the random access response according to the RA-RNTI corresponding to all the random access channel resources used for transmitting the preamble.
- [34] Preferably, the method for detecting the random access response by the second type of UE comprises:
- [35] detecting and receiving the random access response in the random access response detection window corresponding to each random access channel resource used for transmitting the preamble according to the RA-RNTI responding to the random access channel resource, after every random access channel resource in the random access channel resource set..
- [36] Preferably, the method for detecting the random access response by the second type of UE comprises:
- [37] terminating detecting and receiving the random access response, when the random access response is detected and received successfully in a random access response detection window corresponding to a random access channel resource in the random access channel resources used for transmitting the preamble according to the RA-RNTI corresponding to the random access channel resource.
- [38] Preferably, the method for detecting the random access response by the second type of UE comprises:
- [39] detecting in a random access response detection window corresponding to a random

access channel resource in the random access channel resource set used for transmitting the preamble according to the RA-RNTI of the random access channel resource.

[40] Preferably, the method for detecting the random access response by the second type of UE comprises:

[41] determining the procedure of receiving the random access response fails, when no random access response is successfully received in any random access response detection window corresponding to all the random access channels in the random access channel resource set used for transmitting the preamble according to the RA-RNTIs of the random access channels.

[42] Preferably, the method for detecting the random access response by the second type of UE comprises:

[43] detecting, by the second type of UE, the random access response; and

[44] if a plurality of random access responses are detected in the corresponding random access response detection windows, determining the message 3 priorities of the multiple random access responses according to received energy indexes in the plurality of random access responses.

[45] Preferably, the method for detecting the random access response by the second type of UE comprises:

[46] detecting, by the second type of UE, the random access response; and

[47] if multiple timing advances and uplink grant are detected in the random access response, determining the message 3 priorities of the plurality of timing advances and uplink grant according to the received power indexes in the random access response.

[48] In order to achieve the purpose, the present disclosure provides a method for transmitting a random access response, which includes the following steps:

[49] transmitting configuration information of a random access channel; wherein the configuration information comprises configuration information for configuring a random access response detection window for a first type of UE and configuration information for configuring a random access response detection window for a second type of UE; wherein the first type UE has beam correspondence, and the second type UE does not have the beam correspondence;

[50] transmitting a random access response according to random access channel resources, a preamble detected and configuration of the random access response detection window, after detecting the transmission of the preamble.

[51] Preferably, the configuration information for configuring the random access response detection window for the first type of UE comprises: information of the length of the random access response detection window, and/or information of the start position of the random access response detection window; and

[52] the configuration information for configuring the random access response detection

window for the second type of UE comprises: information of the length of the random access response detection window, and / or information of the start position of the random access response detection window.

[53] Preferably, the configuration information for configuring the random access response detection window for the second type of UE comprises:

[54] information of the start position and information of the length of each random access response detection window corresponding to each random access channel resource in the random access channel resource set.

[55] Preferably, the information of the start position of the random access response detection window comprises: information of the start position of a random access response detection window corresponding to the first random access channel resource in the random access channel resource set and gap between two adjacent random access response detection windows.

[56] Preferably, transmitting the random access response according to random access channel resources, the detected preamble and the configuration of the random access response detection window comprises:

[57] determining the capability of the beam correspondence of a transmitting UE based on the detected time-frequency resource for transmitting the preamble and/or the detected preamble; and

[58] transmitting the random access response according to the configuration of the corresponding random access response detection window.

[59] Preferably, transmitting the random access response comprises:

[60] transmitting the random access response in the random access response detection window after detecting the preamble if a preamble is detected on a first type of random access channel resources which are used for the first type UE to transmit the preamble;

[61] transmitting the random access response in the random access response detection window after the random access channel resource set if the transmission of the preamble is detected on a second type of random access channel resources which are used for the second type UE to transmit the preamble.

[62] Preferably, transmitting the random access response comprises:

[63] transmitting the random access response in the random access response detection window after the preamble is detected, if the transmission of the preamble for the first type UE is detected; and

[64] transmitting the random access response in the random access response detection window after the random access channel resource set if the transmission of the preamble for the second type UE is detected.

[65] Preferably, transmitting the random access response comprises: selecting a random access channel resource with the strongest correlation detection and transmitting the

random access response in a random access response detection window corresponding to the random access channel resource, if a preamble is detected on the second type of random access channel resources used for the second type of UE to transmit the preamble, or if the transmission of the preamble for the second type UE is detected, or if a same preamble is detected on a plurality of random access channel resources in the same random access channel resource set.

[66] Preferably, transmitting the random access response comprises: sorting and numbering the random access channel resources in which same preambles are detected according to energies of correlation detection, and transmitting corresponding index information in the corresponding random access response, if a preamble is detected on the second type of random access channel resources used for the second type of UE to transmit the preamble, or if the transmission of the preamble for the second type UE is detected, or if a same preamble is detected on a plurality of random access channel resources in the same random access channel resource set.

[67] Preferably, transmitting the random access response comprises: selecting a random access channel resource with the strongest correlation detection and transmitting the random access response in a random access response detection window corresponding to the random access response if the transmission of the same preamble is detected in different directions of the receiving beam on a same random access channel resource. .

[68] Preferably, transmitting the random access response comprises: sorting and numbering the random access channel resources in which same preambles are detected according to energies of correlation detection, and transmitting corresponding index information in the corresponding random access response if the transmission of the same preamble is detected in different directions of the receiving beam on a same random access channel resource.

[69] In order to achieve the purpose, the present disclosure provides a device for detecting random access response, which includes the following processing modules:

[70] a random access channel configuration information acquisition module is to obtain configuration information of a random access channel; wherein, the configuration information of the random access channel comprises configuration information for configuring a random access response detection window for a first type of UE and configuration information for configuring a random access response detection window for a second type of UE; wherein, the first type of UE has beam correspondence, and the second type of UE does not have the beam correspondence;. and

[71] a random access response detecting module is to detect a random access response according to its beam correspondence and configuration of the random access response detection window after transmitting a preamble.

[72] In order to achieve the purpose, the present disclosure provides a device for

transmitting random access response, which includes the following processing modules:

- [73] a random access channel configuration information transmitting module is to transmit configuration information of a random access channel, wherein the configuration information of the random access channel comprises configuration information for configuring a random access response detection window for a first type of UE and configuration information for configuring a random access response detection window for a second type of UE;
- [74] a random access response transmitting module is to transmit a random access response according to the random access channel resources, a preamble detected and configuration of the random access response detection window, after detecting the transmission of the preamble.
- [75] Compared with the prior art, the present disclosure has the technical effects including butnot limited to: supporting the terminal with the beam correspondence and the terminal without the beam correspondence to detect the random access response at the same time, the waste of resources caused by traditional way and mismatching of transmitting / detecting means is avoided, and the runningefficiency of the whole system is improved.

Brief Description of Drawings

- [76] To describe the technical solutions in the embodiments of the present disclosure more clearly, the following the accompanying drawings required for describing the embodiments is introduced briefly. Apparently, the accompanying drawings in the following description show merely some embodiments of the present disclosure, and those skilled in the art may still derive other drawings from these accompanying drawings without creative efforts.
- [77] Figure 1 is a schematic diagram illustrating a flow of traditional contention-based random access;
- [78] Figure 2 is a schematic diagram illustrating the monitoring way of a random access response in the LTE;
- [79] Figure 3 is a flow chart of a method for detecting a random access response of the present disclosure;
- [80] Figure 4 is a flow chart of a method for transmitting a random access response of the present disclosure;
- [81] Figure 5 is the division way of random access channel resources according to embodiment one of the present disclosure;
- [82] Figure 6 is a schematic diagram illustrating transmitting of a random access response of the two configuration ways;

- [83] Figure 7 is a diagram illustrating the way of transmitting multiple TAs in a single random access response detection window;
- [84] Figure 8 is a diagram illustrating the assignment of the random access channel resources;
- [85] Figure 9 is a schematic diagram illustrating the random access response detection window;
- [86] Figure 10 is an example of the random access response;
- [87] Figure 11 is a schematic diagram illustrating the structure of the random access response detection window according to the embodiment two of the present disclosure.;
- [88] Figure 12A is a schematic diagram illustrating the structure of a device for detecting a random access response;
- [89] Figure 12B is another schematic diagram illustrating the structure of a device for detecting a random access response;
- [90] Figure 13A is a schematic diagram illustrating the structure of a device for transmitting a random access response.;
- [91] Figure 13B is another schematic diagram illustrating the structure of a device for transmitting a random access response.

Mode for the Invention

- [92] In order to provide a better understanding of the technical scheme in the detailed description of the present disclosure for those skilled in the art, the technical solution in the embodiments of the present disclosure will be described clearly and completely in connection with the drawings in the embodiments of the present disclosure.
- [93] some of the processes described in the specification, claims and drawings, contain a number of operations that present in a particular order, but it should be clearly understood that these operations may not be carried out in accordance with the order to perform or to perform in parallel, the serial number of the operation such as 101, 102, etc., is only used to distinguish between different operations, the serial number itself does not represent any execution order. In addition, these processes may include more or less operations, and these operations may be performed sequentially or in parallel. It should be noted that the description of "first" and "second" in this application is used to distinguish between different messages, devices, modules, etc., and does not represent the order of precedence, nor the "first" and "second" is different types.
- [94] The technical solution in the embodiments of the detailed description will be described clearly and completely in connection with the drawings in the embodiments of the present disclosure, obviously, the described embodiments are only part of the detailed description, not all the embodiments. Based on the embodiments in the

detailed description, all the other embodiments obtained by those skilled in the art without making creative work are within the protected scope of the detail description.

[95] A method and user equipment of selecting a random access channel of the present detailed description can be applied to a random access procedure of the FDD mode or the TDD mode wireless communication system, comprising a contention-based random access procedure and a contention-free random access procedure. Meanwhile, the method and the user equipment of selecting a random access channel of the present detailed description are suitable for an operation scene of high frequency band multi-beam in the 5G technology.

[96] Referring to Figure 3, the method for detecting a random access response of the present detailed description comprises the following steps:

[97] In Step 1301, configuration information of a random access channel is obtained, wherein the configuration information includes configuration information for configuring a random access response detection window for a first type of UE with the beam correspondence and configuration information for configuring a random access response detection window for a second type of UE without the beam correspondence.

[98] Step 1302, a random access response is detected according to its beam correspondence and configuration information for configuring the random access response detection window after transmitting a preamble.

[99] Referring to Figure 4, the method for transmitting random access response of the present embodiment comprises the following steps:

[100] Step 2401: configuration information of a random access channel is transmitted, wherein the configuration information comprises configuration information for configuring a random access response detection window for a first type of UE with the beam correspondence and configuration information for configuring a random access response detection window for a second type of UE without the beam correspondence.

[101] Step 2402: a random access response is transmitted according to random access channel resources, a preamble detected and configuration of the random access response detection window, after detecting the transmission of the preamble.

[102] Embodiment 1

[103] In the present embodiment, a method for detecting a random access response will be described in connection with a specific system. It is assumed that a system simultaneously supports a terminal with the beam correspondence and a terminal without the beam correspondence to perform a random access procedure. Specifically, the system divides available random access channel resources into a first type of random access channel resources and a second type of random access channel resources. The first type of random access channel resources are used for the terminal with the beam correspondence to perform the random access procedure, and the second type of random

access channel resource is used for the terminal without the beam correspondence to perform the random access procedure.

[104] In the present embodiment, the first type of random access channel resources and the second type of random access channel resources adopt different time-frequency resource positions, and the base station may determine whether or not the terminal has the beam correspondence based on the random access resources, so the terminals with the beam correspondence and the terminals without the beam correspondence may use the same or different preamble resource pools. For example, a terminal with the beam correspondence and a terminal without the beam correspondence uses two completely different (i.e., not overlapping) preamble resource pools, or uses two preamble resource pools which are not exactly the same (i.e., partial preambles are coincident), or uses the same two preamble resource pools. Figure 5 shows a division way of the random access channel resources in the present embodiment.

[105] The base station informs the terminal configuration information of the random access resources by a main information block carried by a broadcast channel or information of system carried on the system information block indicated by the main information block. In a scheme provided by the present embodiment, configuration information of the random access resources includes resource configuration of the first type of random access random access channel resources, which includes time-frequency resource position of the random access channel resource used by the terminal with the beam correspondence, information of a preamble resource pool (range of a preamble index that can be used by the terminal with the beam correspondence) used by the terminal with the beam correspondence, and information needed when the terminal with the beam correspondence detects a random access response, which includes length of a random access response detection window, and the sequence of detecting a random access response.

[106] The configuration information of the random access resources also includes resource configuration of the second type of random access random access channel resources, which includes time-frequency resource position of the random access channel resource used by the terminal without the beam correspondence, information of a preamble resource pool used by the terminal without beam correspondence (range of a preamble index that can be used by the terminal without the beam correspondence), and information needed when the terminal without the beam correspondence detects a random access response, which includes length of a random access response detection window, and the sequence of detecting a random access response.

[107] It is only necessary to inform information (i.e., index range of a preamble) of the preamble resource pool if the terminal with the beam correspondence and the terminal without the beam correspondence adopt the same preamble resource pool.

- [108] The base station detects a preamble on an assigned random access channel. If transmission of the preamble is detected, the random access response is transmitted according to the following sequence:
- [109] If the transmission of the preamble is detected on the first type of random access channel, the random access response is transmitted at the last subframe assigned to the first type of random access channel subframe plus k_1 subframes and the corresponding control channel is scrambled with RA-RNTI.
- [110] If the transmission of the preamble is detected on a second type of random access channel and the base station assigns multiple random access channels (for a terminal without the beam correspondence attempting to use transmitting beams of multiple directions to try transmission of the preamble), the random access response is transmitted at the last subframe assigned to the last random access channel plus $k_2 + i$ subframes, and the random access response is scrambled with RA-RNTI in the corresponding downlink control channel.
- [111] In the configuration information above, the parameters k_1 and k_2 being the same or different are informed to the terminal by configuration information of the random access channel. The parameter i is an optional parameter, if the parameter i is set to be 0, random access responses of all random access channels are transmitted on the same subframe; in another configuration mode, the parameter i may be related to the index of the random access channel, that is different random access channels correspond to different random access response detection windows. The two transmission modes of the random access response for the terminal without the beam correspondence can be described by Figure 6.
- [112] Figure 6 is for a case that a terminal without the beam correspondence may be configured with multiple random access channels by the base station, on which the terminal transmits a preamble by the way of transmitting beam handover. In this case, the base station may detect the same preamble on multiple random access channels. Now, the resources of the random access response can be configured in two modes as shown in Figure 6:
- [113] - Mode 1: i is set to be 0. The RA-RNTI corresponding to the multiple random access channels instructs different downlink shared channels to transmit different random access responses on the same downlink control channel. In this case, the base station may select a random access channel with the strongest receiving energy from the random access channels detecting the same preamble, calculate the corresponding timing advance, and use the RA-RNTI corresponding to the random access channel to instruct the downlink share channel to transmit a random access response; or the base station may calculate all the random access channels detecting the preamble, calculate the corresponding timing advance, and use the RA-RNTI corresponding the random

access channel to instruct different downlink share channels to transmit a random access response on the same downlink control channel.

[114] - Mode 2: i is not set to be 0. The RA-RNTI corresponding to the multiplerandom access channels instructs different downlink shared channels to transmit different random access responses on different downlink control channels. A simple example, for the N^{th} random access channel, the random access response corresponding to the random access channel is transmitted at the last subframe assigned to the last random access channel plus $k_2 + M_n$ subframes, that is $i=M_n$, wherein, M is a positive integer and configured by the base station through configuration information of the random access channel. In this way, positions of random access responses corresponding to different random access channels are different. If the base station detects that multiplerandom access channels transmit the same preamble, the base station selects a random access channel with the strongest receiving energy, transmits a random access response in the random access response transmitting time corresponding to the random access channel; or the base station transmits the corresponding random access response on the random access response transmitting time corresponding to all the detected random access channels.

[115] It should be noted that detecting a preamble described above is to be understood that the correlation detecting result of the preamble is greater than a predetermined threshold. And the information such as timing advance may be calculated by the correlation detecting result.

[116] It should also be noted that, for the case that the base station does not have the beam correspondence, the base station needs to be configured the same preamble to perform repeated transmissions in order to detect the preambles by the way of receiving beam scan in the base station. In this case, the base station may detect the same preamble on multiplereceiving beams on the same random access channel. For the transmission configuration mode 1 of the random access response, the base station may process the random access response as follows:

[117] - if the base station detects the same preamble on the plurality of receiving beams, the base station selects the receiving beam direction with the strongest receiving energy, calculates the corresponding timing advance, generates a random access response, and uses the RA-RNTI generated by the time-frequency resource corresponding to the random access channel to instruct the corresponding physical downlink shared channel to transmit the random access response;

[118] - if the base station detects the same preamble in a plurality of beam directions, the base station calculates the timing advance required to receive the beam direction of the preamble, uses the RA-RNTI generated by the time-frequency resource corresponding to the random access channel to instruct the corresponding physical downlink shared

channel to transmit the random access response, wherein, the random access response contains multipletiming advances. The mode above can be described by Figure 7.

[119] In Figure 7, each dashed frame corresponds to a receiving beam direction of the base station, and the base station receives the same preamble in multiplereceiving beam directions, and the base station uses the RA-RNTI generated by the random access channel resource in the detection window corresponding to the random access channel resource to scramble a control channel, and transmits the random access response in the downlink share channel instructed by the control channel. The random access response carries multipledetected timing advances, and the resource assignment information transmitted by the corresponding message 3.

[120] Whether or not the base station side has the beam correspondence and whether or not the terminal side has the beam correspondence is not contradictory, and the process above may be used in combination.

[121] The operation on the base station side may affect the detection of a random access response on the terminal side. Before attempting a process of random access, the terminal reads configuration information of the random access channel from the broadcast channel in the sync signal block, and acquires the random access channel resources assigned to the terminal with beam correspondence and the terminal without beam correspondence, and the corresponding configuration information for configuring a random access response detection window. The configuration information includes information such as the start position indication k_1 and k_2 of the random access response detection window, length of the random access response detection window, and the like.

[122] For a terminal with the beam correspondence, after transmitting a preamble, the terminal may use the RA-RNTI corresponding to time-frequency resources of the random access channel used for transmitting the preamble to monitor the downlink control channel in a random access response detection window. The start position of the random access response detection window is the subframe (time slot) that contains the end of the preamble transmission plus k_1 subframes (time slots), the length of window is N_1 subframes (time slots), and the base station configures and informs the terminal by configuration information of the random access channel. For a terminal with the beam correspondence, the downlink control channel is monitored only by one RA-RNTI (determined by the random access channel time-frequency resource transmitting the preamble). If the control information scrambled by the corresponding RA-RNTI is detected in the downlink control channel, the random access response is read on the downlink shared channel indicated by the control channel.

[123] For a terminal without the beam correspondence, the base station configures a plurality of random access channels so that the terminal without the beam corre-

spondence transmits the same or different preambles by the way of beam handover/scan. If the base station adopts the configuration mode 1, after the assigned multiplexed random access channels transmitting a preamble, the terminal may use multiple RA-RNTIs to monitor the downlink control channel in a random access response detection window. As for the configuration mode 1, the start position of the random access response detection window is the last subframe(time slot) of the last random access channel plus k_2 subframes (time slots), length of the window is N_2 subframes (time slots), which is configured and informed to the terminal through configuration information of the random access channel by the base station. In this mode, the terminal needs to use multiple RA-RNTIs simultaneously to monitor the downlink control channel, the multiple RA-RNTIs are determined by the random access channel for transmitting the preamble. If the terminal successfully decodes in the random access response detection window by one or more RA-RNTIs, the downlink resource assignment assigned by the corresponding control channel is continued. If a preamble identifier used for transmission is detected on the downlink resource assignment corresponding to the one or more RA-RNTIs, detecting of the random access response is successful.

[124] If the base station adopts the configuration mode 2 and the base station assigns N random access channels, the terminal monitors the N random access response detection windows, and the starting position of the random access response detection window of the n^{th} random access channel is the last subframe(slot) of the last random access channel plus $K_2 + i_n$ subframes, wherein, i_n is a parameter related to the random access channel index n , for example, $i_n = Mn$. The random access response detection windows corresponding to the respective random access channel do not overlap each other. The terminal uses the corresponding RA-RNTI within the random access response detection window corresponding to each random access channel to monitor the downlink control channel. If the decoding is successful, the corresponding downlink resource assignment information is read and the preamble identifier contained therein is detected. If it is detected that one or more preamble identifiers match with the transmitted preamble, then detecting of the random access response is successful.

[125] It should be noted that the method provided in the present embodiment is also applicable to the case that only one type of terminals exists in the system or the base station is configured with the random access channel resources suitable for one type of terminals only. For example, if the system only supports a terminal without the beam correspondence, the base station only assigns and informs the random access channel resources and configuration information of the corresponding random access response detection for the terminal without the beam correspondence. Terminals in the cell are processed according to the mode of the random access preamble transmission and the

random access response detecting of the terminal without the beam correspondence. In addition, the way provided by the present embodiment is applicable to a Contention-based or Contention-free random access procedure. For a Contention-free random access procedure, the base station may configure a plurality of random access channel resources referring to the processing way for the terminal without the beam correspondence, and the terminal may select random access channel resources, of which the number is not larger than number of the configured random access channel resources, to transmit the preamble according to its own requirements (e.g., the number of coverage or transmission beams), and detect the random access response according to the corresponding detecting method of the random access response.

[126] Similarly, the mode provided by the present embodiment is also applicable to a case that only a terminal with the beam correspondence is present in the system or a base station is configured with random access channel resources only suitable for the terminal with the beam correspondence.

[127] Embodiment 2

[128] In the present embodiment, a method for detecting a random access response will be described in connection with a specific system. In the present embodiment, time-frequency resources of the random access channel for a terminal with the beam correspondence and a terminal without the beam correspondence are shared, but using random access preamble groups which do not overlap each other. That is all the available preambles are divided into a first group of preambles and a second group of preambles. The two groups of preambles do not overlap each other, the first group of preambles are used for terminals with the beam correspondence, and the second group of preambles are used for terminals without the beam correspondence.

[129] In order to support a terminal with the beam correspondence and a terminal without the beam correspondence to perform a process of random access simultaneously, the base station assigns a plurality of random access channel resource sets, each of which is composed of a plurality of random access channels. The division of the random access channel resource set and the time-frequency position of the random access channels constituting the random access channel resource set are informed to the terminal by the base station through the main information block in the broadcast channel in the synchronization signal block or the random access configuration carried in the system information carried by the system information block indicated by the main information block. The random access channel resource set designated by the random access configuration information carried by the broadcast channel in different synchronization signal blocks is different, which is used to distinguish the different transmitting beam directions on the base station side. The base station enables the random access channel in the random access channel resource set to transmit a single

or repeated or a plurality of preambles according to whether or not the terminal has the beam correspondence, and informs the terminal by the information such as the preamble format.

- [130] For a terminal with the beam correspondence, a random access channel in the random access channel resource set is selected according to the configuration information of the base station or a random access channel used for transmitting a preamble is selected randomly in equal probability from all of the available random access channels. The base station may also configure the terminal to transmit by the same beam in a plurality of random access channels of the same random access channel resource set.
- [131] For a terminal without the beam correspondence, the terminal transmits a preamble by different beam directions on different random access channels according to the number of transmitting beam directions supported by it.
- [132] The assignment of the channel resources may be described by Figure 8.
- [133] In Figure 8, a random access channel resource set is composed of M random access channel resources, wherein, the parameter M is a positive integer. For a terminal with the beam correspondence, a random access channel resource is selected for transmitting of a preamble (a plurality of random access channels may be selected to transmit except for the example shown in the figure); for a terminal without the beam correspondence, multiple even all the random access channel resources are selected for transmitting the preamble. It is also to be noted that the example shown in Figure 8 is that each random access channel in the random access channel resource set is discrete in time, and the other possibility is each random access channel in the random access channel resource set is continuous in time. The random access resource set corresponding to different broadcast channel resources is divided by time or by frequency in order to correspond to different transmitting beam directions on the base station side.
- [134] In the present embodiment, the mode and flow of detecting a random access response of a terminal with the beam correspondence is inconsistent with that of a terminal without the beam correspondence. Specifically, when the base station configures the random access channel resources, the base station simultaneously configures the two types of the start position of terminal and the length of the random access response detection windows for the two types of terminals. For the terminal with the beam correspondence, after completing the transmission of a preamble, the terminal detects the random access response on the last subframe (or slot) of the assigned random access channel resource plus k_1 subframes (or slots); for the terminal without the beam correspondence, the terminal detects the random access response on the last subframe (or slot) of the assigned random access channel resource set used for transmitting the preamble plus k_2 subframes (or slots). The parameters k_1 and k_2 are configured by the

base station. If k_1 is equal to k_2 , only one parameter is required to be configured or be pre-set. The mode described above can be described by Figure 9.

[135] In Figure 9, the position of the random access response detection windows of the two types of terminals does not overlap to avoid unnecessary collisions.

[136] Specifically, if the base station detects a preamble in the first group of preambles in a random access channel in the random access channel resource set, the base station calculates a RA-RNTI according to the time-frequency resource of the random access channel of the detected preamble, and uses the RA-RNTI to scramble in the downlink control channel in the corresponding random access response detection window, transmits a random access response in the downlink time-frequency resource assigned by the control channel.

[137] If the base station detects a preamble in the second group of preambles in one or more random access channels in the random access channel resource set, the processing mode may be as follows:

[138] - for a plurality of random access channels detecting the same preamble, a random access channel with the strongest correlation detection is selected, a corresponding RA-RNTI is calculated based on the time-frequency resources of the random access channel, and the RA-RNTI is used to scramble in the random access response detection window, a random access response is transmitted in the downlink time-frequency resource assigned by the corresponding control channel.

[139] - for a plurality of random access channels detecting the same preamble, multiple corresponding RA-RNTIs are calculated based on the time-frequency resources of the random access channels, and multiple corresponding random access responses are generated. The following modes may be used to transmit the multiplier random access responses:

[140] 1. the multiple random access responses are indicated by the same control channel within the random access response detection window. That is, a plurality of control information scrambled by different RA-RNTIs is transmitted in the same control channel simultaneously, which indicates different downlink resources, and a corresponding random access response is transmitted.

[141] 2. the multiple random access responses are indicated by multiple control channels. That is the i^{th} random access channel in the random access channel resource set, the starting position of the random access response detection window of the i^{th} random access channel is the $(k_2 + n(i))^{\text{th}}$ subframe, wherein, the function $n(i)$ is a parameter related to i , for example, defined as $n(i) = Mi$, M is a positive integer, which is a parameter configured or pre-set by the base station. If the transmission of the preamble is detected on the i^{th} random access channel, a corresponding RA-RNTI is calculated and the RA-RNTI is used to scramble the control information in the downlink control

channel in the corresponding random access response detection window, a corresponding random access response is transmitted on the downlink time-frequency resource indicated by the control information. It should be noted that, in this way, the random access response detection windows corresponding to the different random access channels should not overlap.

- [142] The modes described in the present embodiment also affect behaviour of the terminals. Specifically, after completing the downlink synchronization, the terminal reads configuration information of the random access response in the main information block or the system information block carried in the broadcast channel in the corresponding synchronization signal block to determine assignment of the random access channel time-frequency resource and information (I.e., a index range of the first group of preambles and a index range of the second group of preambles) of a preamble resource pool used by the terminal with the beam correspondence and the terminal without the beam correspondence.
- [143] The terminal selects a preamble based on the capability of the beam correspondence (i.e., whether or not having the beam correspondence). If having beam correspondence, the first group of preambles are selected; if not having beam correspondence, the second group of preambles are selected. The terminal randomly selects a preamble in the selected preamble group with equal probability.
- [144] The terminal selects the random access channel resources according to the capability of beam correspondence (i.e., whether or not having the beam correspondence). If having beam correspondence, a random access channel assigned by the base station or a random access channel resource selected randomly with equal probability from the random access channel resources in the random access channel resource set assigned by the base station is used to transmit a preamble. If not having beam correspondence, all or part of the random access channel resources in the random access channel resource set assigned by the base station are used to transmit a preamble.
- [145] The terminal detects a random access response in a random access response detection window after completing the transmission of a preamble.
- [146] If the terminal has the beam correspondence, the starting position of the random access response detection window is the subframe(or slot) that contains the end of the preamble transmission plus k_1 subframes (or timeslots) , length of the window is configured by the base station;
- [147] If the terminal does not have the beam correspondence, according to the mode configured or pre-set by the base station, behaviour of the terminal is one of the following:
- [148] - The terminal detects a random access response within a random access response detection window, the start position of the random access response detection window

is at the last subframe(or slot) of the last random access channel of the random access channel resource set plus k_2 subframes (or timeslots) , length of the window is configured by the base station; the terminal calculates a RA-RNTI corresponding to each random access channel resource for transmitting the preamble, and uses the calculated RA-RNTI to monitor the downlink control channel in the random access detection window.

- [149] - The terminal detects random access responses within a plurality of random access response detection windows. The start position of a random access response detection window corresponding to the i^{th} random access channel resource in the random access channel resource set is last subframe(or slot) of the last random access channel of the random access channel resource set plus $k_2+n(i)$ subframes (or slots) , length of the window is configured by the base station. Wherein, $n(i)$ is a function related to index i , a simple deterministic mode is $n(i) = Mi$, wherein, M is a positive integer, which is either configured or by pre-set by the base station. The terminal uses the corresponding RA-RNTI to detect the downlink control channel in the random access detection window within the random access response detection window corresponding to the used random access channel resource.
- [150] The conditions of the terminal terminating to monitor a random access response are as follows:
- [151] - If the terminal has the beam correspondence, monitoring the random access response is terminated after the random access response containing a random access preamble identifier matching the transmitted preamble is successfully received. That is, if the downlink resource assignment indicated in the PDCCH scrambled by the RA-RNTI is successfully received and the random access response therein contains the random access response preamble identifier corresponding to the transmitted random access response preamble, the random access response is received successfully;
- [152] - If the terminal does not have the beam correspondence and only one random access response detection window is monitored in the mode described above, the possible behaviour of the terminal is one of the following possibilities:
- [153] 1. The terminal uses the RA-RNTI corresponding to the random access resource used for transmitting the preamble to detect the downlink control channel in the random access response detection window individually, if the downlink resource assignment indicated in the PDCCH scrambled by a RA-RNTI is successfully received and the random access response therein contains a random access response preamble identifier corresponding to the transmitted random access response preamble, the random access response is received successfully and the monitoring in the random access response detection window is terminated;
- [154] 2. The terminal uses RA-RNTIs corresponding to all the random access resources

used for transmitting the preamble to detect the downlink control channel in the random access response detection window. As for a random access channel, if the downlink resource assignment indicated in the PDCCH scrambled by a RA-RNTI corresponding to the random access channel resource is successfully received and the random access response therein contains a random access response preamble identifier corresponding to the transmitted random access response preamble, the random access response corresponding to the random access channel is received successfully, detecting the random access response detection window by the RA-RNTI corresponding to the random access channel resource is terminated, the RA-RNTIs corresponding to the other undetected random access channel resources are used to detect the random access response detection window until the RA-RNTIs corresponding to all the random access channel resources used for transmitting the preamble completes the monitoring of the random access response detection window.

[155] - If the terminal does not have the beam correspondence and multiple random access response detection windows are monitored in the mode described above, the possible behaviour of the terminal is one of the following possibilities:

[156] 1. The terminal uses a RA-RNTI corresponding to the random access resource used for transmitting the preamble to detect the downlink control channel in the corresponding random access response detection window individually, if the downlink resource assignment indicated in the PDCCH scrambled by a RA-RNTI is received successfully and the random access response therein contains a random access response preamble identifier corresponding to the transmitted random access response preamble, the random access response is received successfully and the monitoring in the subsequent random access response detection windows is terminated;

[157] 2. The terminal uses RA-RNTIs corresponding to all the random access resources used for transmitting the preamble to detect the downlink control channel in the corresponding random access response detection window. As for a random access channel, if the downlink resource assignment indicated in the PDCCH scrambled by a RA-RNTI corresponding to the random access channel resource is successfully received and the random access response therein contains a random access response preamble identifier corresponding to the transmitted random access response preamble, the random access response corresponding to the random access channel is received successfully, detecting the random access response detection window by the RA-RNTI corresponding to the random access channel resource is terminated, the RA-RNTIs corresponding to the other undetected random access channel resources are used to detect the random access response detection window until the RA-RNTIs corresponding to all the random access channel resources used for transmitting the preamble completes the monitoring of the corresponding random access response detection

window.

[158] It should be noted that the method provided in the present embodiment is also applicable to the case that only one type of terminals exists in the system or the base station is configured with the random access channel resources suitable for one type of terminals only. For example, if the system only supports a terminal without the beam correspondence, the base station only assigns and informs the random access channel resources and configuration information of the corresponding random access response detection for the terminal without the beam correspondence. Terminals in the cell are processed according to the mode of the random access preamble transmission and the random access response detecting of the terminal without the beam correspondence. In addition, the way provided by the present embodiment is applicable to a Contention-based or Contention-free random access procedure. For a Contention-free random access procedure, the base station may configure a plurality of random access channel resources referring to the processing way for the terminal without the beam correspondence, and the terminal may select random access channel resources, of which the number is not larger than number of the configured random access channel resources, to transmit the preamble according to its own requirements (e.g., the number of coverage or transmission beams), and detect the random access response according to the corresponding detecting method of the random access response.

[159] Similarly, the mode provided by the present embodiment is also applicable to a case that only a terminal with the beam correspondence is present in the system or a base station is configured with random access channel resources only suitable for the terminal with the beam correspondence.

[160] Embodiment 3

[161] In the present embodiment, a method for detecting and transmitting a random access response will be described in connection with a specific system. The focus of this embodiment is the mode of the base station transmitting a random access response and the mode of the terminal detecting the random access response after a terminal without the beam correspondence transmitting a preamble. The scheme according to the present embodiment is applicable to the resource assignment mode of the embodiment 1 and the embodiment 2, without affecting the terminal without the beam correspondence and the base station's modes of detecting and transmitting the random access response.

[162] As described above, the base station assigns a plurality of random access channel resources in the random access channel resource set for the sake of transmitting the preamble conveniently by the terminal without the beam correspondence. The terminal transmits the preamble on multiple or all the random access channel resources, to determine the optimal beam direction from a plurality of transmit beam directions. The base station may detect the same preamble on a plurality of random access channel

resources and feedback the corresponding plurality of random access responses.

[163] If the base station detects the same preamble on a plurality of random access channel resources, the plurality of random access channel resources are sorted. The criteria for sorting is according to size of the output values of the correlation detection of the preambles, from big to small and the multiple random access channel resources are assigned indexes in turn. The base station informs the terminal the priority indexes representing the corresponding priority in the way of explicit or implicit indication in the corresponding random access response. The mode of explicit indication includes informing the corresponding index directly in the random access response, that is transmitting the bits for characterizing the corresponding receiving index of the random access channel in the random access response.

[164] In another case, if the base station side does not have the beam correspondence, the base station needs to configure the terminal to transmit a duplicate preamble so that the base station may receive the preamble in a way of receiving a beam scan. In this case, the base station may detect the same preamble in multiple receiving beam directions on the same random access channel resources and determine multiple timing advances. This multiple timing advances correspond to the same random access channel and the same preamble, so they are transmitted in the same random access response. In the present embodiment, if the base station detects the same preamble in a plurality of receiving beam directions on the same random access channel resource, the plurality of receiving beam directions are sorted. The sorting criterion is according to size of the output values of the preambles correlation, from big to small and the base station sequentially assigns the priority indexes representing the priorities to the timing advances and the resource assignment indications of message 3 detected on the corresponding receiving beam directions. The base station informs the respective receiving beam directions the determined timing advances, corresponding resource assignment information of the message 3, the temporary cell radio network temporary identifier (TC-RNTI) assigned to the preamble detected on the receiving beam direction in the corresponding random access response, and informs the corresponding indexes in an explicit or implicit way. Wherein, the explicit way is informing the corresponding indexes directly; the implicit way is to sort the timing advances and resource assignments of message 3 in the order of the indexes. Figure 10 shows an example of an explicit and implicit indication in a random access response.

[165] In Figure 10, other information refers to other information contained in the random access response.

[166] In the present embodiment, the aforementioned transmission description affects the behaviour of a terminal. Specifically, if the random access responses corresponding to a plurality of random access channel resources are detected successfully when

- detecting the random access responses, the possible behaviour of the terminal includes:
- [167] - the terminal selects a random access response with the highest priority characterized by the priority index information, transmits the message 3 according to the content of the random access response;
- [168] - the terminal selects a access response with the highest priority random characterized by multiple priority index information, transmits the message 3 according to the content of the random access response;
- [169] - the terminal transmits the message 3 respectively according to the contents of each random access response.
- [170] If the terminal receives a plurality of timing advances, uplink grant and other information in a random access response, the behaviour of the terminal may comprise:
- [171] - the terminal selects a random access response with the highest priority characterized by the priority index information, transmits the message 3 according to the content of the random access response;
- [172] - the terminal selects a access response with the highest priority random characterized by multiple priority index information, transmits the message 3 according to the content of the random access response;
- [173] - the terminal transmits the message 3 respectively according to the contents of each random access response.
- [174] It should be noted that the method provided in the present embodiment is also applicable to the case that only one type of terminals exists in the system or the base station is configured with the random access channel resources suitable for one type of terminals only. For example, if the system only supports a terminal without the beam correspondence, the base station only assigns and informs the random access channel resources and configuration information of the corresponding random access response detection for the terminal without the beam correspondence. Terminals in the cell are processed according to the mode of the random access preamble transmission and the random access response detecting of the terminal without the beam correspondence. In addition, the way provided by the present embodiment is applicable to a Contention-based or Contention-free random access procedure. For a Contention-free random access procedure, the base station may configure a plurality of random access channel resources referring to the processing way for the terminal without the beam correspondence, and the terminal may select random access channel resources, of which the number is not larger than number of the configured random access channel resources, to transmit the preamble according to its own requirements (e.g., the number of coverage or transmission beams), and detect the random access response according to the corresponding detecting method of the random access response.
- [175] Similarly, the mode provided by the present embodiment is also applicable to a case

that only a terminal with the beam correspondence is present in the system or a base station is configured with random access channel resources only suitable for the terminal with the beam correspondence.

[176] Embodiment 4

[177] In the present embodiment, a method of detecting and transmitting a random access response will be described. In the present embodiment, the random access response is detected by using a way of a plurality of sub-randomaccess windows in a random access detection window. The way described in the present embodiment is applicable to a terminal for transmitting a preamble on one or more random access timings when transmitting the preamble. Wherein, the transmission of the preamble on the multiple random access timings may adopt the same or different uplink transmitting beams. The random access timing is to be understood as a random access channel resource in the foregoing embodiments for transmitting a complete preamble meeting the preamble format.

[178] In the present embodiment, the base station configures one or more random access timings used for transmitting the preamble for the terminal needed to transmit the preamble. If the base station configures a plurality of random access timings, the terminal may transmit the preamble by the same or different uplink transmitting beams on the multiple random access timings. The number of random access timings used by the terminal is determined by the number of uplink transmitting beams of the terminal, but not greater than a maximum of number of the random access timings configured by the base station.

[179] The way of a terminal to detect the random access response is as follows:

[180] After transmitting the preamble on a first random access timing, the terminal begins to detect the random access response in the random access response window starting at the k^{th} subframe. The terminal detects a downlink control channel based on a RA-RNTI calculated by time-frequency resource of the first random access timing. Wherein, the parameter k is determined by preconditioning or configuration of the base station. If the configuration of the base station is adopted, the relevant parameter k is transmitted in configuration information of the random access.

[181] Length of the random access response detection window is configured by the base station and needed to cover all the random access timings configured by the base station. In the duration of the random access response window, when the terminal needs to transmit the preamble, the detecting of the random access response is suspended, and the preamble of the random access response is transmitted on the time-frequency resource of the random access timing. After the new preamble of the random access response is transmitted, the terminal needs to use a RA-RNTI calculated by the time-frequency resources of all the random access timings that have been used for the

preamble to detect within the random access response detection window.

[182] Using the way above will cause that number of RA-RNTIs used by the terminal to detect the random access responses is more and more, which increases the complexity of the terminal detecting the random access responses. One possible simplification scheme is to configure k_1 for the effective length of each RA-RNTI except the length of the random access response detection window. That is, the effective length of each RA-RNTI starts from the k^{th} subframe after the end of the random access timing, and ends at the $(k + k_1)^{\text{th}}$ subframe, all the RA-RNTIs calculated by the time-frequency resources of the random access timings in the k_1 subframes can be used to detect the random access response. It should be noted that the effective length of the RA-RNTI corresponding to the different random access timings may overlap, that is, the terminal may use multiple RA-RNTIs still to detect the random access response within the random access response detection window, but the number of RA-RNTIs used simultaneously will be reduced. The parameter k' is configured by the base station or is pre-set. The effective length of the RA-RNTI corresponding to the first random access timing is calculated from the start time of the random access response detection window. The process above is shown in Figure 11.

[183] If the terminal successfully detects a random access response within the effective length of a RA-RNTI, a possible way is to transmit the preamble on the random access timing configured for the terminal, and the random access response is detected in the random access response detection window continuously. In this case, it is necessary to carry a measuring result or the sorting result of the measuring result of the corresponding preamble in the random access response so that the terminal selects the optimal transmitting beam. For example, the base station configures eight random access timings that can be used to transmit the preamble, and the terminal transmits the preamble on the eight random access timings and detects the random access response in the way described in the present embodiment. The terminal successfully detects the random access response within the effective length of the RA-RNTI calculated by the time-frequency resources of the second, fourth, and fifth random access timings, and the sorting result of the measuring result of the preamble carried in the random access response is 4, 2, 5. The terminal determines the appropriate uplink transmitting beam according to the preset criteria. The preset criterion is to select an uplink transmitting beam adopted by the random access timing corresponding to the random access response carrying with the best measuring result or optimal sorting result of the measuring results. Another possible preset criterion is to select a random access response with equal probability in the detected random access responses randomly, and to determine the uplink transmitting beam according to its corresponding random access timing.

- [184] In another way, if the terminal detects a random access response within the effective length of a RA-RNTI successfully, the random access response is detected successfully, the detection of the random access response can be terminated and the subsequent access or data transmission step is continued. In this way, it is not necessary to carry the measuring result information within the random access response.
- [185] If the terminal does not transmit the preamble at all the configured random access timings, after the effective length of the RA-RNTI calculated by the time-frequency resource of the last random access timing used for transmitting the preamble, the detection of the random access response may be terminated. If the random access response is not detected still at this time, the random access procedure is considered to fail.
- [186] The present disclosure also provides a device for detecting a random access response which may be on the terminal side, in accordance with the method for detecting a random access response on the terminal side.
- [187] Figure 12A is a structure schematic of the corresponding device and Figure 12B is another structure schematic of the corresponding device.
- [188] As shown in Figure 12A, the device (1210) includes a random access channel configuration information acquisition module (1220) and a random access response detecting module (1230).
- [189] Wherein, the random access channel configuration information acquisition module is used to obtain configuration information of a random access channel. The random access response detecting module is used to detect a random access response according to its beam correspondence and configuration of the random access response detection window after transmitting a preamble.
- [190] As shown in Figure 12B, a device (1240) includes a transceiver and a processor.
- [191] The transceiver (1250) is capable of transmitting the preamble.
- [192] The processor (1260) obtains the configuration information of a random access channel.
- [193] The processor (1260) detects the random access response according to its beam correspondence and configuration of the random access response detection window.
- [194] The present disclosure also provides a device for transmitting a random access response which may be on the base station side, in accordance with the method for transmitting a random access response on the base station side.
- [195] Figure 13A is a structure schematic of the corresponding device and Figure 13B is another structure schematic of the corresponding device.
- [196] As shown in Figure 13A, the device (1310) includes a random access channel configuration information transmitting module (1320) and a random access response transmitting module (1330).

- [197] Wherein, a random access channel configuration information transmitting module is used to transmit configuration information of a random access channel. The random access response transmitting module is used to transmit a random access response according to the random access channel resources, a preamble detected and configuration of the random access response detection window, after detecting the transmission of the preamble.
- [198] As shown in Figure 13B, a device (1340) includes a transceiver and a processor.
- [199] The transceiver (1350) transmits the configuration information of a random access channel.
- [200] The transceiver is capable of the random access response according to the random access channel resources, a preamble detected and configuration of the random access response detection window.
- [201] The processor (1360) detects the transmission of the preamble.
- [202] The processor (1360) transmits a random access response according to the random access channel resources, the preamble detected and configuration of the random access response detection window.
- [203] In several embodiments provided in the detailed description, it is to be understood that the disclosed systems, device and method may be implemented in other ways. For example, the embodiment of the device described above is merely schematic, for example, the dividing of the modules is only a kind of logical function dividing, and there may be additional dividing ways in the process of actually implementation, for example, multiple modules or components may be combined or integrated into another system, or some features may be ignored, or not executed. In other words, the coupling, direct coupling or communication connection shown or discussed may be through some interfaces, and the coupling or communication connection of devices or modules may be electrical, mechanical, or other forms.
- [204] The modules considered as the separate component description may be or may not be physically separate, and the components shown as modules may be or may not be physical modules, i.e., being located in one place or being distributed over a plurality of network modules. The part or all of the modules may be selected according to the actual needs to achieve object of the scheme of the present embodiment.
- [205] In addition, the functional modules in the various embodiments of the present application may be integrated in a processing module, or each module may be physically present individually, or two or more modules may be integrated in one module. The integrated module may be implemented in the form of hardware, and may also be achieved in the form of software function modules.
- [206] Those skilled in the art may understand that all or a part of steps of the various methods of the various embodiments described above may be accomplished by a

program to instruct the associated hardware, and the program may be stored in a computer readable storage medium, which may include: a read only memory (ROM), a random access memory (RAM), a magnetic disk, or an optical disk.

[207] The method and the device provided in the detailed description of the present disclosure has been described in detail, to those skilled in the art, according to concept of the embodiments of the detailed description, there will be a change in the detailed description and the application range, in summary, the contents of this specifications should not be considered as the limiting of the detailed description of the present disclosure.

Claims

- [Claim 1] A method for detecting a random access response, the method comprising:
obtaining configuration information of a random access channel;,
wherein the configuration information comprises configuration first information for configuring about a random access response detection window for a first type of user equipment (UE) and configuration second information for configuring about a random access response detection window for a second type of UE;,
wherein the first type of UE has beam correspondence, and the second type of UE does not have the beam correspondence; and
detecting the random access response according to its beam correspondence and configuration of a random access response detection window corresponding to its beam correspondence after transmitting a preamble.
- [Claim 2] The method of claim 1, wherein
the configuration information for configuring about the random access response detection window for the first type of UE with the beam correspondence comprises: at least one of information of the length of the random access response detection window, and/or information of the start position of the random access response detection window;
the configuration information for configuring about the random access response detection window for the second type of UE without the beam correspondence comprises: at least one of information of the length of the random access response detection window, and/or information of the start position of the random access response detection window.
- [Claim 3] The method of claim 2, wherein the configuration information for configuring about the random access response detection window for the second type of UE comprises:
information of the start position and information of the length of each random access response detection window corresponding to each random access channel resource in a random access channel resource set.
- [Claim 4] The method of claim 3, wherein the information of the start position of the random access response detection window comprises: information of the start position of a random access response detection window cor-

responding to the first random access channel resource in the random access channel resource set and gap between two adjacent random access response detection windows.

[Claim 5] The method of claim 1, wherein detecting the random access response according to its beam correspondence and the configuration of the random access response detection window comprises:
detecting, by the first type UE having the beam correspondence, the random access response according to the configuration of the random access response detection window of the first type of UE after transmitting the preamble; or
detecting, by the second type UE without the beam correspondence, the random access response according to the configuration of the random access response detection window of the second type of UE after the last random access channel resource in the random access channel resource set; wherein
the random access channel resource set comprises one or more random access channel resources.

[Claim 6] The method of claim 5, wherein when the UE transmitting the preamble does not have the beam correspondence, the method for detecting the random access response comprises:
determining, by the UE, a random access response detection window according to the configuration of the random access response detection window after every random access channel resource in the random access channel resource set; and
detecting and receiving the random access response according to the random access response-radio network temporary identification (RA-RNTI) corresponding to the one or more random access channel resources used for transmitting the preamble.

[Claim 7] The method of claim 6, wherein, detecting and receiving the random access response according to the RA-RNTI corresponding to the one or more random access channel resources used for transmitting the preamble comprises:
terminating detecting and receiving the random access response, when if the random access response is detected and received successfully according to the RA-RNTI corresponding to a random access channel resource in the random access channel resources used for transmitting the preamble.

[Claim 8] The method of claim 5, wherein the method for detecting the random

access response by the second type of UE comprises:
detecting and receiving the random access response in the random access response detection window corresponding to each random access channel resource used for transmitting the preamble according to the RA-RNTI responding to the random access channel resource, after every random access channel resource in the random access channel resource set.

[Claim 9] The method of claim 8, wherein the method for detecting the random access response by the second type of UE comprises:
terminating detecting and receiving the random access response, whenif the random access response is detected and received successfully in a random access response detection window corresponding to a random access channel resource in the random access channel resources used for transmitting the preamble according to the RA-RNTI corresponding to the random access channel resource.

[Claim 10] The method of claim 5, wherein the method for detecting the random access response by the second type of UE comprises:
determining the procedure of receiving the random access response fails, whenif no random access response is successfullyreceived in any random access response detection window corresponding to all the random access channels in the random access channel resource set used for transmitting the preamble according to the RA-RNTIs of the random access channels.

[Claim 11] The method of claim 5, wherein the method for detecting the random access response by the second type of UE comprises:
detecting, by the second type of UE, the random access response; and if multiple random access responses are detected in the corresponding random access response detection windows, determining the message 3 priorities of the multiple random access responses according to received energy indexes in the random access responses.

[Claim 12] The method of claim 5, wherein the method for detecting the random access response by the second type of UE comprises :
detecting, by the second type of UE, the random access response; and if multiple timing advances and uplink grant are detected in the random access response, determining the message 3 priorities of the plurality of timing advances and uplink grant according to the received power indexes in the random access response.

[Claim 13] A method for transmitting a random access response, comprising:

transmitting configuration information of a random access channel; wherein the configuration information comprises configuration information for configuring a random access response detection window for a first type of UE and configuration information for configuring a random access response detection window for a second type of UE; wherein the first type UE has beam correspondence, and the second type UE does not have the beam correspondence; transmitting a random access response according to random access channel resources, a preamble detected and configuration of the random access response detection window, after detecting the transmission of the preamble.

[Claim 14]

A device for detecting random access response, comprising: a random access channel configuration information acquisition module,transceiver configured to: obtain configuration information of a random access channel; transmit a preamble; wherein, the configuration information of the random access channel comprises configuration information for configuring a random access response detection window for a first type of UE and configuration information for configuring a random access response detection window for a second type of UE; wherein, the first type of UE has beam correspondence, and the second type of UE does not have the beam correspondence;. and a random access response detecting module,processor configured to: obtain configuration information of a random access channel, detect a random access response according to its beam correspondence and configuration of the random access response detection window, wherein the configuration information of the random access channel comprises first information about a random access response detection window for a first type UE and second information about a random access response detection window for a second type UE, wherein the first type UE has beam correspondence, and the second type UE does not have the beam correspondence after transmitting a preamble.

[Claim 15]

A device for transmitting random access response, comprising: a random access channel configuration information transmitting module,transceiver configured to: transmit configuration information of a random access channel,; and wherein the configuration information of the random access channel

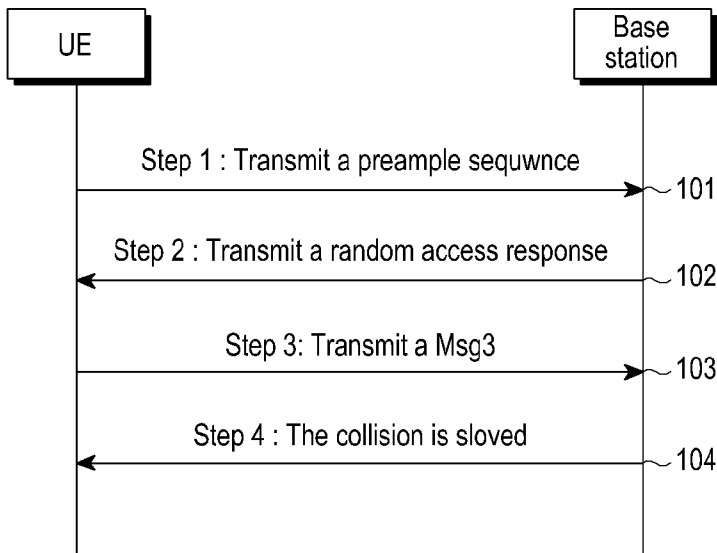
comprises configuration information for configuring a random access response detection window for a first type of UE and configuration information for configuring a random access response detection window for a second type of UE;

a random access response transmitting module, processor configured to: transmit a random access response according to the random access channel resources, a preamble detected and configuration of the random access response detection window, after detecting the a transmission of the preamble., and

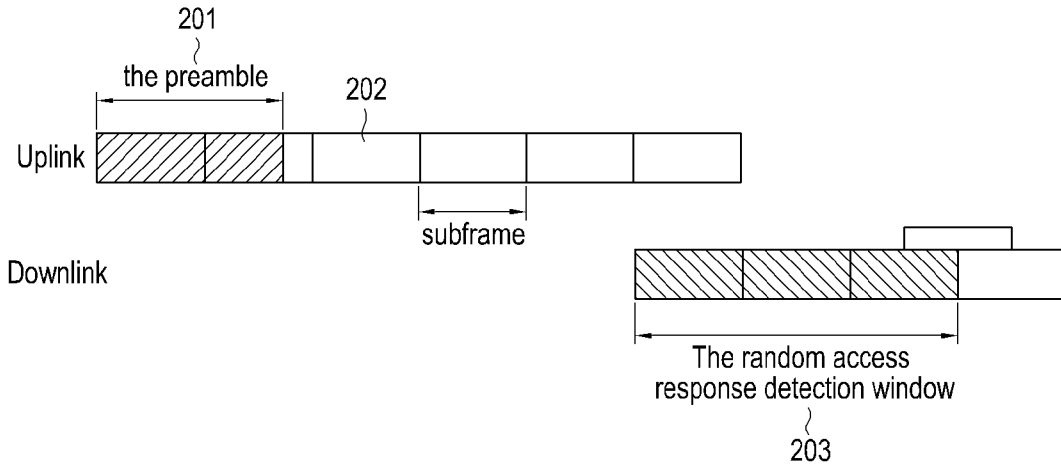
transmit a random access response according to the random access channel resources, the preamble detected and configuration of the random access response detection window,

wherein the configuration information of the random access channel comprises first information about a random access response detection window for a first type UE and configuration information about a random access response detection window for a second type UE.

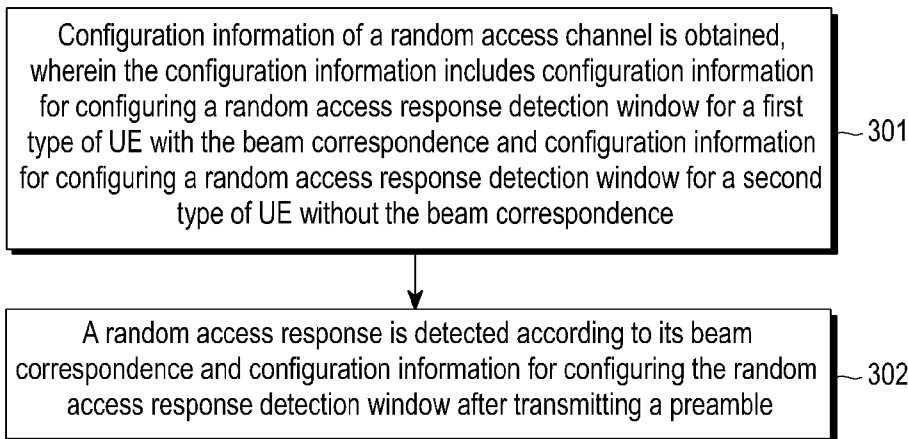
[Fig. 1]



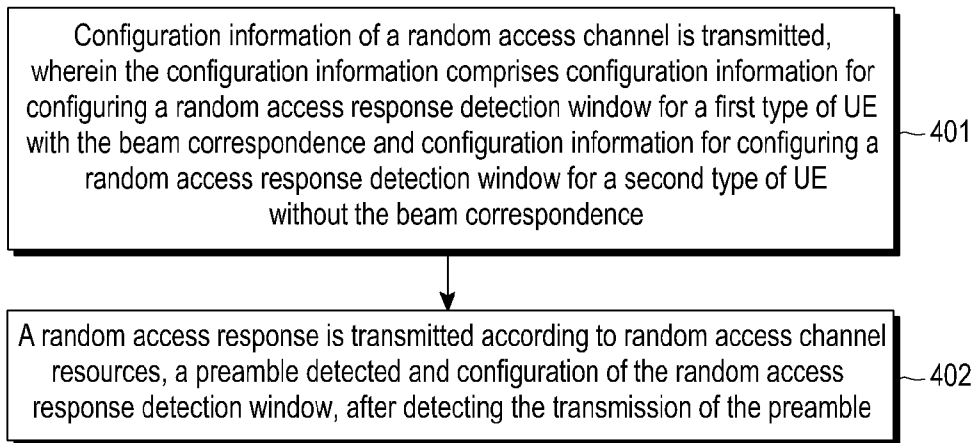
[Fig. 2]



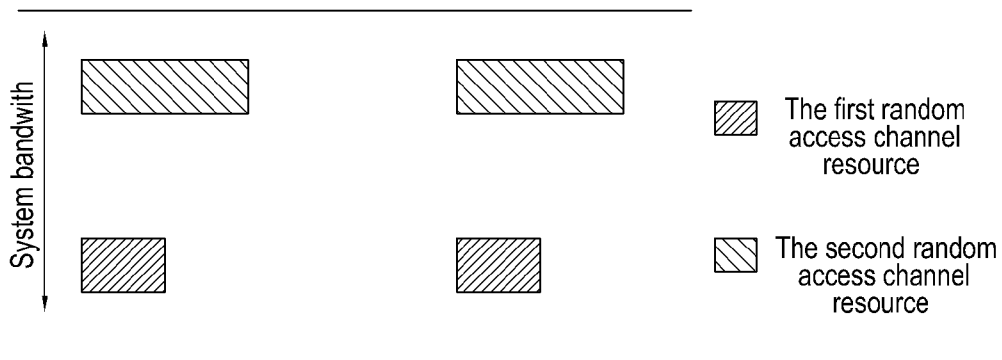
[Fig. 3]



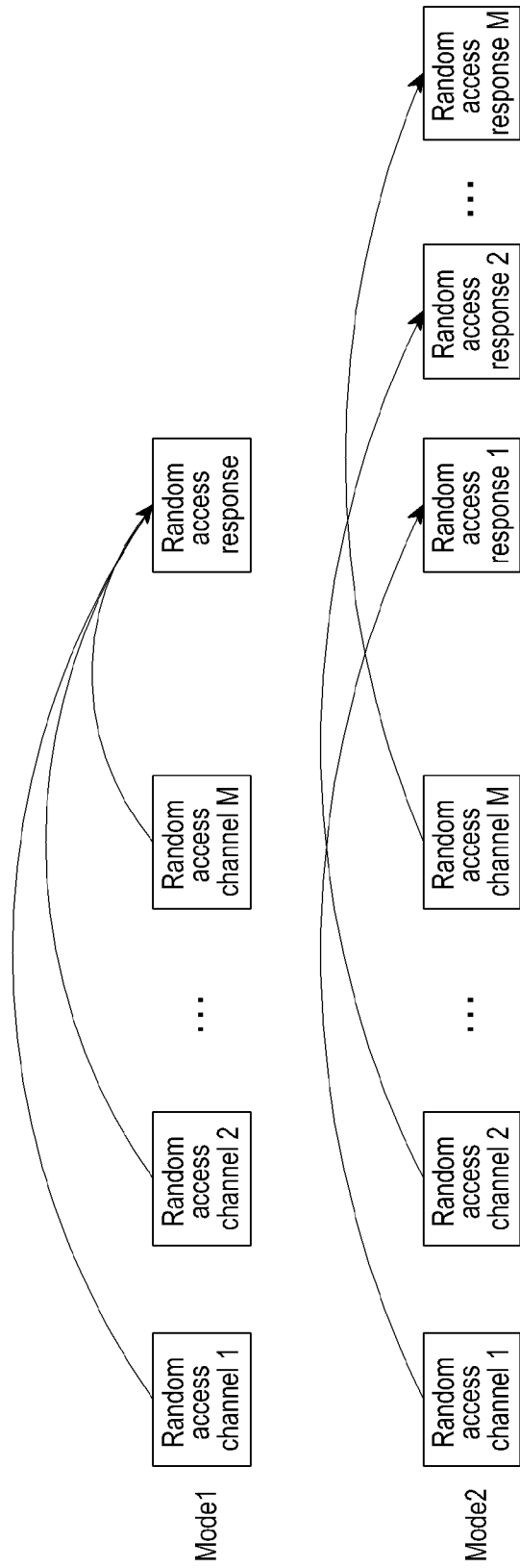
[Fig. 4]



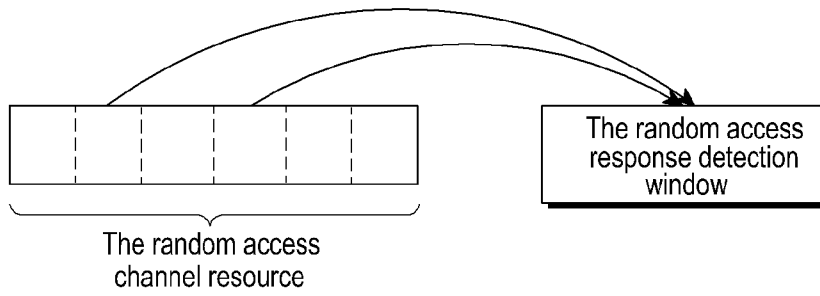
[Fig. 5]



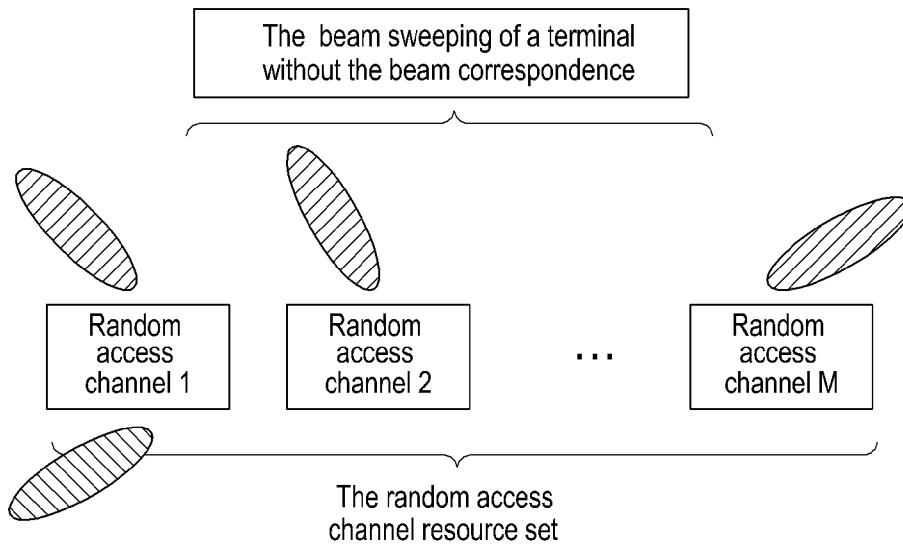
[Fig. 6]



[Fig. 7]

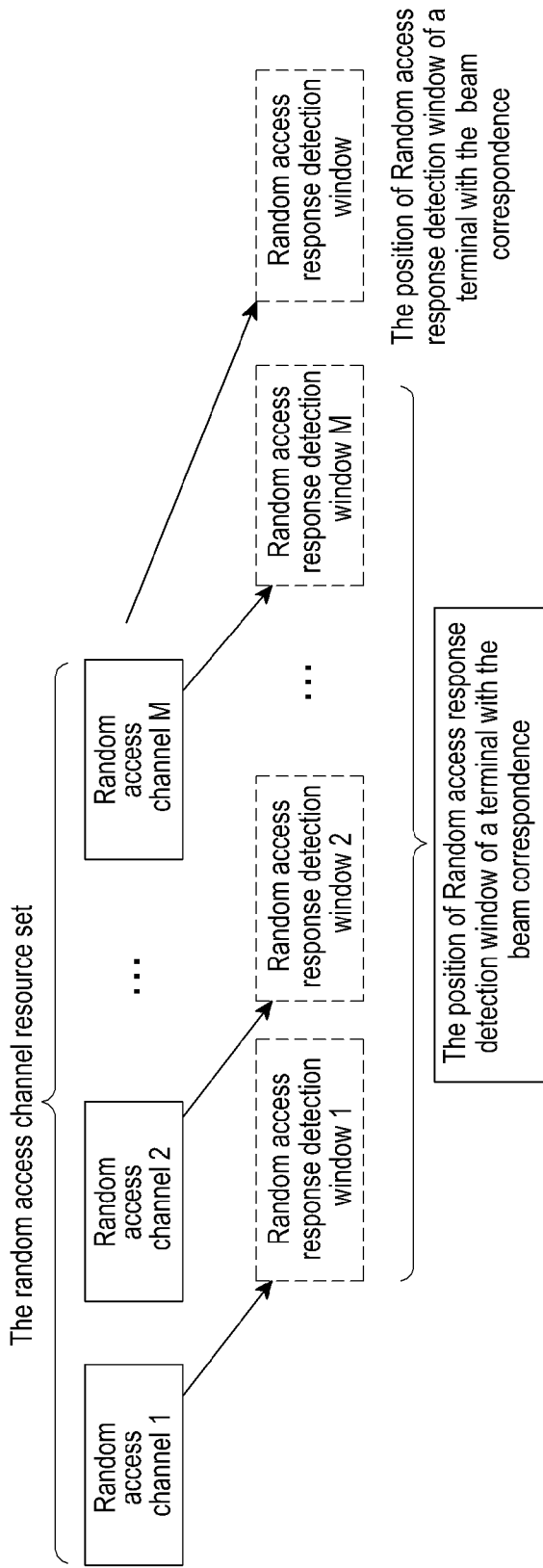


[Fig. 8]



A preamble transmission of a terminal with the beam correspondence

[Fig. 9]



[Fig. 10]

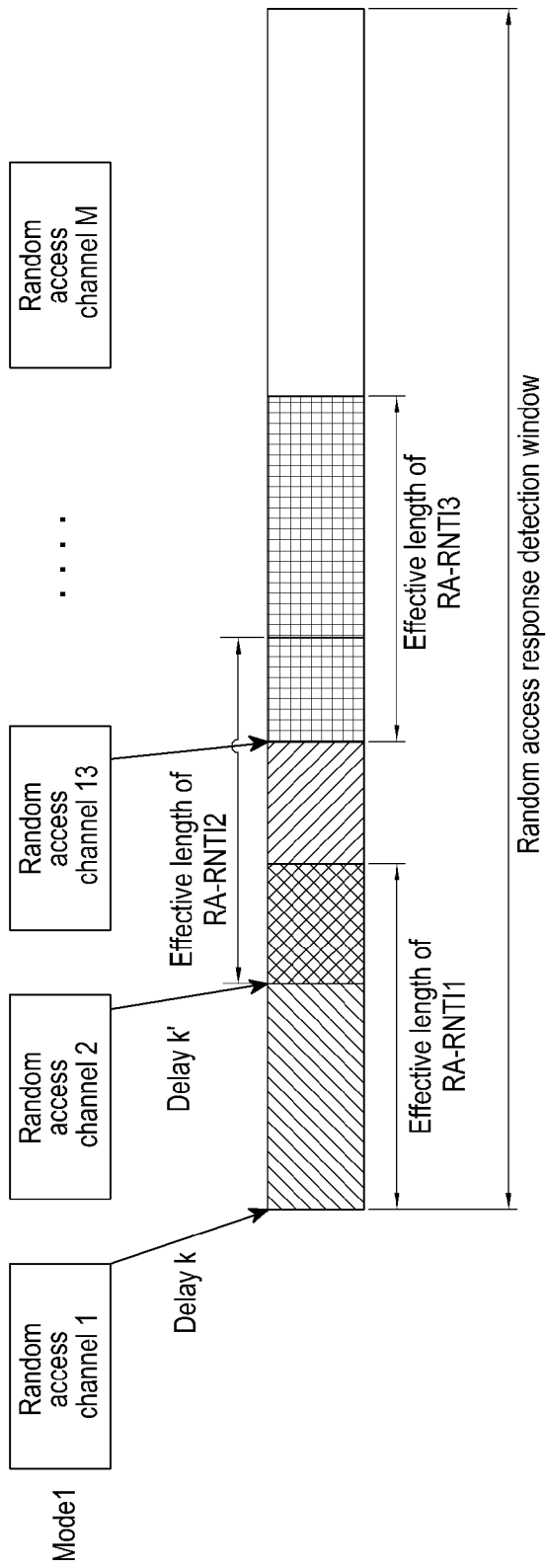
The preamble identifier			
Timing advance	Resource assignment	TC-RNTI	index
Timing advance	Resource assignment ⋮	TC-RNTI	index
Timing advance	Resource assignment	TC-RNTI	index
The other information			

Explicit indication mode

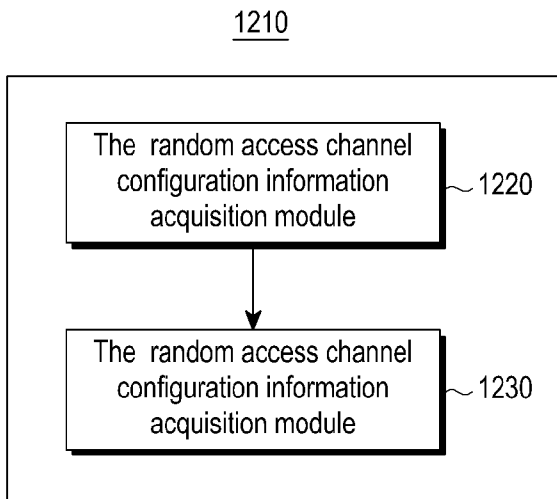
The preamble identifier		
Timing advance	Resource assignment	TC-RNTI
Timing advance	Resource assignment	TC-RNTI
⋮		
Timing advance	Resource assignment	TC-RNTI
The other information		

Implicit indication mode

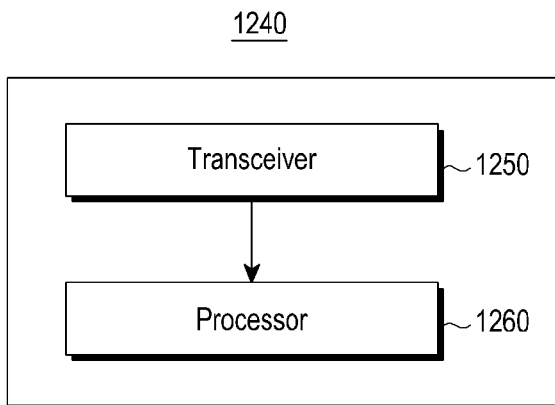
[Fig. 11]



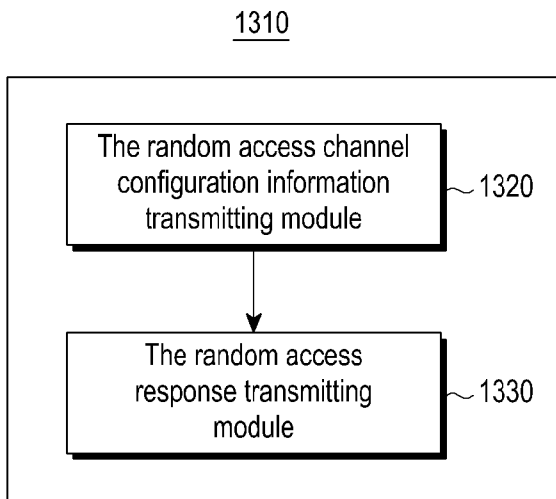
[Fig. 12A]



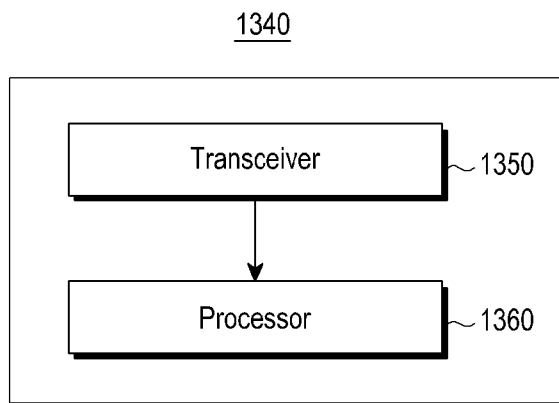
[Fig. 12B]



[Fig. 13A]



[Fig. 13B]



A. CLASSIFICATION OF SUBJECT MATTER**H04W 74/00(2009.01)i, H04W 74/08(2009.01)i**

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

B. FIELDS SEARCHEDMinimum documentation searched (classification system followed by classification symbols)
H04W 74/00; H04W 74/08; H04B 7/26; H04J 11/00; H04W 72/04Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility modelsElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: UE, random access response, random access channel, configuration information, first type of UE, second type of UE, beam correspondence, random access detection window**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2014-003436 A1 (LG ELECTRONICS INC.) 03 January 2014 See paragraphs [0083], [0088]; claims 1, 4; and figure 8.	1-15
A	US 2013-0272220 A1 (SAMSUNG ELECTRONICS CO., LTD.) 17 October 2013 See paragraph [0088]; claim 1; and figure 6.	1-15
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A	ERICSSON, `Narrowband LTE - Random Access Design`, R1-156011, 3GPP TSG-RAN1 #82bis, Malmo, Sweden, 30 September 2015 See section 2.	1-15
A	WO 2011-136558 A2 (LG ELECTRONICS INC.) 03 November 2011 See paragraphs [97]-[113]; and figure 7.	1-15

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

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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

05 June 2018 (05.06.2018)

Date of mailing of the international search report

05 June 2018 (05.06.2018)

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International application No.

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