

Certification

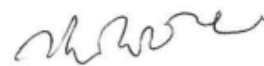
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I, Jeong Ho KIM, hereby declare:

That I possess advanced knowledge of the Korean and English languages. The attached Korean into English translation has been translated by me and to the best of my knowledge and belief, it is a true and accurate translation of:

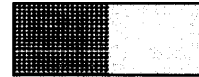
Korean Patent Application No. 10-2008-0047656.

Signed this 17th day of April 2025



J. H. KIM

For and on behalf of RWS Translations Ltd



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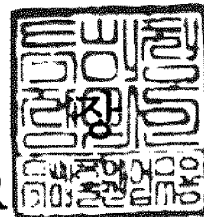
출 원 번 호 : 10-2008-0047656
Application Number

출 원 년 월 일 : 2008년 05월 22일
Filing Date MAY 22, 2008

출 원 인 : 엘지전자 주식회사
Applicant(s) LG Electronics Inc.

2009 년 04 월 01 일

특 허 청
COMMISSIONER



[Bibliography]

[Document name] Patent application document

[Reference number] 0003

[Application classification] Patent application

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[Comprehensive delegation registration number] 2007-001879-5

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[Comprehensive delegation registration number] 2007-001886-1

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방법

[Name of Invention in English] A METHOD FOR TRANSMITTING AND RECEIVING
RANDOM ACCESS REQUEST AND TRANSMITTING AND RECEIVING RANDOM ACCESS
RESPONSE

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[Claim of priority]

[Application country] US

[Application number] 61/018,492

[Application date] Jan 01, 2008

[Attestation document] Not attached

Submit to the Commissioner of the Patent Office as above.

Agent KIM, Yong In (Seal)

Agent PARK Young Bok (Seal)

[Fees]

[Application fee] 0 page 38,000 KRW

[Additional application fee] 55 pages 0 KRW

[Priority claim fee] 1 case 20,000 KRW

[Examination request fee] 0 paragraph 0 KRW

[Total] 58,000 KRW

[Abstract]

[Summary]

To a random access request (random access preamble) of a user equipment, a base station transmits a random access response. The random access response includes information on the time at which the random access request is transmitted and sequence number information of the random access request preamble. By using the sequence number information included in the received random access response and the information on the time at which the random access request is transmitted, the user equipment determines whether the received random access response is a response to the random access request transmitted by the user equipment.

[Representative drawing]

FIG. 3a

[Index]

Random access, base station, user equipment, subframe number

[SPECIFICATION]

[TITLE OF THE INVENTION]

METHOD FOR TRANSMITTING AND RECEIVING RANDOM ACCESS REQUEST AND
TRANSMITTING AND RECEIVING RANDOM ACCESS RESPONSE

[DETAILED DESCRIPTION OF THE INVENTION]

[TECHNICAL FIELD]

<1> The present invention relates to a wideband radio access system, and more particularly, to a method for transmitting and receiving a random access request (random access preamble) and transmitting and receiving a random access response in a wideband radio access system.

[BACKGROUND ART]

<2> In a technology related to a wideband radio access system, each user equipment may attempt to access the system with a randomly selected sequence or opportunity in each random access channel (RACH) slot. When a base station detects a random access sequence (or an RACH sequence), the base station transmits a random access response (or an RACH response) thereto. Each user equipment receives the random access response from the base station, regards the response, if the response includes a sequence transmitted by the user equipment, as a response to the user equipment, and performs an operation such as timing advance.

<3> In this field of technology, each user equipment may attempt access with a randomly selected sequence or opportunity in each RACH slot. If a base station detects an RACH sequence, the base station transmits a response to the RACH sequence. Each user equipment receives the RACH response from the base station, regards the response, if the response includes a sequence transmitted by the user equipment, as a response to the user equipment, and performs an operation such as timing advance. At this time, if there is no accurate time interval during the time each user equipment waits for a response, each user equipment may erroneously receive a response to another user equipment as a response to itself. This state is shown in FIG. 1a. FIG. 1a is an example showing how an RACH response (random access response) is performed. This state may appear in all RACH periods. Referring to "3GPP TS 36.211 v.8.1.0, 'Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation', 2007-12-20" regarding random access in a wideband radio access system, a table for a random access preamble format, a random access preamble parameter, and random access preamble timing for preamble formats 0 to 3 is described. FIG. 1a shows an RACH slot having a preamble format of 0 and a period of 1 ms.

<4> In FIG. 1a, a first user equipment 1 attempts access with a randomly selected sequence 1 in an uplink (UL) subframe 0 (S110). In an uplink subframe 1, a second user equipment 2 attempts access with a randomly selected sequence 1 (S120). If a base station detects the sequences of the two user equipments, the base station transmits responses to the detected sequences (S130). At this time, the two user equipments 1 and 2 which have attempted access wait for responses to themselves. If a response to the sequence 1 reaches an uplink subframe 7, both the user equipment 1 (UE1) and the

user equipment 2 (UE2) may determine that the response that reached the uplink subframe 7 is a response to the sequence of its own attempted access. In this case, one of the two user equipments erroneously determines that the response that reached the uplink subframe 7 is the response to itself. Since the two user equipments perform time synchronization by the response that reached the uplink subframe 7, one of the user equipments performs erroneous time synchronization. In addition, since data or a control signal is transmitted back to the uplink by using the same resource indicated by the response, there is a problem in that the two user equipments use the same resource.

<5> In FIG. 1a and the description related to FIG. 1a, a cell radius is not considered in order to facilitate the understanding of problems of a technology related to the present invention. However, if the cell radius is actually about 50 km and the propagation speed of an electromagnetic wave is considered, it can be understood that a random access preamble transmitted by the user equipment 1 in the uplink subframe 0 may reach a base station in a downlink subframe 0 or a downlink subframe 1, and a random access preamble transmitted by the user equipment 2 in the uplink subframe 1 may reach a base station in a downlink subframe 1 or a downlink subframe 2. In addition, a random access response transmitted by the base station in the downlink subframe 1 may reach the user equipment 1 and/or the user equipment 2 in the uplink subframe 1 or an uplink subframe 2, and a random access response transmitted by the base station in the downlink subframe 2 may reach the user equipment 1 and/or the user equipment 2 in the uplink subframe 2 or an uplink subframe 3 (see FIG. 1b).

<6> In addition, unlike the above-described example, if there is no resource available in a time domain in which the base station needs to transmit a response, there is a problem in that the response

cannot be provided on time. In this case, a response to a corresponding RACH slot is not transmitted or transmitted with a delay. At this time, there is a need for a method for distinguishing between a response transmitted with a delay and a response transmitted on time, or between responses transmitted with a delay.

<7> In addition, if responses of several RACH slots are collected and are simultaneously transmitted, there is a need for a method for distinguishing between the RACH slots.

[DISCLOSURE OF THE INVENTION]

[PROBLEMS TO BE SOLVED]

<8> The present invention is devised to solve the problems described above, and an object of the present invention is to provide a method for transmitting and receiving a random access response, the method being capable of preventing a user equipment, which attempts to access by using a randomly selected sequence, from erroneously receiving a response to access of another user equipment, which attempts access with the same sequence as the user equipment, as a response to the access attempt of the user equipment.

[MEANS FOR SOLVING THE PROBLEM]

<9> In order to solve the problems described above, according to the present invention, a method for transmitting a random access preamble and receiving a random access response includes transmitting, by a user equipment, a random access preamble, and receiving, by the user equipment, a random access response, wherein the random access response received by the user equipment includes time-related

information related to a point in time when the random access preamble corresponding to the received random access response has been transmitted. The time-related information may be a number associated with a subframe at the point in time when the user equipment transmits the random access preamble. The number associated with the subframe may be a number allocated only to a subframe in which a random access channel (RACH) slot is present among subframes. The above-described allocation may be performed by a modulo operation on the number of the subframe in which the random access channel (RACH) slot is present among the subframes. The modulo operation may be a modulo-4 operation. In addition, the random access preamble transmitted by the user equipment may include time-related information related to a point in time when the user equipment transmits the random access preamble.

<10> In another aspect of the present invention for solving the problems described above, according to the present invention, a method for receiving a random access preamble and transmitting a random access response includes receiving, by a base station, a random access preamble, and transmitting, by the base station, a random access response of the received random access preamble, wherein the transmitted random access response includes time-related information related to a point in time when the received random access preamble has been transmitted, or delay offset information related to processing delay time consumed for transmitting the random access response from the time when the base station has received the random access preamble. The point in time of transmission may be estimated by the base station on the basis of a cell size. The received random access preamble may include time-related information related to a point in time when the received random access preamble

has been transmitted, and the time-related information included in the transmitted random access response may be associated with the time-related information included in the received random access request.

<11> In another aspect of the present invention for solving the problems described above, according to the present invention, a method for transmitting a random access and receiving a random access response includes transmitting, by a user equipment, a random access preamble, and receiving, by the user equipment, a random access response, wherein the receiving of the random access response by the user equipment is performed within a predetermined time domain including a predetermined time point after a point in time when the random access preamble is transmitted, wherein the predetermined time point is a time point when time obtained by adding a predetermined offset time to time corresponding to half of the number of hybrid automatic repeat request (HARQ) processes elapses after the point in time when the random access preamble is transmitted. The random access response may include delay offset information, wherein the delay offset information may be used to change the predetermined time domain.

[EFFECT]

<12> According to the present invention, it is possible to solve a problem in which a user equipment recognizes a random access response to a random access request transmitted by another user equipment as a response to the random access request transmitted by the user equipment.

[DETAILED DESCRIPTION OF THE INVENTION]

<13> The configuration, operation, and other features of the present invention will be easily understood by the preferred embodiments of the present invention described below with reference to the attached drawings. The following embodiments are examples in which the technical features of the present invention are applied to a wideband radio access system, which may refer to "3GPP TS 36.211 v.8.1.0, 'Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation', 2007-12-20" regarding random access in a wideband radio access system.

<14> In the wideband radio access system, a 'channel' refers to a passage of a portion allocated to each transceiver pair, and indicates a logical signal passage rather than a physical transmission path. Accordingly, several channels may be present in one transmission path.

<15> In an asynchronous wideband code division multiple access (WCDMA) (asynchronous wideband CDMA), three channels are defined for each layer. The first channel is a logical channel between a radio link control (RLC) layer and a medium access control (MAC) layer, and is classified depending on which type of information is included, that is, according to 'type of information.' The second channel, which is a transport channel, is a channel between the MAC layer and a physical layer, which is classified according to "characteristics of delivered information," and is largely classified into a dedicated transport channel and a common transport channel. The third channel, which is a physical channel, is a channel transmitted via an actual antenna, and is classified according to "radio resources, particularly efficiency of a code and RF output" (see FIG. 15 and FIG. 16). In the RLC layer, which is responsible for the reliability of transmission, retransmission is performed in the unit of logical channels. That is, when an error occurs on a receiving side, logical channel retransmission is performed

in the unit of information (transmission time interval (TTI)) rather than the unit of frames configured in the physical layer.

<16> The transport channel is a delivery channel between the physical layer and an upper layer and is defined according to characteristics of transported data and a transport method. The transport channel is responsible for transporting data delivered from the logical channel, but the logical channel and the transport channel do not correspond one-to-one, and several logical channels may be transported using one transport channel. Accordingly, the MAC layer between the logical channel and the transport channel perform mapping between the logical channel and the transport channel.

<17> Similar to the logical channel, the transport channel may be regarded as a flow of data rather than a physically classified channel. Particularly, since all protocols are located at the same location in a user equipment, the transport channel of the user equipment is defined only internally between the MAC layer and the physical layer. Since the physical layer is located in Node B in a universal mobile telecommunication system (UMTS) terrestrial radio access network (UTRAN), an appropriate interface should be defined for data exchange with the MAC layer located in the RLC.

<18> The transport channel is classified into the dedicated transport channel and the common transport channel according to the characteristics of the delivery information. A dedicated channel (DCH) belongs to the dedicated transport channel, and a broadcasting channel (BCH), a forward access channel (FACH), a paging channel (PCH), a random access channel (RACH), a downlink shared channel (DSCH), a common packet channel (CPCH), and a high speed-downlink shared channel (HS-DSCH) belong to the common transport channel.

<19> The RACH is a channel for transmitting short packet data such as short messaging service (SMS) and control information such as call set-up to an uplink, and operates by a process similar to a synchronous random access channel on the basis of a slotted ALOHA random access scheme. Accordingly, there is a collision risk with a signal of another user equipment, and an open-loop power control is used. While a transmission rate of 9.6 kbps is defined in a synchronous CDMA system, a transmission rate of up to 120 kbps is defined in an asynchronous system. However, in practice, the transmission rate is limited to about 15 kbps.

<20> The physical channel is a channel transmitted via an actual antenna and various types of information are transmitted via one physical channel or several physical channels. Since some overhead physical channels are used purely for the purpose of aiding the transmission and reception of physical channels regardless of an upper layer, the overhead physical channels are generated by a base station without a direct mapping relation with the transport channel. Among the transport channels, the RACH is mapped to a physical random access channel (PRACH) of the physical channel.

<21> In uplink random access, a user equipment which does not access a base station uses a slotted ALOHA random access scheme in order to access the base station, and gradually increases and repeatedly transmits a probe output until access becomes successful when a probe (an action for identifying and searching for a certain presence) transmission fails. In the WCDMA system, an Acquisition Indication Sense Multiple Access (AiSMA) scheme of transmitting only a preamble part in each probe, receiving information that synchronization acquisition of an access preamble is performed from the base station via an acquisition indication channel (AICH) in downlink, and then

transmitting a message part is adopted. Accordingly, since the transmission time of the random access probe in the WCDMA system is extremely shorter than that of the synchronous system, a base station reception noise phenomenon due to probes which fail in the access to the base station is remarkably reduced. Information about subgroups and codes available for a random access preamble part is specified according to access service rating via a system information block (SIB) 5 message from a radio resource management layer which is an upper layer, and information about a transmission format of a message part, a system frame number, and the like is received from the MAC layer. A random access channel is used to perform an operation related to a request for the set-up of a call to the base station and to transmit short one-way packet data of one or two frames to an uplink.

<22> A message part transmitted after an ACK signal for a preamble signal is received is composed of 10 msec or 20 msec, and a substantial data part and a control part are multiplexed to an I/Q channel, are BPSK-modulated, and are simultaneously transmitted.

<23> In order to minimize a probability that RACH signals from several user equipments collide, the transmission of the RACH signals is started in respective access slots specified to the user equipments. The access slot number is uniquely specified in an upper layer. Parameters related to the RACH are broadcast to all reception-standby user equipments via the SIB5 of the BCH.

<24> FIG. 2a is a view showing an example of a frame structure used in a wideband radio access system.

<25> In "3GPP TS 36.211 v.8.1.0, 'Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation', 2007-12-20," a physical channel for an evolved UTRA is described. Two

types of frame structures may be used, and the first frame structure of which (see FIG. 2a) is applicable to a full duplex frequency division duplex (FDD) and a half duplex FDD. Each radio frame has a length of 10 ms, and is configured by 20 slots each having a length of 0.5 ms. The slots have numbers of 0 to 19. One subframe is configured by two continuous slots. In an FDD, 10 subframes are used for uplink transmission and downlink transmission for 10 ms, respectively.

<26> FIG. 2b is a view showing an example of a random access preamble format.

<27> As illustrated in FIG. 2b, a physical layer random access preamble includes a cyclic prefix having a length of T_{CP} and a sequence part having a length of T_{SEQ} . Parameters therefor are listed in Table 1 and the parameters are determined by a frame structure and a random access configuration. The preamble format is controlled by an upper layer.

<28> <Table 1>

<29>

Preamble format	T_{CP}	T_{SEQ}
0	$3618 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4	$448 \cdot T_s$	$4096 \cdot T_s$
(Corresponding to only frame structure)		

<30> For the preamble formats 0 to 3, there is a maximum of one random access resource per subframe. Table 2 shows subframes in which random access preamble transmission is allowed in the

given configuration. If it is assumed that a timing advance is zero, the start of the random access preamble will be aligned in parallel to the start of an uplink subframe corresponding to a user equipment (UE; or terminal). Referring to Table 2, a random access channel may have a period of a minimum of 1 ms to a maximum of 20 ms.

<31> <Table 2>

<32>

PRACH configuration	System frame number	Subframe number
0	Even	1
1	Even	4
2	Even	7
3	Any	1
4	Any	4
5	Any	7
6	Any	1, 6
7	Any	2, 7
8	Any	3, 8
9	Any	1, 4, 7
10	Any	2, 5, 8
11	Any	3, 6, 9
12	Any	0, 2, 4, 6, 8
13	Any	1, 3, 5, 7, 9
14	Any	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
15	Even	9

<33> In the following description, the RACH configuration having a period of 1 ms will be described.

However, the present invention is not limited to such an RACH period. In addition, since the effect of the present invention is further increased when the period is short, the present invention may be used only in a specific RACH configuration having a short period. In addition, for convenience, a 3GPP LTE (hereinafter, 'LTE') system will be described as an example only for convenience of description, but the present invention is not limited thereto. For example, the present invention is applicable to a

ranging channel of the IEEE 802.16 (hereinafter, 802.16). In other words, an RACH response of the LTE described in the present invention may be interpreted as a ranging response of 802.16.

<34> FIG. 3a is a view for describing a method of random access response including time information, according to an embodiment of the present invention.

<35> In the embodiment of the present invention in FIG. 3a, since a method of transmitting a random access response including time location information is used, it is possible to prevent the random access response from being erroneously received. In this case, since additional information is further transmitted, signaling overhead may slightly occur. For example, as shown in FIG. 3a, when a base station transmits a random access response, it is possible for the base station to transmit an uplink subframe number (UL subframe number) at a point in time when a user equipment has transmitted a random access request (random access preamble) (hereinafter, the uplink subframe number of an uplink subframe 0 is denoted by '0'). As in the embodiment in FIG. 3a, it is possible to assume that each subframe has a length of 1 ms in a time domain. In addition, it is possible to assume that an RACH slot for transmitting a random access preamble has a period of 1 ms. A user equipment 1 may transmit a random access preamble having a randomly selected sequence number 1 in an uplink subframe 0 (S310). A user equipment 2 may transmit a random access preamble having a sequence number 1, which is randomly selected but is identical to the sequence transmitted by the user equipment 1, in an uplink subframe 1 (S320). A base station may receive the random access sequence transmitted by the user equipment 1 in a downlink subframe 3, and then may transmit a random access response thereto (S330). The random access response may include information about the sequence number 1 and the

uplink subframe 0. Thereafter, the base station may receive the random access sequence transmitted by the user equipment 2 in a downlink subframe 4, and then may transmit a random access response thereto (S340). The random access response may include information about the sequence number 1 and the uplink subframe 1. The user equipment 1 and the user equipment 2 may receive, in an uplink subframe 7, a random access response to a random access preamble transmitted by the user equipment 1. Thereafter, the user equipment 1 and the user equipment 2 may check whether the number information of the uplink subframe included in the received random access response matches the uplink subframe number of the random access preambles respectively transmitted by the user equipment 1 and the user equipment 2. If the number of an uplink subframe included in the random access response received by the user equipment 1 is identical to the number of an uplink subframe of the random access preamble transmitted by the user equipment 1, the random access response received by the user equipment 1 may be recognized as a response to the random access transmitted by the user equipment 1. However, if the number of the uplink subframe included in the random access response received by the user equipment 1 is not identical to the number of the uplink subframe of the random access preamble transmitted by the user equipment 1, the random access response received by the user equipment 1 may be recognized as not a response to the random access transmitted by the user equipment 1. Similarly, if the number of an uplink subframe included in the random access response received by the user equipment 2 is identical to the number of an uplink subframe of the random access preamble transmitted by the user equipment 2, the random access response received by the user equipment 2 may be determined to be a response to the random access transmitted by the user

equipment 2. However, if the number of the uplink subframe included in the random access response received by the user equipment 2 is not identical to the number of the uplink subframe of the random access preamble transmitted by the user equipment 2, the random access response received by the user equipment 2 may be determined not to be a response to the random access transmitted by the user equipment 2.

<36> In FIG. 3a and the description related to FIG. 3a, a cell radius is not considered in order to facilitate the understanding of the spirit of the present invention. However, if the cell radius is actually about 50 km and the propagation speed of an electromagnetic wave is considered, a random access preamble transmitted by the user equipment 1 in the uplink subframe 0 may reach a base station in a downlink subframe 0 or a downlink subframe 1, and a random access preamble transmitted by the user equipment 2 in the uplink subframe 1 may reach a base station in a downlink subframe 1 or a downlink subframe 2. Similarly, it can be understood that if a base station transmits a random access response to the downlink subframe 1, the random access response may reach the user equipment 1 and/or the user equipment 2 in the uplink subframe 1 or an uplink subframe 2, and if the base station transmits a random access response in the downlink subframe 2, the random access response may reach the user equipment 1 and/or the user equipment 2 in the uplink subframe 2 or an uplink subframe 3 (see FIG. 3b).

<37> FIG. 4 is a flowchart showing a process of transmitting and receiving a random access between a user equipment 1, a user equipment 2, and a base station, according to another embodiment of the present invention.

<38>

The user equipment 1 and the user equipment 2 select random access channel parameters, such as a PRACH configuration and a preamble format, in steps S410 and S410', respectively. As the PRACH configuration and the preamble format, one of the configurations shown in Table 1 and Table 2 above may be selected. The user equipment 1 and the user equipment 2 may each determine the sequence number of a random access preamble to be transmitted and apply the sequence number to the preamble. The random access preamble sequence numbers transmitted by the user equipment 1 and the user equipment 2 may be identical to each other or different from each other. In this embodiment, it is assumed that the sequence numbers transmitted by the user equipment 1 and the user equipment 2 are the same as each other, which is '1.' The user equipment 1 and the user equipment 2 extract and store uplink subframe numbers at points in time when the random access preambles are transmitted, in steps S420 and S420', respectively. The time point when the random access preamble is transmitted by the user equipment 1 may be different from the time point when the random access preamble is transmitted by the user equipment 2. Hereinafter, the respective uplink subframe numbers stored by the user equipment 1 and the user equipment 2 are denoted by sf_F_N . In this embodiment, random access preambles RAP1 and RAP2 transmitted by the user equipment 1 and the user equipment 2 are transmitted at time points corresponding to the uplink subframe numbers $sf_F_N=1$ and $sf_F_N=2$, respectively. The user equipment 1 and the user equipment 2 transmit the random access preambles in steps S430 and S430', respectively.

<39>

If a base station 3 receives a random access preamble (e.g., RAP1, RAP2), the base station 3 extracts the sequence number of the received random access preamble, and estimates an uplink

subframe number (sf_F_N=j), at which the received random access preamble might have been transmitted, in consideration of a cell radius (cell size). The base station 3 includes the estimated information in a random access response to the received random access preamble (S440). Thereafter, the base station 3 transmits the random access response (S450). The transmitted random access response may reach both the user equipment 1 and the user equipment 2. In this embodiment, the base station 3 transmits the random access response to the random access preamble transmitted by the user equipment 1 before transmitting the random access response to the random access preamble transmitted by the user equipment 2. The user equipment 1 and the user equipment 2, respectively, receive the random access response transmitted in the step S450. The user equipment 1 and the user equipment 2, respectively, extract uplink subframe numbers included in the received random access responses, and then compare the extracted subframe numbers with the uplink subframe numbers stored in the step S420 (step S420'), in the steps S460 and S460'. In the user equipment 1, since the uplink subframe number sf_R_N=1 included in the received random access response is identical to the stored uplink subframe number sf_F_N=1 of the random access preamble transmitted by the user equipment 1, it may be determined that the received random access response is a response to the random access preamble transmitted by the user equipment 1. In the user equipment 2, since the uplink subframe number sf_R_N=1 included in the received random access response is different from the stored uplink subframe number sf_F_N=2 of the random access preamble transmitted by the user equipment 2, it may be determined that the received random access response is not a response to the random access preamble transmitted by the user equipment 2. Each user equipment may further use sequence

information included in the received random access response as well as the uplink subframe number included in the received random access response, in order to check whether the random access response received by each user equipment is the response to the random access preamble transmitted by each user equipment. If the sequence information and the uplink subframe number included in the random access response received by any user equipment are identical to the sequence information included in the random access preamble transmitted by any user equipment and the uplink subframe number at a point in time when the user equipment has transmitted the random access preamble, it may be determined that the received random access response is a response to the random access preamble transmitted by the user equipment.

<40> FIG. 5a shows a case in which each subframe has a length of 1 ms in a time domain and an RACH slot for transmitting a random access preamble has a period of 2 ms.

<41> A user equipment 1 transmits a random access preamble having a randomly selected sequence number 1 in an uplink subframe 0 (S510). A user equipment 2 transmits a random access preamble having a sequence number 1, which is randomly selected but is identical to the sequence transmitted by the user equipment 1, in an uplink subframe 2 (S520). A base station receives the random access sequence transmitted by the user equipment 1 in a downlink subframe 3, and then transmits a random access response thereto (S530). The random access response (S630) includes a sequence number 1 and an uplink subframe number ($\text{sf_F_N}=0$) at which the random access preamble received in the downlink subframe 3 might have been transmitted, which is estimated by the base station in consideration of a cell radius (cell size). Thereafter, the base station receives the random access sequence transmitted by

the user equipment 2 in a downlink subframe 5, and then transmits a random access response thereto (S540). The random access response (S540) includes a sequence number 1 and an uplink subframe number ($\text{sf_F_N}=2$) at which the random access preamble received in the downlink subframe 5 might have been transmitted, which is estimated by the base station in consideration of a cell radius (cell size).

<42> The embodiment of FIG. 5a is different from the embodiment of FIG. 3a in that the random access sequence is transmitted only in the uplink subframe having an even number. That is, the random access sequence is transmitted only in uplink subframes 0, 2, 4, 6, and 8, which are hatched parts in FIG. 5a. Accordingly, in order to enable the base station to estimate an uplink subframe number so as to represent the number by a binary number, four signaling bits are necessary. However, if the original uplink subframe numbers $\text{Original}=\{0, 2, 4, 6, 8\}$ are renumbered to $\text{Renumbered}=\{0, 1, 2, 3, 4\}$, the numbers can be represented using only three signaling bits, so that the number of signaling bits may be reduced. This concept is applicable to the embodiment of FIG. 4.

<43> In FIG. 5a and the description related to FIG. 5a, a cell radius is not considered in order to facilitate the understanding of the spirit of the present invention. However, if the cell radius is actually about 50 km and the propagation speed of an electromagnetic wave is considered, a random access preamble transmitted by the user equipment 1 in the uplink subframe 0 may reach a base station in a downlink subframe 0 or a downlink subframe 1, and a random access preamble transmitted by the user equipment 2 in the uplink subframe 2 may reach a base station in a downlink subframe 2 or a downlink subframe 3. Similarly, it can be understood that if a base station transmits a random access response

to the downlink subframe 1, the random access response may reach the user equipment 1 and/or the user equipment 2 in the uplink subframe 1 or an uplink subframe 2, and if the base station transmits a random access response in the downlink subframe 3, the random access response may reach the user equipment 1 and/or the user equipment 2 in the uplink subframe 3 or an uplink subframe 4 (see FIG. 5b).

<44> FIG. 6a is a view showing a delayed random access response if an RACH slot has a period of 2 ms, in the embodiment of FIG. 5a.

<45> That is, the random access response of the uplink subframe 0 is delayed. When a base station receives a random access preamble in a downlink subframe 3 (S610), the base station may not have a resource which will be transmitted in downlink. This may occur in various cases. For example, if a resource is used for a dedicated multicast broadcast single frequency network (MBSFN), a unicast downlink resource cannot be allocated. In contrast, although a resource is not used for a special purpose, all resources may be used for other control signals and data signals at a specific time. In this case, the transmission of the random access response may be delayed. In addition, several random access responses may be simultaneously transmitted by one resource. Accordingly, time information related to the delayed time (that is, delay offset information) is preferably included in the random access response. As the time information (or the time related information), other information related to the time and/or the subframe number may be used.

<46> In FIG. 6a and the description related to FIG. 6a, a cell radius is not considered in order to facilitate the understanding of the problems of the technology related to the present invention.

However, if the cell radius is actually about 50 km and the propagation speed of an electromagnetic wave is considered, the random access preamble transmitted by the user equipment 1 in the uplink subframe 0 may reach the base station in a downlink subframe 0 or a downlink subframe 1, and a random access preamble transmitted by the user equipment 2 in the uplink subframe 2 may reach the base station in a downlink subframe 2 or a downlink subframe 3. Similarly, a random access response transmitted by the base station in the downlink subframe 3 may reach the user equipment 1 and/or the user equipment 2 in the uplink subframe 3 or an uplink subframe 4 (see FIG. 6b).

<47> FIGs. 7a and 7b are views describing renumbering and grouping, according to another embodiment of the present invention.

<48> In the above, an uplink subframe number or a renumbered uplink subframe number is used as the time information included in a random access response. However, a grouping method may be used when the uplink subframe number is renumbered. Herein, as the grouping method, a modulo operation and/or various known methods may be used (the modulo operation indicates an operation for obtaining a remainder when a number is divided by another number). For example, a modulo-4 operation indicates an operation for obtaining a remainder when any number is divided by 4 as a result value. For example, a subframe number may be renumbered so as to be repeated in a period of 10 ms or less. For example, while 4-bit signaling is necessary if a fifteenth PRACH configuration of Table 2 is used, 2-bit signaling is necessary if the number of an uplink subframe is operated in units of four. Alternatively, application examples may be made using various PRACH configurations of Table 2. FIGs. 7a and 7b show one of such examples. In FIGs. 7a and 7b, in a configuration in which the length

of an uplink subframe is 1 ms and RACH slots are repeated in a period of 2 ms, the number of an uplink subframe in which the RACH slot is present is renumbered. Here, the numbers of the uplink subframes are grouped and repeated by the modulo-4 operation.

<49> FIG. 8 shows the embodiment of FIG. 7 applied to the embodiment of FIG. 4, and shows, in detail, processing performed in the step S420 of FIG. 4.

<50> In a step S810, a subframe in which an RACH slot is present is detected. In a step S820, a number is reallocated only to an uplink subframe in which the RACH slot is present. In a step S830, the reallocated number of the uplink subframe at a time point when a random access will be transmitted is determined. In a step S840, a searched reallocated number is stored. Although, in this embodiment, the RACH slot is present only in even-numbered frames, the RACH slot may be present in any numbered frames. That is, the reallocation of the numbers in the step S830 may use a grouping method, and in more detail, a modulo operation may be used.

<51> FIG. 9 is a flowchart illustrating a method for transmitting and receiving a random access request and a random access response, according to another embodiment of the present invention, and is a view showing a process of transmitting and receiving a random access between a user equipment 1, a user equipment 2, and a base station.

<52> The user equipment 1 and the user equipment 2 may select random access channel parameters, such as a PRACH configuration and a preamble format, in steps S910 and S910', respectively. As the PRACH configuration and the preamble format, one of the configurations shown in Table 1 and Table 2 may be selected. The user equipment 1 and the user equipment 2 each determines the sequence

number of a random access preamble to be transmitted and applies the sequence number to the random access preamble. In this embodiment, the random access preamble sequence numbers transmitted by the user equipment 1 and the user equipment 2 may be identical to each other or different from each other. The user equipment 1 and the user equipment 2 may extract uplink subframe numbers at time points when the random access preambles are transmitted, in steps S920 and S920', respectively, and include the extracted uplink subframe numbers in the random access preambles to be transmitted. The time point when the random access preamble is transmitted by the user equipment 1 may be different from the time point when the random access preamble is transmitted by the user equipment 2. Hereinafter, the respective uplink subframe numbers included in the random access preambles transmitted by the user equipment 1 and the user equipment 2 are denoted by sf_F_N . In this embodiment, random access preambles RAP1 and RAP2 transmitted by the user equipment 1 and the user equipment 2 are transmitted at time points corresponding to the uplink subframe numbers $sf_F_N=1$ and $sf_F_N=2$, respectively. The user equipment 1 and the user equipment 2 transmit the random access preambles in steps S930 and S930', respectively. In this embodiment, it is assumed that the random access preambles transmitted by the user equipment 1 and the user equipment 2 all have a sequence number 1.

<53>

If a base station 3 receives a random access preamble (e.g., RAP1, RAP2), the base station 3 may extract a sequence number and an uplink subframe number ($sf_F_N=j$) included in the received random access preamble, and then include the extracted information in a random access response to the received random access preamble (S940). Hereinafter, the uplink subframe number included in the

random access response is denoted by sf_R_N . Thereafter, the base station 3 transmits a random access response RAR1 (S950). The transmitted random access response RAR1 may reach both the user equipment 1 and the user equipment 2. In this embodiment, the base station 3 may transmit the random access response RAR1 to the random access preamble transmitted by the user equipment 1 before transmitting the random access response to the random access preamble transmitted by the user equipment 2. The user equipment 1 and the user equipment 2, respectively, receive the random access response RAR1 transmitted in the step S950. The user equipment 1 and the user equipment 2, respectively, extract uplink subframe numbers included in the received random access responses RAR1, and then compare the extracted subframe numbers with uplink subframe numbers included in respective random accesses transmitted by the user equipments, in the steps S960 and S960', respectively. In the user equipment 1, since the uplink subframe number $sf_R_N=1$ included in the received random access response RAR1 is identical to the uplink subframe number $sf_F_N=1$ of the random access preamble RAP1 transmitted by the user equipment 1, it may be determined that the received random access response RAR1 is a response to the random access preamble RAP1 transmitted by the user equipment 1. In the user equipment 2, since the uplink subframe number $sf_R_N=1$ included in the received random access response RAR1 is different from the uplink subframe number $sf_F_N=2$ of the random access preamble RAP2 transmitted by the user equipment 2, it may be determined that the received random access response RAR1 is not a response to the random access preamble RAP2 transmitted by the user equipment 2. Each user equipment may use sequence information included in the received random access response as well as the uplink subframe number

included in the received random access response, in order to check whether the random access response received by each user equipment is the response to the random access preamble transmitted by each user equipment. If the sequence information and the uplink subframe number included in the random access response received by any user equipment are identical to the sequence information included in the random access preamble transmitted by the user equipment and the uplink subframe number, it may be determined that the received random access response is a response to the random access preamble transmitted by the user equipment.

<54> FIG. 10 is a view describing an internal processing process of step S920 (or S920') of FIG. 9 in more detail.

<55> User equipments 1 and 2 determine, in a step S1010, uplink subframe numbers at points in time when random access preambles are transmitted. Thereafter, the user equipments 1 and 2 add, in a step S1020, the uplink subframe numbers determined in the step S1010 to preambles to be transmitted. FIGs. 11, 12, and 13 are views for facilitating the understanding of other embodiments of the present invention, and are views respectively showing the principle of an ARQ, the principle of a HARQ, and a detailed example of HARQ processing, respectively.

<56> In another embodiment of the present invention, a user equipment waits for a response in a predetermined time period. Each user equipment which has transmitted a random access preamble may know in advance at which point in time a response to the random access preamble transmitted by the user equipment will be transmitted, on the basis of the predetermined time period.

<57> For example, the predetermined time period may be determined in association with HARQ timing. The HARQ is a hybrid technology in which an ARQ technology of a MAC layer and a channel coding technology of a physical layer are combined. The ARQ is a closed-loop error correction method based on feedback. If an error occurs in spite of efforts to suppress the occurrence of the error during transmission by means of forward error correction (FEC) in the physical layer, a packet in which the error occurs is retransmitted by the ARQ in an RLC layer, and as a result, when data is uploaded to the RLC layer in uplink, information may be restored and uploaded only with packets without an error.

<58> FIG. 11 is a view showing the principle of the ARQ. If an error occurs when a receiver Rx receives a packet P₁ transmitted by a transmitter Tx (S1110), the receiver Rx transmits a negative acknowledgment (NAK) signal (S1120). The transmitter Tx which has received the NAK signal retransmits the same packet P₁ as the packet P₁ in which the error has occurred upon transmission (S1130). If the receiver Rx confirms that there is no error in the retransmitted packet, the receiver Rx transmits an ACK signal to the transmitter Tx (S1140). The transmitter Tx which has received the ACK signal transmits a new packet P₂ (S1150).

<59> FIG. 12 is a view showing the principle of the HARQ. The HARQ is different from the ARQ in that channel coding of a physical layer is combined with the ARQ. If an error occurs when a receiver Rx receives a packet P_{1A} transmitted by a transmitter Tx (S1210), the receiver Rx transmits a NAK signal (S1220). The transmitter Tx which has received the NAK signal transmits a packet P_{1B} (S1230). In FIG. 12, the packet P_{1A} and the packet P_{1B} are made of the same information bits, that is, the same channel encoder input packet P_{1A}, and are identical to each other or slightly different from each other.

In the HARQ, even if there is an error in the packet P_{1A} which is first transmitted, since the packet P_{1A} is a signal with a certain amount of information, the packet P_{1A} is stored without being discarded until a retransmitted signal is received and then is soft-combined with a retransmitted signal P_{1B} or is demodulated using another method. A method for utilizing packets in which errors have occurred and newly retransmitted packets includes a chase combining (CC) method, an incremental redundancy (IR) method, and the like.

<60> Each user equipment may estimate a random access response location on the basis of HARQ timing at a time location of an RACH slot transmitted by the user equipment and receive only a downlink signal in a specific time location section. For example, as in FIG. 13 showing an example of the HARQ process, if it is assumed that a time consumed for performing one HARQ process is 1 ms and the number of HARQ processes is 8, a time consumed for, at the user equipment, processing a signal transmitted from a base station in a downlink, and, at the base station, processing the signal transmitted by the user equipment in an uplink is 8 ms. In FIG. 13, T_{prop} denotes a propagation delay time. A half of a HARQ round trip time or a half of the total number of HARQ processes is consumed for receiving a response to a transmitted signal excluding the processing time of the received signal.

<61> The user equipment which attempts a random access may wait for a half of the HARQ round trip time or a half of the total number of HARQ processes from a time point when a random access preamble is transmitted, and may wait for a response within a predetermined time period from a time point when the half of the HARQ round trip time or the half of the total number of HARQ processes has elapsed. Alternatively, a method of applying an offset (delay offset) in consideration of a difference

between a data processing time and a random access processing time may be used. For example, a method of receiving a downlink signal by the user equipment with an offset of one subframe from a time determined by the HARQ round trip time or the total number of HARQ processes may be used. The offset may be represented by adding or subtracting a predetermined number, and may be represented by a multiple of the number of HARQ processes.

<62> If the RACH having a length of 2 ms or 3 ms is transmitted in the above method, a method of estimating a time for waiting for a response from a time location for a start time location of an RACH slot is possible. Alternatively, a method of estimating a time for waiting for a response from a time location for an end time location of an RACH slot is possible.

<63> It is possible to prevent each user equipment from erroneously receiving a response for another user equipment as its response by using a predetermined response reception time location. If the above-described method is used, signaling overhead is no longer included in random data in which overhead is transmitted and received.

<64> FIG. 14 is a flowchart showing a process of transmitting and receiving a random access between a user equipment 1, a user equipment 2, and a base station 3, according to another embodiment of the present invention.

<65> The user equipment 1 and the user equipment 2 select random access channel parameters, such as a PRACH configuration and a preamble format, in steps S1410 and S1410', respectively. As the PRACH configuration and the preamble format, one of the configurations shown in Table 1 and Table 2 may be selected. The user equipment 1 and the user equipment 2 each determines the sequence

number of a random access preamble to be transmitted and applies the sequence number to the random access preamble. In this embodiment, the random access preamble sequence numbers transmitted by the user equipment 1 and the user equipment 2 may be identical to each other or different from each other. The user equipment 1 and the user equipment 2 decide default times, in which the random access responses of the random access preambles to be transmitted will be received, or default uplink subframe sections in advance, in steps S1420 and S1420'. The default time or the default uplink subframe section may be changed if processing delay occurs in the base station. This change may be, although described below, performed by, at the base station, transmitting a random access response including information about a processing delay time if processing delay occurs in the base station. The time point when the random access preamble is transmitted by the user equipment 1 may be different from the time point when the random access preamble is transmitted by the user equipment 2. In this embodiment, random access preambles RAP1 and RAP2 transmitted by the user equipment 1 and the user equipment 2 are transmitted at points in time corresponding to the uplink subframe numbers $sf_F_N=1$ and $sf_F_N=2$, respectively. The user equipment 1 and the user equipment 2 transmit the random access preambles in steps S1430 and S1430', respectively.

<66>

If the base station 3 receives a random access preamble (e.g., RAP1, RAP2), the base station 3 transmits a random access response RAR1 to the received random access preamble. At this time, as described above with reference to FIG. 7, if the base station uses all resources for other processes, and thus is not able to allocate a resource to a random access request, processing delay may occur when the random access response is transmitted. If such processing delay occurs, the base station 3 may

include information about the processing delay time (timing offset) in the random access response (S1440). Thereafter, the base station 3 transmits the random access response RAR1 (S1450). The transmitted random access response may reach both the user equipment 1 and the user equipment 2. In this embodiment, the base station 3 transmits the random access response RAR1 to the random access preamble transmitted by the user equipment 1 before transmitting the random access response to the random access preamble transmitted by the user equipment 2. The user equipment 1 and the user equipment 2, respectively, receive the random access responses transmitted in the steps S1460 and S1460'. In the steps S1460 and S1460', the user equipment 1 and the user equipment 2 check, respectively, whether the received random access responses are received at the default time set in the steps S1420 and S1420'. Hereinafter, the step S1460 of the user equipment 1 will be mainly described.

<67>

It is assumed that the received random access response has been received at the default time set by the user equipment 1. At this time, the received random access response may be or may not be a response to the random access preamble transmitted by the user equipment 1. If the offset included in the received random access response is 0 (zero), it indicates that processing delay has not occurred in the base station 3, and accordingly, it may be determined that the random access response received at the default time set by the user equipment 1 is the response to the random access preamble transmitted by the user equipment 1. However, if the offset included in the received random access response is not 0 (zero), it indicates that processing delay has occurred in the base station 3, and accordingly, it may be determined that the random access response received at the default time set by the user equipment 1 is not the response to the random access preamble transmitted by the user equipment 1.

<68>

Subsequently, the step S1460 of the user equipment 1 will be mainly described. It is assumed that the received random access response has not been received at the default time set by the user equipment 1. At this time, the received random access response may be or may not be the response of the random access preamble transmitted by the user equipment 1. If the offset included in the received random access response is 0 (zero), it indicates that processing delay has not occurred in the base station 3. Accordingly, the user equipment 1 should have received the random access response at the default time set by the user equipment 1. Accordingly, it may be determined that the received random access response is not the response of the random access preamble transmitted by the user equipment 1. In contrast, if the offset included in the received random access response is not 0 (zero), it indicates that processing delay has occurred in the base station 3, and accordingly, it may be determined that the random access response received at the default time set by the user equipment 1 is the response of the random access preamble transmitted by the user equipment 1. It is assumed that the user equipment 1 receives the random access response after j sections (or the number of subframes or the time) from a time decided in the step S1420. At this time, if the offset included in the received random access response corresponds to the j sections it is determined that the received random access response is the response of the random access preamble transmitted by the user equipment 1. In contrast, if the offset included in the received random access response does not correspond to the j sections, it is determined that the received random access response is not the response of the random access preamble transmitted by the user equipment 1.

<69> The embodiments described above are combinations of constituent components and features of the present invention in a predetermined form. Each constituent component or feature should be considered optional unless otherwise explicitly stated. Each constituent component or feature may be implemented in a form that is not combined with other constituent components or features. Also, some constituent components and/or features may be combined to implement the embodiments of the present invention. The order of operations to be described in the embodiments of the present invention may be changed to another. Some configurations or features of any embodiment may also be included in other embodiments, or may be replaced with corresponding configurations or features of other embodiments. It is apparent that claims that do not have an explicit citation relationship in the patent claims may be combined to configure an embodiment or may be included as new claims by amendment after an application.

<70> In the present document, the embodiments of the present invention have been described focusing on a data transmission/reception relationship between a base station and a terminal. Here, the base station is a terminal node of a network via which the base station directly communicates with the terminal. A specific operation performed by the base station in the present invention may also be performed by an upper node of the base station, as necessary. In other words, it is apparent that various operations performed for communication with a user equipment in a network composed of a plurality of network nodes including a base station may be performed by the base station or network nodes other than the base station. The term 'base station' may be replaced with a term such as a fixed station, Node-

B, eNode-B (eNB), or an access point. In addition, the term 'terminal' may also be replaced with a term such as a user equipment (UE), a mobile station (MS), or a mobile subscriber station (MSS).

<71> The embodiments of the present invention may be implemented by a variety of means, for example, hardware, firmware, software, or a combination thereof. In the case of implementing the present invention by hardware, an embodiment of the present invention may be implemented by one or more application specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), a processor, a controller, a microcontroller, a microprocessor, and the like.

<72> In the case of implementing the present invention by firmware or software, an embodiment of the present invention may be implemented in the form of a module, a procedure, a function, or the like that performs the functions or operations described above. Software codes may be stored in a memory unit and driven by a processor. The memory unit is located inside or outside of the processor, and may exchange data with the processor by various known means.

<73> It will be apparent to those skilled in the art that the present invention may be embodied in other specific forms without departing from the spirit and essential features of the present invention. Accordingly, the above detailed description should not be construed as being limited in all respects and should be considered as illustrative. The scope of the present invention should be determined by reasonable interpretation of the appended claims, and all changes within the equivalent scope of the present invention are included in the scope of the present invention.

[CLAIMS]

1. A method for transmitting a random access preamble and receiving a random access response, the method comprising:

transmitting, by a user equipment, a random access preamble; and

receiving, by the user equipment, a random access response to the random access preamble,

wherein the random access response received by the user equipment includes time-related information related to a point in time when the random access preamble corresponding to the received random access response has been transmitted.
2. The method of claim 1, wherein the time-related information is a number associated with a subframe at the point in time when the user equipment transmits the random access preamble.
3. The method of claim 2, wherein the number associated with the subframe is a number allocated only to a subframe in which a random access channel (RACH) slot is present among subframes.

4. The method of claim 3, wherein the above-described allocation is performed by a modulo operation on the number of the subframe in which the random access channel (RACH) slot is present among the subframes.

5. The method of claim 4, wherein the modulo operation is a modulo-4 operation.

6. The method of claim 1, wherein the time-related information is estimated on the basis of a cell size.

7. A method for receiving a random access preamble and transmitting a random access response, the method comprising:

receiving, by a base station, a random access preamble; and

transmitting, by the base station, a random access response to the received random access preamble, wherein the transmitted random access response includes time-related information related to a point in time when the received random access preamble has been transmitted, or delay offset information related to processing delay time consumed for transmitting the random access response from the time when the base station has received the random access preamble.

8. The method of claim 7, wherein the point in time of transmission is estimated by the base station on the basis of a cell size.

9. The method of claim 7, wherein:

the received random access preamble comprises time-related information related to a point in time when the received random access preamble has been transmitted; and

the time-related information included in the transmitted random access response is associated with the time-related information included in the received random access request.

10. A method for transmitting a random access preamble and receiving a random access response, the method comprising:

transmitting, by a user equipment, a random access preamble; and

receiving, by the user equipment, a random access response, wherein the receiving of the random access response by the user equipment is performed within a predetermined time domain including a predetermined time point after a point in time when the random access preamble is transmitted, wherein the predetermined time point is a time point when time obtained by adding a predetermined offset time to time corresponding to half of a round trip time of a hybrid automatic repeat request (HARQ) process elapses after the point in time when the random access preamble is transmitted.

11. The method of claim 10, wherein the random access response comprises delay offset information, wherein the delay offset information is used to change the predetermined time domain.

[BRIEF DESCRIPTION OF THE DRAWINGS]

<74> FIGs. 1a and 1b are views showing an example of a random access response method.

<75> FIG. 2a is a view showing an example of a frame structure used in a wideband radio access system.

<76> FIG. 2b is a view showing an example of a random access preamble format.

<77> FIGs. 3a and 3b are views for describing a method of random access response including time information, according to an embodiment of the present invention.

- <78> FIG. 4 is a flowchart illustrating a method of transmitting and receiving a random access request and a random access response, according to another embodiment of the present invention.
- <79> FIGs. 5a and 5b are views illustrating a random access response including time information if an RACH slot has a period of 2 ms, according to another embodiment of the present invention.
- <80> FIGs. 6a and 6b are views illustrating a delayed random access response if an RACH slot has a period of 2 ms, among embodiments of the present invention.
- <81> FIGs. 7a and 7b are views describing renumbering and grouping, according to another embodiment of the present invention.
- <82> FIG. 8 is a flowchart illustrating an internal processing process of step S420 of FIG. 4 in more detail, according to another embodiment of the present invention.
- <83> FIG. 9 is a flowchart illustrating a method for transmitting and receiving a random access request and a random access response, according to another embodiment of the present invention.
- <84> FIG. 10 is a view describing an internal processing process of step S920 (S920') of FIG. 9 in more detail.
- <85> FIG. 11 is a view for describing the principle of an automatic repeat request (ARQ).
- <86> FIG. 12 is a view for describing the principle of a hybrid automatic repeat request (HARQ).

<87> FIG. 13 is a view showing a detailed example of HARQ processing, according to another embodiment of the present invention.

<88> FIG. 14 is a flowchart illustrating a method for transmitting and receiving a random access request and a random access response, according to another embodiment of the present invention.

<89> FIG. 15 is a view for describing the classification of channels according to layers, in a wideband radio access system.

<90> FIG. 16 is a view for describing the classification of channels according to layers and areas.

[DRAWINGS]

FIG. 1a

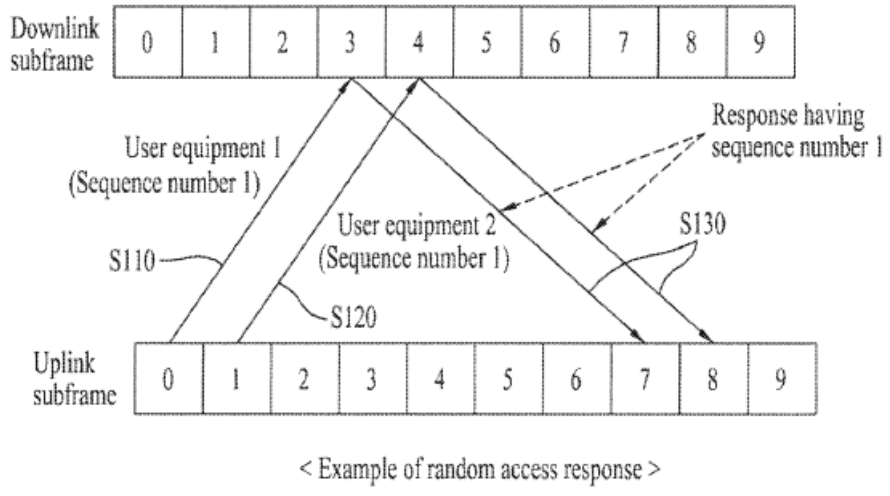


FIG. 1b

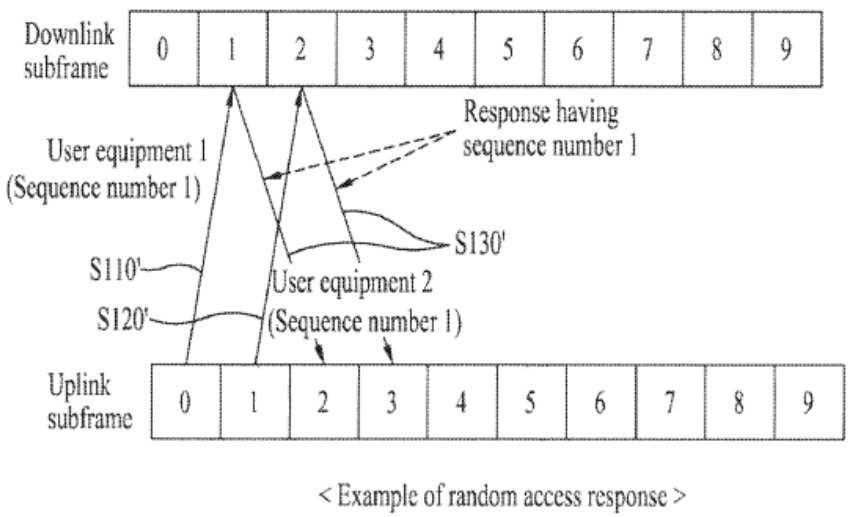


FIG. 2a

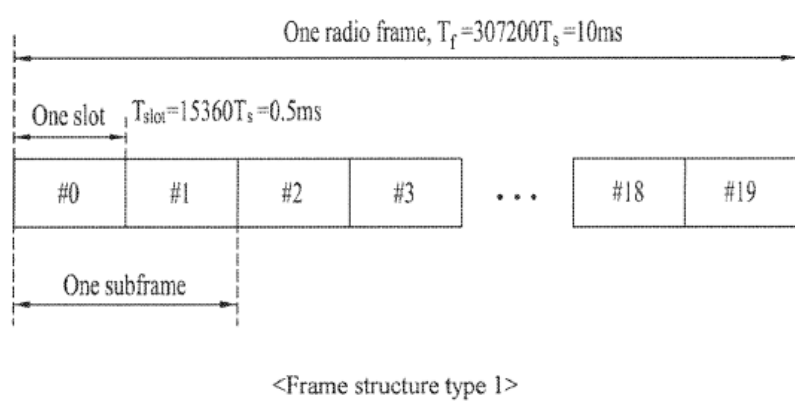


FIG. 2b

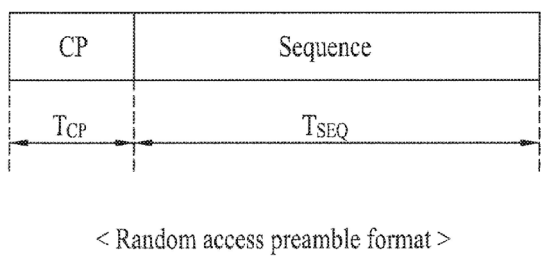


FIG. 3a

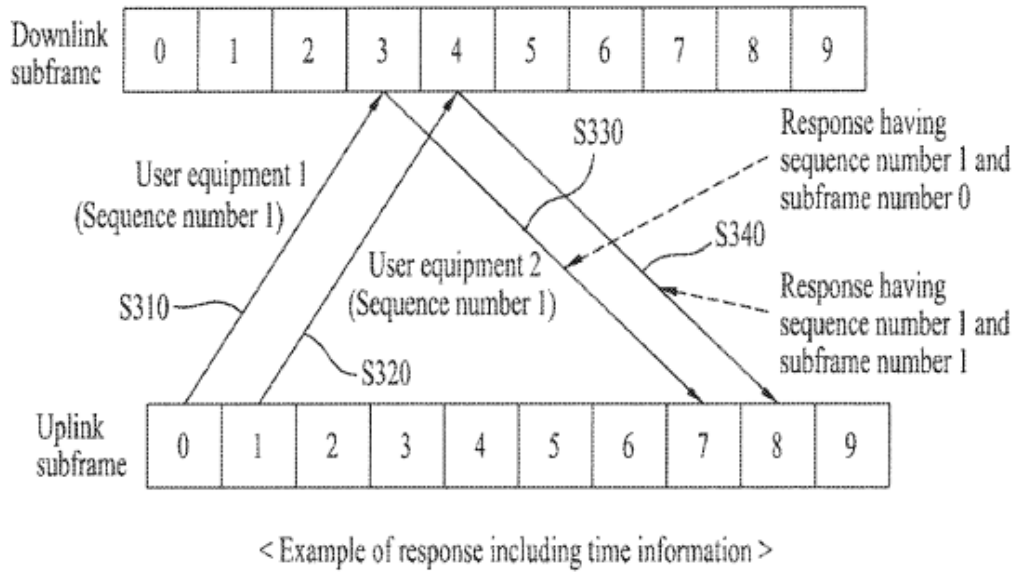
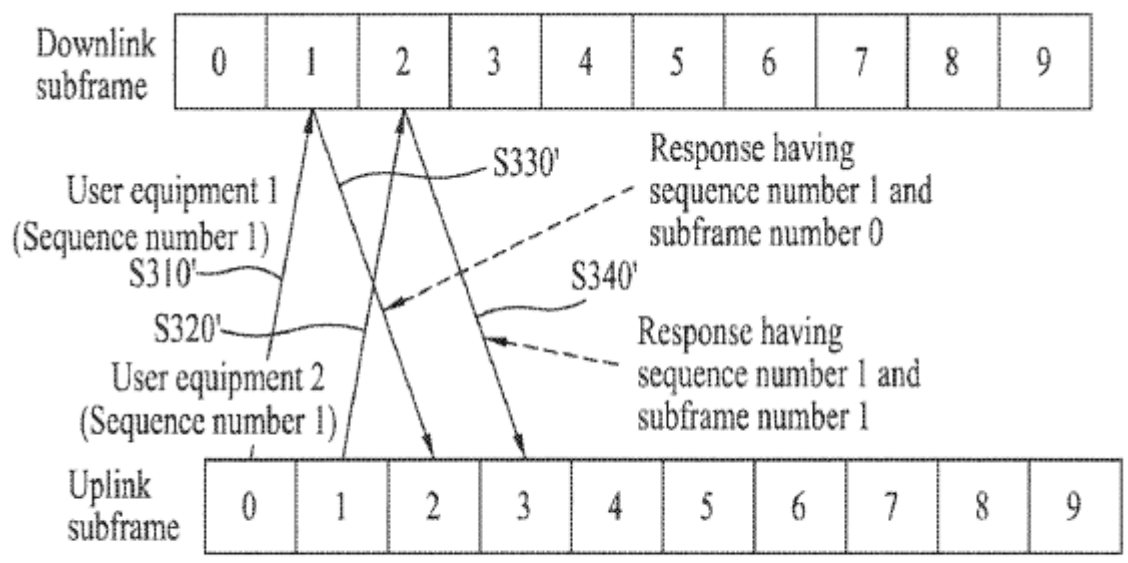


FIG. 3b



< Example of response including time information >

FIG. 4

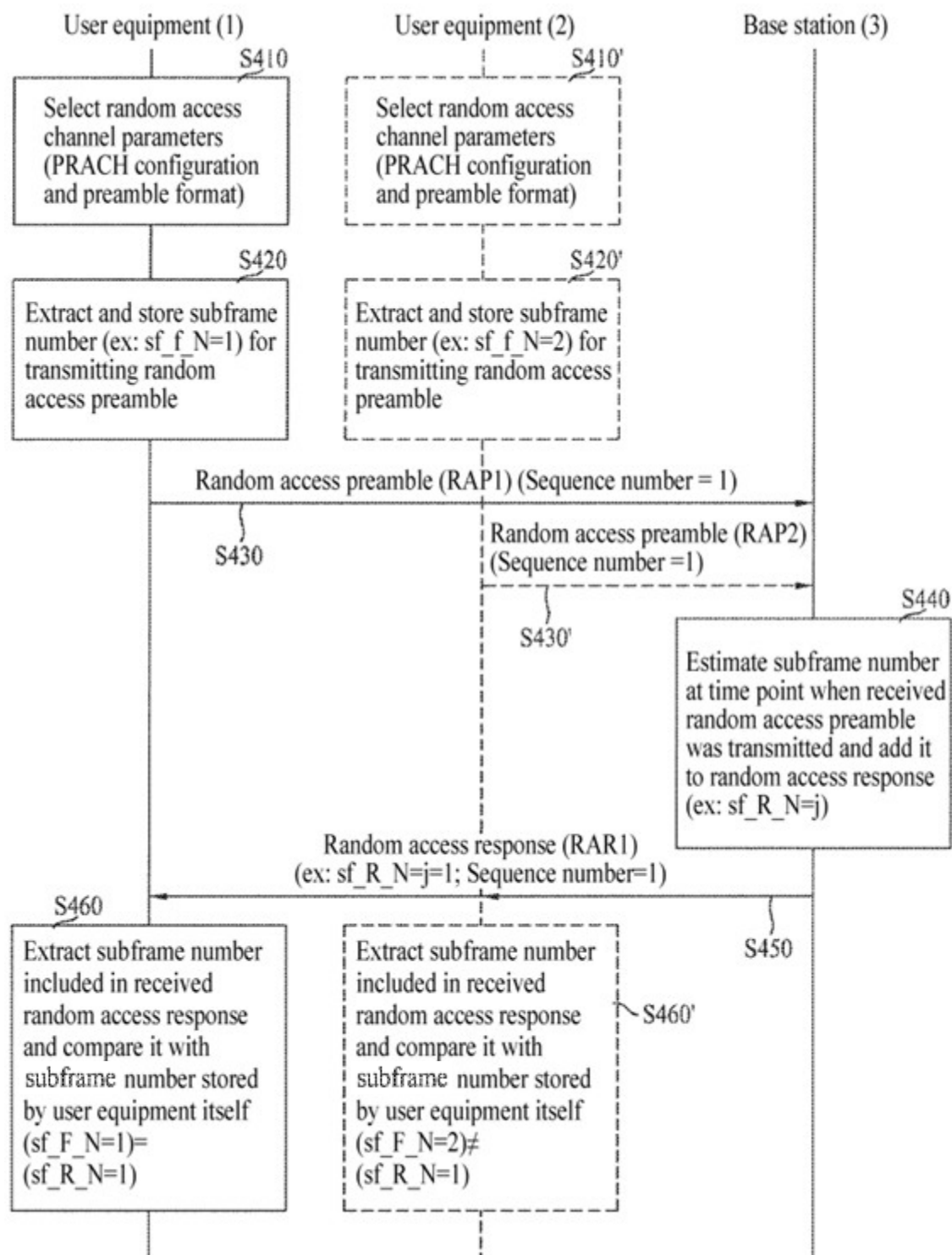
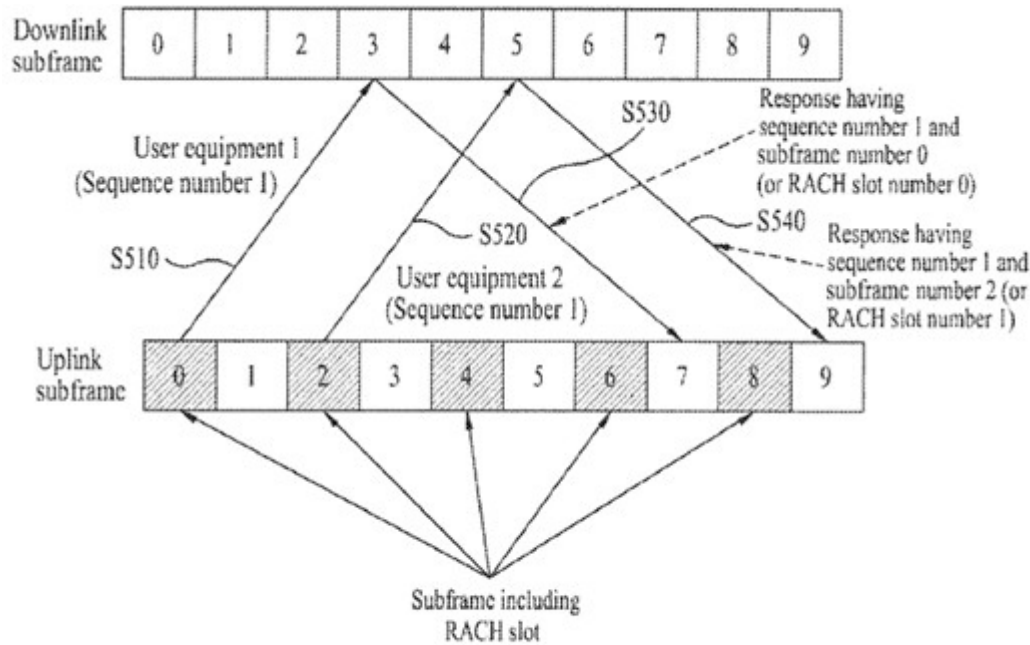
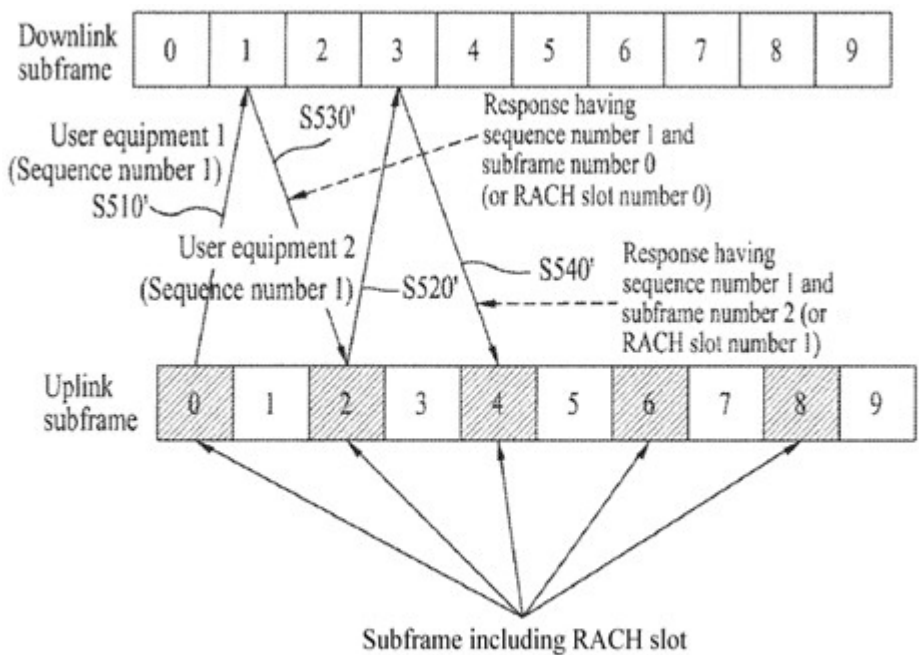


FIG. 5a



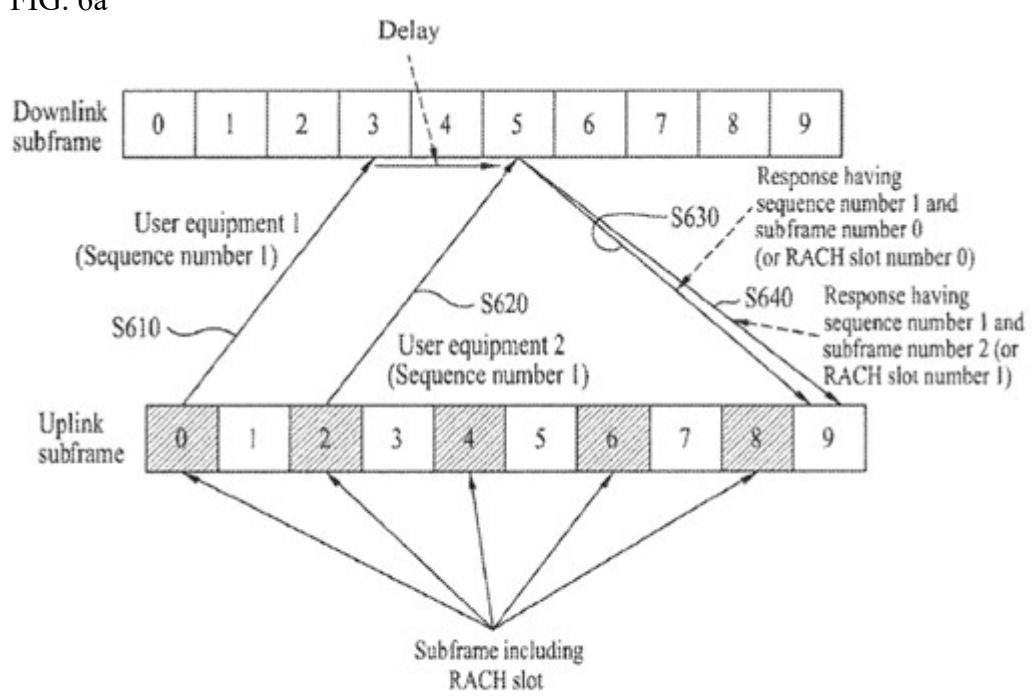
< Example of response including time information if RACH slot has period of 2 ms >

FIG. 5b



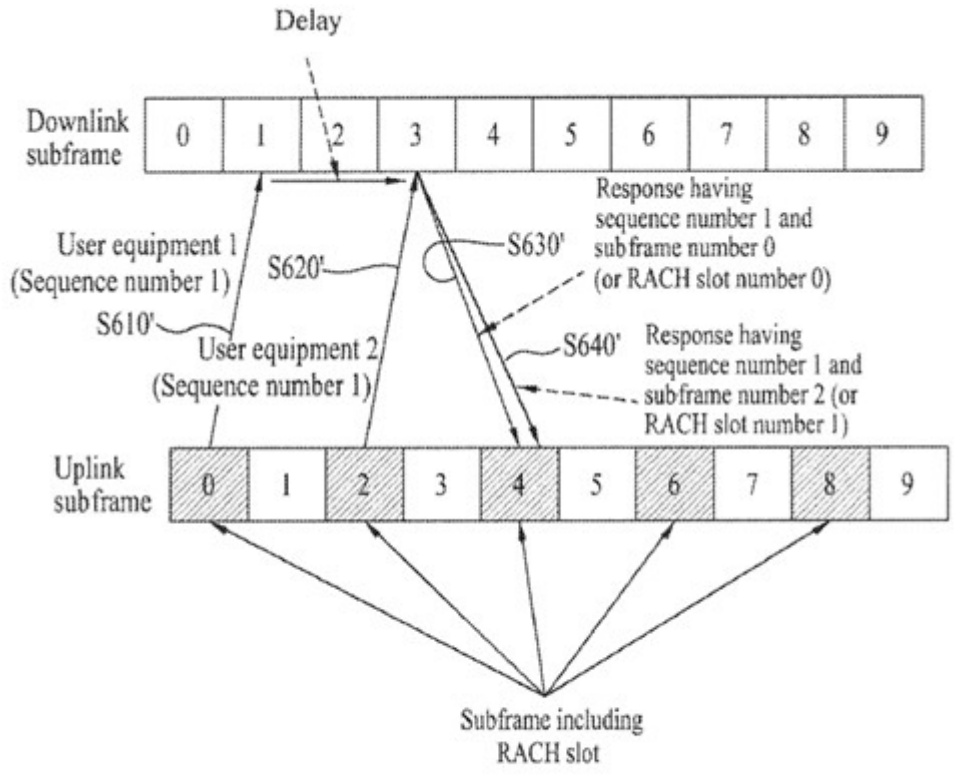
< Example of response including time information if RACH slot has period of 2 ms >

FIG. 6a



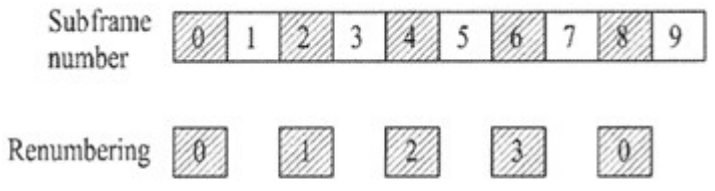
< Example of delayed response if RACH slot has period of 2 ms >

FIG. 6b



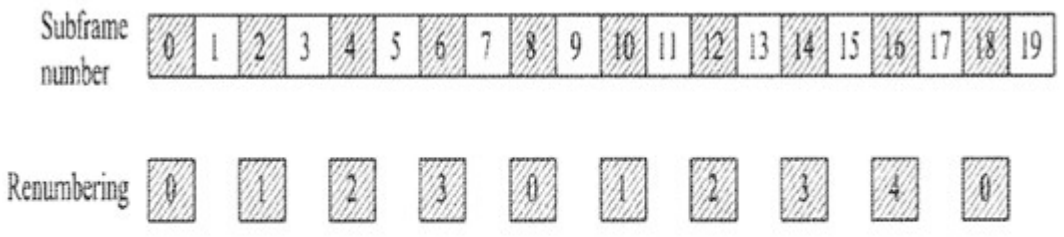
< Example of delayed response if RACH slot has period of 2 ms >

FIG. 7a



< Renumbering and grouping (or modulo operation) >

FIG. 7b



<Renumbering and grouping (or modular operation)>

FIG. 8

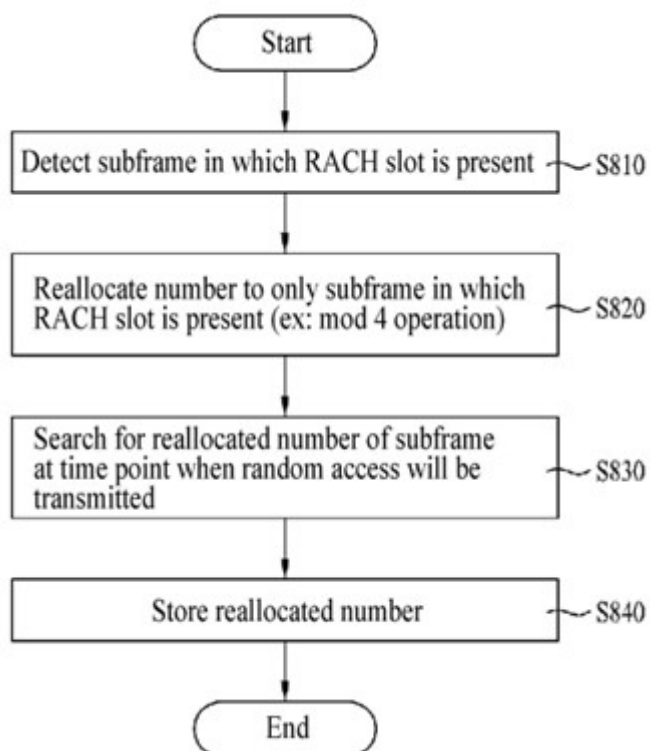


FIG. 9

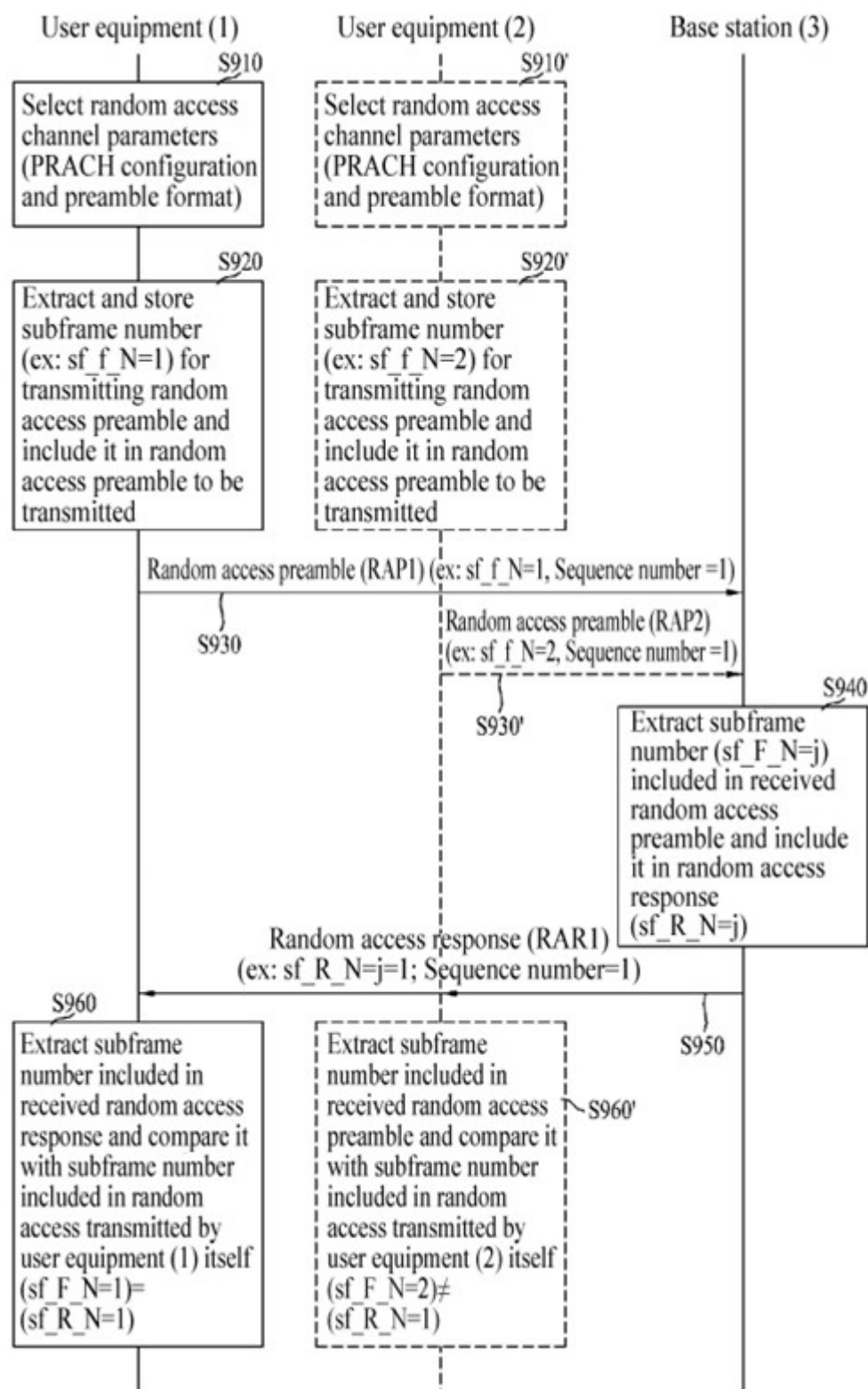


FIG. 10

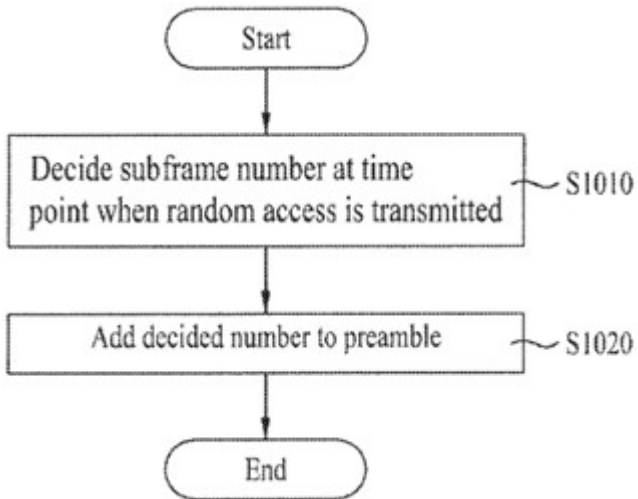


FIG. 11

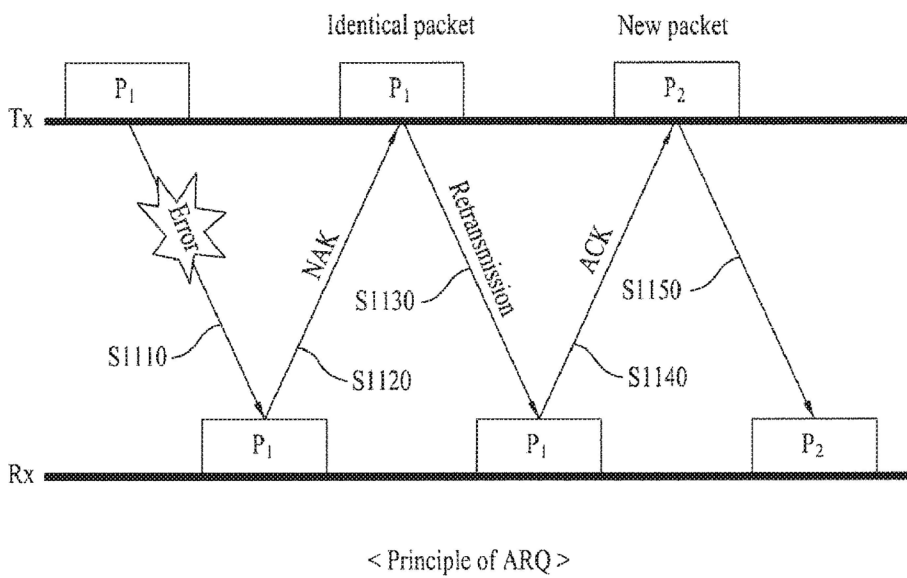
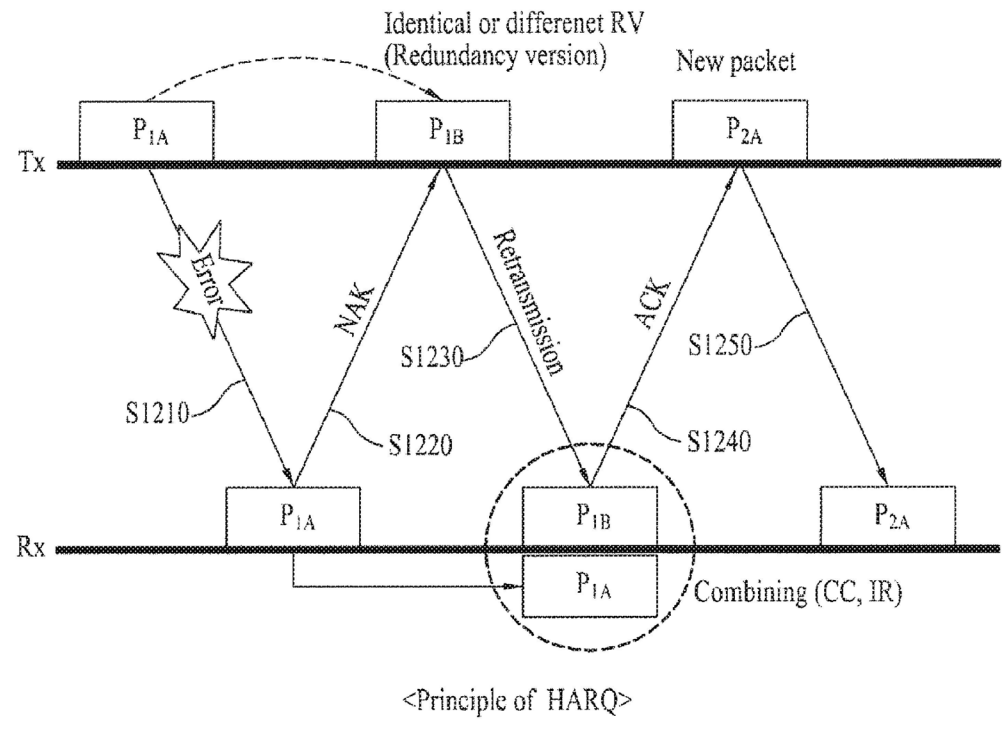


FIG. 12



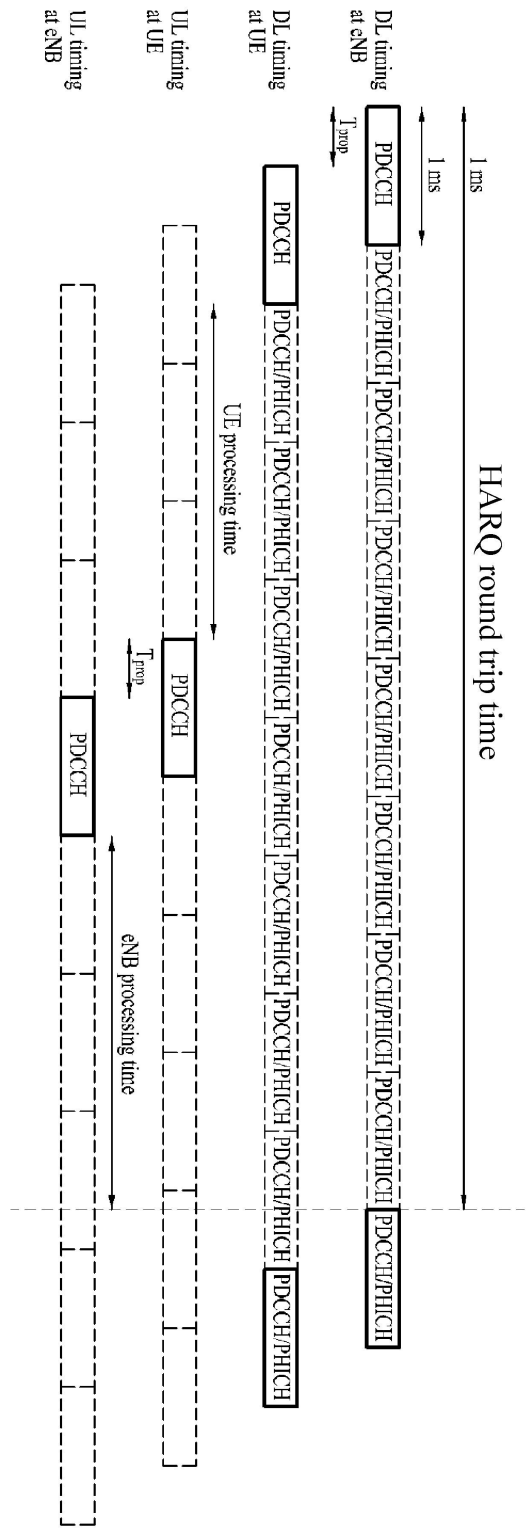


FIG. 13

<Example of HARQ process>

FIG. 14

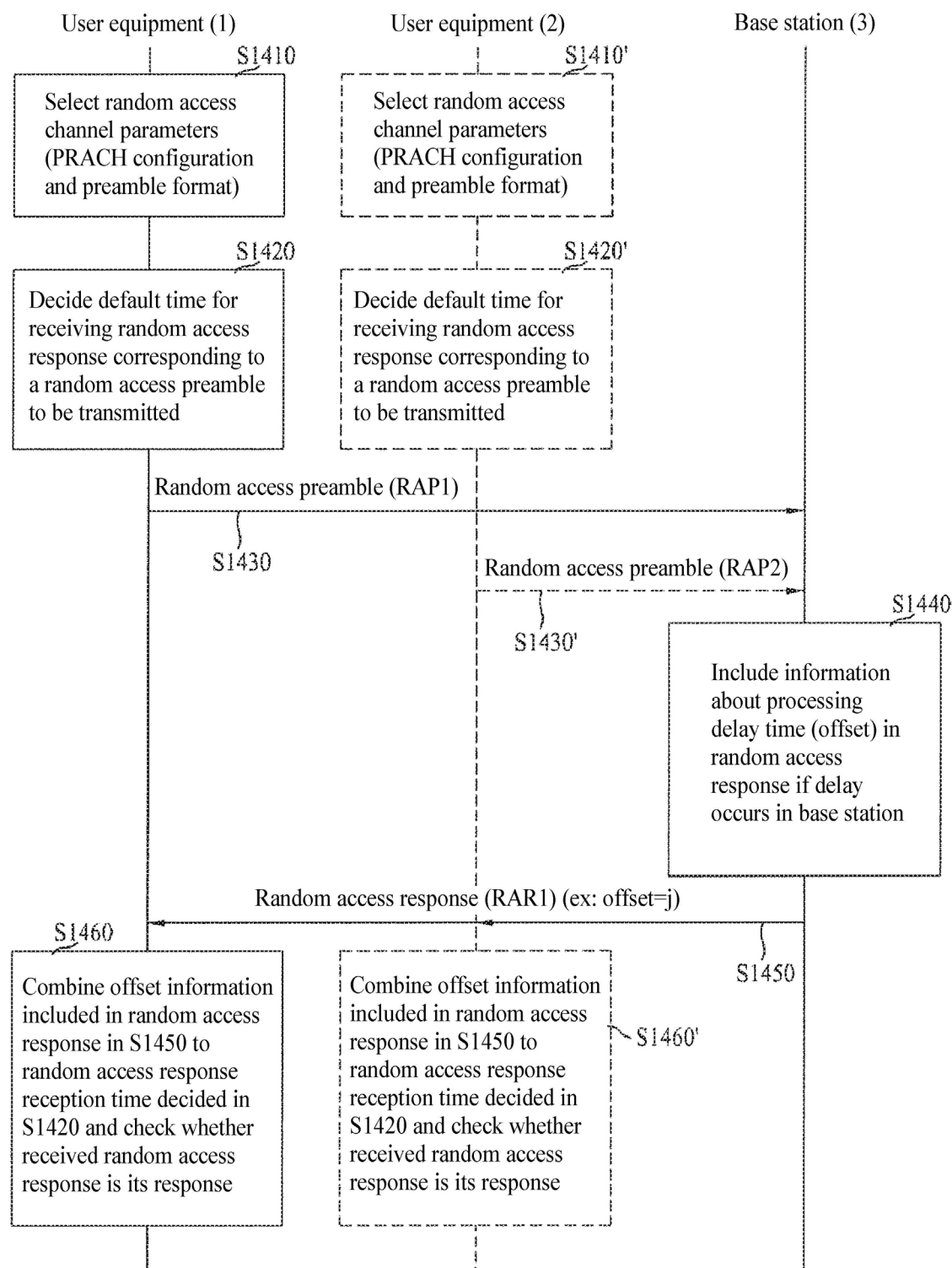
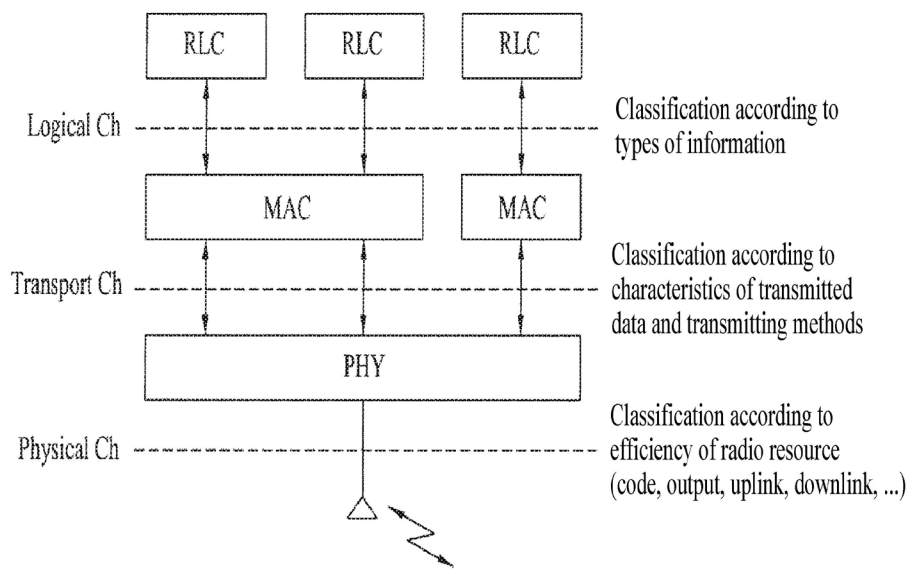
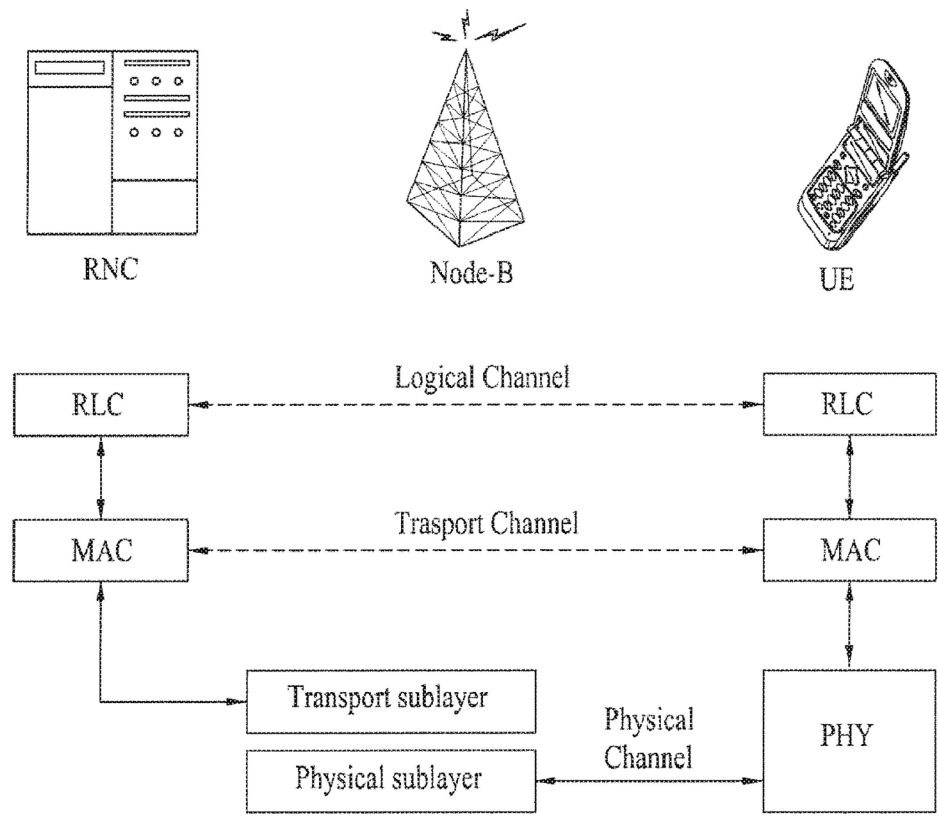


FIG. 15



<Classification of channel according to layers>

FIG. 16



<Classification of channel according to layers and areas>