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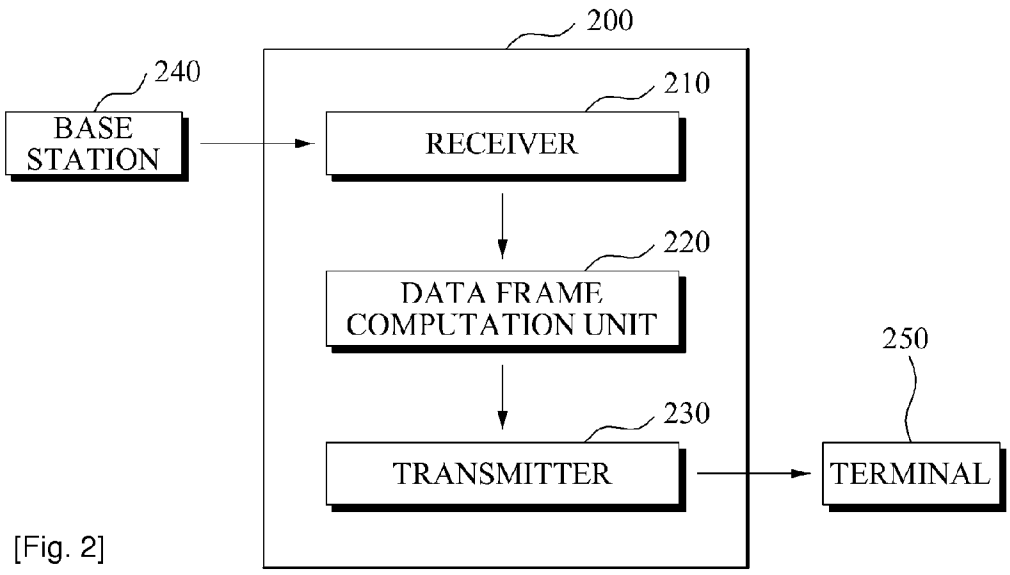

[Fig. 2]

(57) Abstract: A relay including a receiver to receive from a base station, data, a first data frame, and a second data frame, the first data frame includes data and data transmission time information associated with the data, and the second data frame includes map information corresponding to the data and map information transmission time information associated with the map information; a data frame computation unit to compute a third data frame and a fourth data frame, wherein the third data frame is used to transmit the data to a terminal and the fourth data frame is used to transmit the map information to the terminal; and a transmitter to transmit the data to the terminal using the map information when the third data frame is the same as the fourth data frame.

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Description

DATA TRANSMISSION SYSTEM FOR ASYNCHRONOUS TRANSMITTING DATA AND MAP INFORMATION

Technical Field

[1] Aspects of the present invention relate to a wireless communication system that can transmit data from a base station to a terminal, and more particularly, to a relay system that can transmit data via a relay.

Background Art

[2] There are increasing demands to use voice communication, video communication, data communication, and the like with a wireless communication network. The bandwidth for transmission of data to be transmitted between a base station and a terminal via a radio link is determined based on the state of the radio link. The state of the radio link is unstable due to fading and other factors. When the bandwidth for data transmitted to the terminal accessed to the base station increases, the number of terminals with which one base station can simultaneously communicate may be reduced. The coverage of each base station may also be reduced.

Disclosure of Invention

Technical Problem

[3] Aspects of the present invention provide a relay system that can transmit data from a base station to a terminal via a relay. The relay system can directly transmit data from the base station to the terminal and also can transmit data from the base station to the terminal via the relay, depending on a data transmission mode. The relay system can select a radio link with a better channel state from radio links from the base station to the terminal and other radio links from the relay to the terminal, and transmit data using the selected radio link. Therefore, data transmission efficiency can be improved.

[4] Additional aspects of the present invention provide a relay system that can allocate radio resource to a radio link from the relay to a terminal and transmit data using the allocated radio resource. When transmitting in advance to the terminal map information that includes information about the allocated radio resource, the terminal can receive the data using the map information.

[5] Further aspects of the present invention provide a base station that can transmit to a relay data and map information corresponding to the data, using the same data frame. The data and the map information can be synchronously transmitted, and thus can be easily bound. The relay includes the data in a subsequent data frame followed by the data frame received from the base station, and thereby transmits the data and the map information to the terminal.

Technical Solution

[6] According to an aspect of the present invention, a relay is provided. The relay includes a receiver to receive from a base station data, a first data frame, and a second data frame, the first data frame including data and data transmission time information associated with the data, and the second data frame including map information corresponding to the data and map information transmission time information associated with the map information; a data frame computation unit to compute a third data frame and a fourth data frame, wherein the third data frame is used to transmit the data to a terminal and the fourth data frame is used to transmit the map information to the terminal; and a transmitter to transmit the data to the terminal using the map information when the third data frame is the same as the fourth data frame.

[7] According to another aspect of the present invention, a base station apparatus is provided. The base station apparatus includes a radio resource allocation unit to allocate a radio resource to a radio link between a relay and a terminal; and a transmitter to transmit to the relay a first data frame and a second data frame, the first data frame including data and data transmission time information associated with the data, and the second data frame including map information corresponding to the data and map information transmission time information associated with the map information; wherein the data is included in a third data frame corresponding to the data transmission time information based on the map information, and is transmitted from the relay to the terminal.

[8] According to still another aspect of the present invention, a method of forwarding data is provided. The method includes receiving from a base station apparatus a first data frame including data and data transmission time information associated with the data; receiving from the base station apparatus second data frame including map information corresponding to the data and map information transmission time information associated with the map information; computing a third data frame to transmit the data to a terminal; computing a fourth data frame to transmit the map information to the terminal; and transmitting the data to the terminal using the map information when the third data frame is the same as the fourth data frame.

[9] Additional aspects and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

[10] Additional aspects and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

Brief Description of the Drawings

[11] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

[12] FIG. 1 illustrates a relay system for transmitting data to a terminal via a relay according to an embodiment of the present invention;

[13] FIG. 2 is a block diagram illustrating a configuration of a relay according to an embodiment of the present invention;

[14] FIG. 3 illustrates an operation of transmitting data and map information to a relay using data frames according to an embodiment of the present invention;

[15] FIGS. 4 and 5 illustrate an operation of a relay system transmitting data via a plurality of relays according to an embodiment of the present invention;

[16] FIG. 6 is a block diagram illustrating a configuration of a base station apparatus according to an embodiment of the present invention; and

[17] FIG. 7 is a flowchart illustrating a method of forwarding data via a relay according to an embodiment of the present invention.

Mode for the Invention

[18] Reference will now be made in detail to the present embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

[19] FIG. 1 shows a relay system for transmitting data to a terminal via a relay according to an aspect of the present invention. A base station 110 transmits data to terminals 121, 122, and 123 that are located within a coverage area 130 of the base station 110. A terminal 124 is located outside the coverage area 130. When the terminal 124 is located within a coverage area 140 of a relay 150 associated with the base station 110, the base station 110 may transmit the data to the terminal 124 via the relay 150. According to an aspect of the present invention, even though the terminals 121, 122, and 123 are located within the coverage area 130 of the base station 110 and thus may directly receive data from the base station 110, the terminals 121, 122, and 123 may transmit the data from the base station 110 via the relay 150 in order to improve the performance of the entire relay system.

[20] The base station 110 and the terminals 121, 122, 123, and 124 are used herein for convenience of description. The term 'base station' denotes an apparatus that can transmit user data, and the term 'terminal' denotes an apparatus that can receive the user data. Accordingly, aspects of the present invention may be applicable to a downlink and an uplink of a mobile communication system. The mobile communication system may communicate using any wireless technology, such as WiMAX,

WiBro, Wi-Fi, or cellular technology. Similarly, the terminals 121, 122, 123, and 124 may be any device capable of communicating wirelessly, including non-portable devices, such as desktop PCs, set-top boxes, and home entertainment devices; and portable devices, such as laptop computers, personal digital assistants (PDAs), mobile phones, and personal entertainment devices.

[21] The base station 110 may transmit map information to the terminals 121, 122, 123, and 124. The terminals 121, 122, 123, and 124 may receive data based on the map information. The map information includes information about a time to transmit the data.

[22] The base station 110 transmits the data to the terminal 124 via the relay 150. The relay 150 forwards to the terminal 124 data and map information corresponding to the data. The map information may not be needed when the relay 150 receives the data. However, when the relay 150 receives a plurality of data or a plurality of map information, the relay 150 should determine which data corresponds to which map information, which may be referred to as 'binding'. The relay 150 may bind corresponding data and map information based on information about the time to transmit the data from the relay 150 to the terminal 124 and information about a time to transmit the map information from the relay 150 to the terminal 124.

[23] When data and map information corresponding to the data are transmitted with a predetermined temporal relevance, it can be said that the data and the map information are synchronously transmitted. For example, when the base station 110 separates the entire data transmission time into predetermined time periods and transmits data during each time period, data and map information corresponding to the data may be transmitted during the same time period. In this case, it can be said that the data and the map information corresponding to the data are synchronously transmitted. Conversely, when the data and the map information corresponding to the data are transmitted during different time periods, it can be said that the data and the map information corresponding to the data are asynchronously transmitted.

[24] According to an aspect of the present invention, when the relay 150 separates the entire data transmission time into a plurality of time periods having a predetermined length and transmits data during each time period, the relay 150 may determine that data and map information that are transmitted from the relay 150 to the terminal 124 during the same time duration correspond to each other, and bind the data and the map information.

[25] When the base station 110 transmits data to the terminal 124 directly, the terminal 124 receives the data using map information that is received from the base station 110. Therefore, the data and the map information corresponding to the data may be synchronously transmitted.

[26] When the base station 110 transmits data to the terminal 124 via the relay 150, the

base station 110 transmits to the terminal 124 map information corresponding to the data via the relay 150, in addition to the data. The relay 150 does not receive the data using the map information and thus may receive the data and the map information synchronously or asynchronously. The relay 150 may bind the data and the map information, and synchronously transmit to the terminal 124 the data and the map information corresponding to the data.

[27] According to an aspect of the present invention, the base station 110, the relay 150, and the terminals 121, 122, 123, and 124 may transmit the data using a Media Access Control (MAC) data frame of a MAC layer. In this case, 'the predetermined time period' may be interpreted as the time that is needed to transmit each MAC data frame. The map information may include a point in time when the MAC data frame starts, a point in time when transmission of data corresponding to the map information starts, or a time period when the data corresponding to the map information is transmitted.

[28] The data transmitted from the base station 110 to the terminal 124 may be included in a burst of the MAC data frame and may be transmitted. Hereinafter, it is assumed that the base station 110, the terminals 121, 122, 123, and 124, and the relay 150 according to an aspect of the present invention transmit data using MAC data frames. Transmitting data using MAC data frames will be referred to as "transmit data or map information using data frames". According to other aspects of the present invention, the data may be transmitted in another fashion.

[29] The relay 150 receives data from the base station 110 using a first data frame, and transmits the data to the terminal 124 using a third data frame. The relay 150 receives from the base station 110 map information about a radio link between the terminal 124 and the relay 150 using a second data frame. The relay 150 transmits the map information to the terminal 124 using a fourth data frame.

[30] The map information includes information about a radio resource to transmit data in a data frame. The map information need not specify the data frame that transmits data from the relay 150 to the terminal 124.

[31] The third data frame where data is transmitted from the relay 150 to the terminal 124 may be determined based on data transmission time information associated with the data. The fourth data frame where map information is transmitted from the relay 150 to the terminal 124 may be determined based on map information transmission time information associated with the map information. According to an aspect of the present invention, the data transmission time information and the map information transmission time information may include complete or a portion of frame numbers of the third data frame and the fourth data frame. According to another aspect of the present invention, the data transmission time information may include a number of data frames to be transmitted to the terminal 124 between a point in time when the

relay 150 receives the first data frame and a point in time when the relay 150 transmits the third data frame. The map information transmission time information may include a number of data frames to be transmitted to the terminal 124 between a point in time when the relay 150 receives the second data frame and a point in time when the relay 150 transmits the fourth data frame.

[32] When the map information corresponds to the data, transmission time information associated with the data and the map information may be associated with each other. The third data frame that is determined based on the data transmission time information associated with the data may be the same data frame as the fourth data frame that is determined based on the map information transmission time information associated with the map information. According to an aspect of the present invention, the relay 150 may receive a plurality of data and map information from the base station 110 using consecutive data frames. The relay 150 may bind map information corresponding to predetermined data among the plurality of map information, using map information transmission time information associated with the map information.

[33] The relay 150 may synchronously transmit data and map information corresponding to the data to the terminal 124 using the third data frame. The map information may include a point in time when the third data frame starts, a point in time when transmission of data corresponding to the map information starts, or a time period when the data corresponding to the map information is transmitted. The terminal 124 may receive the data corresponding to the map information using the map information that is included in the third data frame.

[34] FIG. 2 shows a configuration of a relay 200 according to an aspect of the present invention. The relay 200 includes a receiver 210, a data frame computation unit 220, and a transmitter 230. According to other aspects of the present invention, the relay 200 may include additional and/or different units. Similarly, the functionality of two or more of the above units may be integrated into a single component.

[35] The receiver 210 receives from a base station 240 a first data frame that includes data and data transmission time information associated with the data. The receiver 210 receives from the base station 240 a second data frame that includes map information corresponding to the data and map information transmission time information associated with the map information. According to an aspect of the present invention, the map information may include a point in time when transmission of data corresponding to the map information starts, or a time period when the data corresponding to the map information is transmitted in a third data frame where the data is transmitted from the relay 200 to a terminal 250.

[36] According to an aspect of the present invention, the base station 240 may transmit to the relay 200 data transmission time information that includes information about a time

when data is transmitted from the relay 240 to the terminal 250. The base station 240 may transmit to the relay 200 map information transmission time information that includes information about a time when map information is transmitted from the relay 200 to the terminal 250.

[37] The data frame computation unit 220 computes the third data frame based on the data transmission time information. The third data frame is used to transmit the data to the terminal 250. The data frame computation unit 220 computes a fourth data frame based on the map information transmission time information. The fourth data frame is used to transmit the map information to the terminal 250. The transmitter 230 transmits the data to the terminal 250 using the third data frame, and transmits the map information to the terminal 250 using the fourth data frame.

[38] According to an aspect of the present invention, the data transmission time information may include complete or a portion of a frame number of the third data frame where the data is transmitted from the relay 200 to the terminal 250. The map information transmission time information may include a complete or a portion of a frame number of the fourth data frame where the map information is transmitted from the relay 200 to the terminal 250.

[39] According to an aspect of the present invention, the data transmission time information may include only a predetermined length of LSB (least significant bits) of the frame number of the third data frame where data is transmitted from the relay 200 to the terminal 250. Also, the map information transmission time information may include only a predetermined length of LSB of the frame number of the fourth data frame where map information is transmitted from the relay 200 to the terminal 250. Data frames may be identified by a data frame number that is assigned to each data frame. Therefore, the data frame number should have a sufficient length to identify different data frames. According to an aspect of the present invention, the data frame number allocated to each data frame may be represented as either 32 bits or 64 bits. When the base station 240 transmits a data frame number having 64 bits as data transmission time information associated with data or map information transmission time information associated with map information, the bandwidth of a radio channel may be wasted.

[40] There may be no great difference between a point in time when the relay 200 receives data from the base station 240 using the first data frame and a point in time when the relay 200 transmits the data to the terminal 250. The relay 200 stores in a buffer the data that is received using the first data frame during a period of time corresponding to the length of frames, based on the data transmission time information, and transmits the stored data using the third data frame. The difference between the first data frame and the third data frame is only the length of data frames. Therefore,

even when transmitting a predetermined length of LSB, instead of the 64-bit data frame number, it is possible to accurately specify the third data frame.

[41] The relay 200 stores data in the buffer until the relay 200 transmits the data using the third data frame after receiving the data using the first data frame. The data transmission time information may include a time period when the data is stored in the buffer of the relay 200.

[42] According to an aspect of the present invention, the data transmission time information may include a number of data frames to be transmitted to the terminal 250 between a point in time when the first data frame is received and a point in time when the third data frame is transmitted. The data transmission time information may include a relative frame number difference between the first data frame and the third data frame. According to an aspect of the present invention, the map information transmission time information may include only a predetermined length of LSB of the frame number of the fourth data frame in order to save the bandwidth of a radio channel.

[43] FIG. 3 shows an operation of transmitting data and map information to a relay using data frames according to an embodiment of the present invention. A base station transmits data using a first data frame 310. The base station transmits map information using a second data frame 320. According to an aspect of the present invention, the first data frame 310 and the second data frame 320 may include control signal transmission regions 311 and 321 to transmit control signals between the base station and the relay, and data transmission regions 312 and 322 to transmit data between the base station and the relay, respectively. According to an aspect of the present invention, data and map information may be included in the data transmission regions 312 and 322, and be transmitted. The data transmission region 322 of the second data frame 320 may include a MAC protocol data unit (MPDU). The MPDU may include the map information.

[44] The relay receives the data 330 and the map information 340. The relay may receive data transmission time information and map information transmission time information with respect to a radio link between the relay and the terminal. The relay may bind the data and the map information based on the received data transmission time information and the map information transmission time information.

[45] The relay transmits the data and the map information to the terminal using a third data frame 350. The third data frame 350 may include a control signal transmission region 351 to transmit control signals between the relay and the terminal, and a data transmission region 352 to transmit data between the relay and the terminal.

[46] According to an aspect of the present invention, the control signal transmission region 351 of the third data frame 350 may include a map information element (MAP

IE). The map information may be transmitted to the terminal using the map information element. The data may be transmitted to the terminal using the data transmission region 352. The terminal receives map information 361 that is included in the control signal transmission region 351 of the third data frame 350. The terminal receives the data 362 using the map information.

[47] According to an aspect of the present invention, each of the first data frame and the second data frame may include at least one of a relay MAC header, a subheader, and an extended subheader. The data transmission time information may be included in the relay MAC header, the subheader, or the extended subheader in the first data frame, and thereby be transmitted from the base station to the relay. The map information transmission time information may be included in the relay MAC header, the subheader, or the extended subheader in the second data frame, and thereby be transmitted from the base station to the relay. The data transmission time information may be included in the map information element of the first data frame and thereby received. The map information transmission time information may be included in the map information element of the second data frame and thereby received.

[48] FIGS. 4 and 5 show an operation of a relay system transmitting data via a plurality of relays according to an aspect of the present invention. A base station 411 may transmit data to a first relay 412 using a first data frame and transmit map information to the first relay 412 using a second data frame. The map information includes information about a time when the data is transmitted from the first relay 412 to a second relay 413 via a radio link. The first relay 412 does not receive the data from the base station 411 using the map information and thus may asynchronously receive the data and the map information corresponding to the data. The base station 411 may transmit to the first relay 412 data transmission time information and map information transmission time information. The first relay 412 may bind the corresponding data and the map information based on the data transmission time information and the map information transmission time information.

[49] According to an aspect of the present invention, the first relay 412 may transmit the data and the map information to the second relay 413 using a third data frame 420. The map information is included in a control signal transmission region 421 of the third data frame 420 and is transmitted. The data is included in a data transmission region 422 of the third data frame 420 and is transmitted.

[50] The second relay 413 may receive the data from the first relay 412 using the map information. According to an aspect of the present invention, the data may include second map information. The second map information includes information about a time when the data is transmitted from the second relay 413 to a terminal 414 via a radio link. The terminal 414 receives the data from the second relay 413 using the

second map information.

[51] According to an aspect of the present invention, the second relay 413 may transmit the data and the second map information to the terminal 414 using a fifth data frame 440. The fifth data frame 440 may include the second map information in a control signal transmission region 441 and include the data in a data transmission region 442. The terminal 414 may receive the data from the second relay 413 using the second map information.

[52] The base station 411 transmits the data and the map information to the first relay 412. The base station 411 may transmit the data to the first relay 412 using the first data frame and transmit the map information to the first relay 412 using the second data frame. The first relay 412 may receive data transmission time information and map information transmission time information about the radio link between the base station 411 and the first relay 412. The first relay 412 may bind the data and the map information based on the received data transmission time information and the map information transmission time information.

[53] According to an aspect of the present invention, the first relay 412 transmits data and map information to the second relay 413 using the third data frame 420. The map information is included in the control signal transmission region 421 of the third data frame 420 and is transmitted. The data is included in the data transmission region 422 of the third data frame 420 and is transmitted.

[54] The second relay 413 receives the map information 431 and receives the data 432 using the map information 431. According to an aspect of the present invention, the data 432 may include second map information. The second map information includes information about the radio link between the second relay 413 and the terminal 414. The second map information may further include second map information transmission time information associated with a transmission time of the second map information. The second relay 413 may transmit the second map information to the terminal 414 based on the second map information transmission time information.

[55] According to another aspect of the present invention, the first relay 412 may transmit the data to the second relay 413 using the third data frame 420 and transmit the second map information to the second relay 413 using a third data frame 430. The second relay 413 does not receive the data using the second map information. Therefore, the data and the second map information corresponding to the data may be asynchronously transmitted to the second relay 413.

[56] According to an aspect of the present invention, the second map information may be included in the control signal transmission region 441 of the fifth data frame 440 that is transmitted from the second relay 413 to the terminal 414, and be transmitted. The terminal 414 may receive the second map information 451 that is included in the fifth

data frame 450, and the data 452 that is included in the data transmission region 442 of the fourth data frame 440.

[57] According to another aspect of the present invention, the first relay 412 may transmit the data to the second relay 413 using the third data frame 420 and transmit third map information to the second relay 413 using the third data frame 430. The second relay 413 may receive the data from the first relay 412 using the second map information. The second relay 413 may bind the data and the third map information based on data transmission time information and map information transmission time information associated with the third map information. The second relay 413 may transmit the data to the terminal 414 using the third map information.

[58] As shown in FIG. 4, the base station 411 transmits the data to the terminal 414 via the first relay 412 and the second relay 413; however, the present invention is not limited thereto. According to another aspect of the present invention, the base station 411 may transmit data to the terminal 414 via at least three relays. In this case, data that is transmitted from each relay to a subsequent relay and map information corresponding to the data may be bound based on data transmission time information and map information transmission time information.

[59] FIG. 6 shows a configuration of a base station 600 according to an aspect of the present invention. The base station 600 includes a radio resource allocation unit 610 and a transmitter 620. According to other aspects of the present invention, the base station 600 may include additional and/or different units. Similarly, the functionality of two or more of the above units may be integrated into a single component.

[60] The radio resource allocation unit 610 determines a point in time when transmission of data using a radio link between a relay 630 and a terminal 640 starts, or a time period when the data is transmitted. According to an aspect of the present invention, the radio resource allocation unit 610 may determine a time period for transmitting data, based on a state of at least one radio link that is selected from radio links connecting the base station 600, the relay 630, and the terminal 640.

[61] The transmitter 620 transmits a first data frame to the relay 630. The first data frame includes data and data transmission time information associated with the data. The transmitter 620 transmits a second data frame to the relay 630. The second data frame includes map information corresponding to the data and map information transmission time information associated with the map information. The map information includes information about the time period where data is transmitted using the radio link between the relay 630 and the terminal 640. The relay 630 binds the received data and the map information based on the data transmission time information and the map information transmission time information. The data is included in a third data frame corresponding to the data transmission time information and is transmitted from the

relay 630 to the terminal 640.

[62] According to an aspect of the present invention, the map information may include a point in time when the third data frame starts, a point in time when transmission of data corresponding to the map information starts, or a time period when the data corresponding to the map information is transmitted. An identifier of the terminal 640 may be further included.

[63] According to an aspect of the present invention, the first data frame or the second data frame may include a control signal transmission region to transmit control signals between the base station 600 and the relay 630, and a data transmission region to transmit data between the base station 600 and the relay 630. According to an aspect of the present invention, the data transmission region may include an MPDU. The MPDU may include map information. The map information is included in the data transmission region of the second data frame and is transmitted from the base station 600 to the relay 630.

[64] According to an aspect of the present invention, each of the first data frame and the second data frame may include at least one of a relay MAC header, a subheader, and/or an extended subheader. The data transmission time information may be included in the relay MAC header, the subheader, or the extended subheader in the first data frame, and thereby be transmitted from the base station to the relay 630. The map information transmission time information may be included in the relay MAC header, the subheader, or the extended subheader in the second data frame, and thereby be transmitted from the base station to the relay 630.

[65] According to an aspect of the present invention, each of the first data frame and the second data frame may include a map information element. The data transmission time information may be included in the map information element of the first data frame and be transmitted to the relay 630. The map information transmission time information may be included in the map information element of the second data frame and be transmitted to the relay 630.

[66] FIG. 7 is a flowchart of a process of forwarding data according to an aspect of the present invention. In operation S710, a first data frame is received from a base station. The first data frame includes data and data transmission time information associated with the data.

[67] In operation S720, a second data frame is received from the base station. The second data frame includes map information and map information transmission time associated with the map information.

[68] In operation S730, a third data frame to transmit the data to the terminal is computed. According to an aspect of the present invention, the third data frame may be computed based on either the first data frame or the data transmission time information. The map

information may include a point in time when the third data frame starts, a point in time when transmission of data corresponding to the map information starts, or a time period when the data corresponding to the map information is transmitted. The map information need not specify the third data frame to transmit the data. According to an aspect of the present invention, the map information may further include an identifier of a terminal.

[69] Data transmission time information includes information about a time when data is transmitted from a relay to a terminal. Map information transmission time information associated with the map information includes information about a point in time when the map information is transmitted from the relay to the terminal. According to an aspect of the present invention, the third data frame may be computed based on a frame number of the first data frame or the data transmission time information. The data transmission time information may include a frame number of the third data frame. In operation S740, the fourth data frame is computed based on the second data frame or the map information transmission time information.

[70] According to an aspect of the present invention, the data transmission time information may include only a predetermined length of LSB of the frame number of the third data frame. The map information transmission time information may also include only a predetermined length of LSB of the frame number of the fourth data frame. There may be no great difference between a point in time when the data or the map information is transmitted from the base station to the relay and a point in time when the data or the map information is transmitted from the relay to the terminal. Only the time length of some data frames may be different. Therefore, by transmitting only the predetermined length of LSB instead of the entire frame number, the relay may compute the frame number of the third data frame based on the frame number of the first data frame, or compute the frame number of the fourth data frame based on the frame number of the second data frame.

[71] According to an aspect of the present invention, the second data frame may include a control signal transmission region to transmit control signals between the base station and the relay and a data transmission region to transmit data. The fourth data frame may include a control signal transmission region to transmit control signals between the relay and the terminal and a data transmission region to transmit data. The data transmission region of the second data frame may include an MPDU and the MPDU may include map information. The map information is included in the data transmission region of the second data frame and is transmitted from the base station to the relay. According to an aspect of the present invention, the control signal transmission region of the fourth data frame may include a map information element. The relay may transmit the map information to the terminal using the map information

element.

[72] According to an aspect of the present invention, each of the first data frame and the second data frame may include at least one of a relay MAC header, a subheader, and an extended subheader. The data transmission time information may be included in the relay MAC header, the subheader, or the extended subheader included in the first data frame, and may be transmitted from the base station to the relay. The map information transmission time information may be included in the relay MAC header, the subheader, or the extended subheader included in the second data frame, and may be transmitted from the base station to the relay.

[73] According to an aspect of the present invention, each of the first data frame and the second data frame may include a map information element. Data transmission time information may be included in the map information element of the first data frame and be transmitted to the relay. Map information transmission time information may be included in the map information element of the second data frame and be transmitted to the relay.

[74] In operation S750, when the third data frame is the same as the fourth data frame, the data is transmitted to the terminal using the map information. The relay may bind the data and the map information based on the data transmission time information and the map information transmission time information.

[75] According to an aspect of the present invention, when the third data frame and the fourth data frame, which are determined based on the transmission time information, are the same data frame, it is possible to determine the data and the map information correspond to each other. Thus, binding may be performed with respect to the data and the map information. Conversely, when the data is different from the map information, the relay may transmit data to the terminal using the map information.

[76] Aspects of the present invention can also be embodied as computer-readable codes on a computer-readable recording medium and can be realized in a common digital computer executing the program using a computer-readable recording medium. The computer-readable recording medium is any data storage device that can store data which can be thereafter read by a computer system. Examples of the computer-readable recording medium include read-only memory (ROM), random-access memory (RAM), CDs, DVDs, Blu-ray discs, magnetic tapes, floppy disks, and optical data storage devices. Aspects of the present invention may also be embodied as a computer data signal embodied in a carrier wave comprising a compression source code segment and an encryption source code segment (such as data transmission through the Internet). The computer-readable recording medium can also be distributed over network coupled computer systems so that the computer-readable code is stored and executed in a distributed fashion. Moreover, the hard disk drive can be used with a

computer, can be a portable drive, and/or can be used with a media player.

[77] Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made to this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

Claims

[1] A relay comprising:
a receiver to receive from a base station data, a first data frame, and a second data frame, the first data frame including data and data transmission time information associated with the data, and the second data frame including map information corresponding to the data and map information transmission time information associated with the map information;
a data frame computation unit to compute a third data frame and a fourth data frame, wherein the third data frame is used to transmit the data to a terminal and the fourth data frame is used to transmit the map information to the terminal; and
a transmitter to transmit the data to the terminal using the map information when the third data frame is the same as the fourth data frame.

[2] The relay according to claim 1, wherein the data frame computation unit computes the third data frame based on either the first data frame or the data transmission time information, and computes the fourth data frame based on either the second data frame or the map information transmission time information.

[3] The relay according to claim 1, wherein the map information comprises at least one of a time when transmission of the data starts in the third data frame, a time period where the data is transmitted in the third data frame, and/or an identifier of the terminal.

[4] The relay according to claim 1, wherein:
the data transmission time information comprises a predetermined length of LSB (least significant bits) of a frame number of the third data frame; or
the map information transmission time information comprises a predetermined length of LSB of a frame number of the fourth data frame.

[5] The relay according to claim 1, wherein:
the data transmission time information comprises a number of data frames to be transmitted to the terminal between a point in time when the first data frame is received and a point in time when the third data frame is transmitted; or
the map information transmission time information comprises a number of data frames to be transmitted to the terminal between a point in time when the second data frame is received and a point in time when the fourth data frame is transmitted.

[6] The relay according to claim 1, wherein the second data frame comprises a Media Access Control Protocol Data Unit (MPDU), and the MPDU includes the map information.

[7] The relay according to claim 1, wherein the fourth data frame comprises a map information element and the map information is transmitted using the map information element.

[8] The relay according to claim 1, wherein the data transmission time information or the map information transmission time information is included in at least one of a relay MAC header, a subheader, and/or an extended subheader.

[9] The relay according to claim 1, wherein the data transmission time information or the map information transmission time information is included in the map information element of each data frame.

[10] The relay as claimed in claim 1, wherein:
the data comprises second map information about a radio link between a second relay and the terminal; and
the transmitter transmits the data to the terminal via the second relay, based on the second map information.

[11] A base station apparatus comprising:
a radio resource allocation unit to allocate a radio resource to a radio link between a relay and a terminal; and
a transmitter to transmit to the relay a first data frame and a second data frame, the first data frame including data and data transmission time information associated with the data, and the second data frame including map information corresponding to the data and map information transmission time information associated with the map information;
wherein the data is included in a third data frame corresponding to the data transmission time information based on the map information, and is transmitted from the relay to the terminal.

[12] The base station apparatus according to claim 11, wherein the map information comprises at least one of a time when transmission of the data starts in the third data frame, a time period where the data is transmitted in the third data frame, and/or an identifier of the terminal.

[13] The base station apparatus according to claim 11, wherein the second data frame comprises an MPDU (Media Access Control Protocol Data Unit), and the MPDU includes the map information.

[14] The base station apparatus according to claim 11, wherein the data transmission time information or the map information transmission time is included in at least one of a relay MAC header, a subheader, and/or an extended subheader.

[15] The base station apparatus according to claim 11, wherein the data transmission time information or the map information transmission time information is included in the map information element of each data frame.

[16] A method of forwarding data, comprising:
receiving from a base station apparatus a first data frame including data and data transmission time information associated with the data;
receiving from the base station apparatus second data frame including map information corresponding to the data and map information transmission time information associated with the map information;
computing a third data frame to transmit the data to a terminal;
computing a fourth data frame to transmit the map information to the terminal; and
transmitting the data to the terminal using the map information when the third data frame is the same as the fourth data frame.

[17] The method as claimed in claim 16, wherein:
the computing of the third data frame comprises computing the third data frame based on either the first data frame or the data transmission time information; and
the computing of the fourth data frame comprises computing the fourth data frame based on either the second data frame or the map information transmission time information.

[18] The method according to claim 16, wherein the map information comprises at least one of a time when transmission of the data starts in the third data frame, a time period where the data is transmitted in the third data frame, and/or an identifier of the terminal.

[19] The method according to claim 16, wherein the data transmission time information comprises a predetermined length of LSB of a frame number of the third data frame or a predetermined length of LSB of a frame number of the fourth data frame.

[20] The method as claimed in claim 16, wherein:
the data transmission time information comprises a number of data frames to be transmitted to the terminal between a point in time when the first data frame is received and a point in time when the third data frame is transmitted; or
the map information transmission time information comprises a number of data frames to be transmitted to the terminal between a point in time when the second data frame is received and a point in time when the fourth data frame is transmitted.

[21] The method as claimed in claim 16, wherein the second data frame comprises an MPDU (Media Access Control Protocol Data Unit), and the MPDU includes the map information.

[22] The method as claimed in claim 16, wherein the fourth data frame comprises a map information element, and the map information is transmitted using the map

information element.

[23] The method as claimed in claim 16, wherein the data transmission time information or the map information transmission time information is included in at least one of a relay MAC header, a subheader, and/or an extended subheader.

[24] The method as claimed in claim 16, wherein the data transmission time information or the map information transmission time information is included in the map information element of each data frame.

[25] A computer-readable recording medium storing a program for implementing a method of forwarding data, comprising:

receiving from a base station apparatus a first data frame including data and data transmission time information associated with the data;

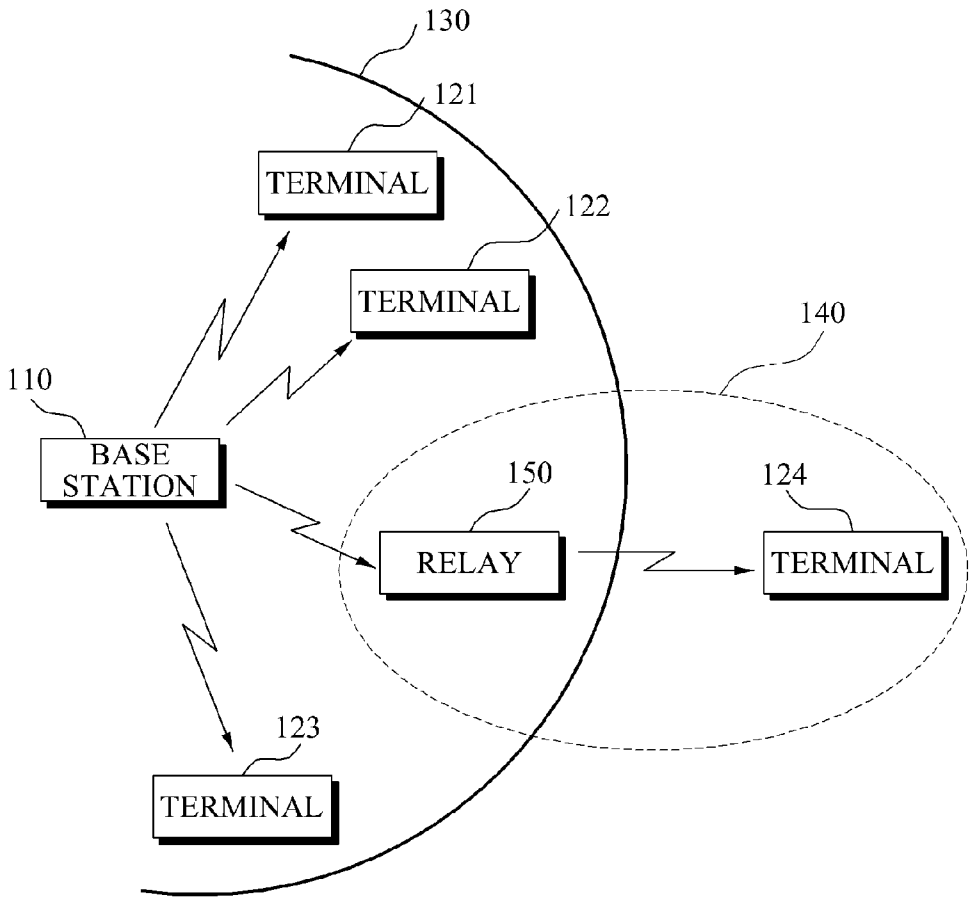
receiving from the base station apparatus second data frame including map information corresponding to the data and map information transmission time information associated with the map information;

computing a third data frame to transmit the data to a terminal;

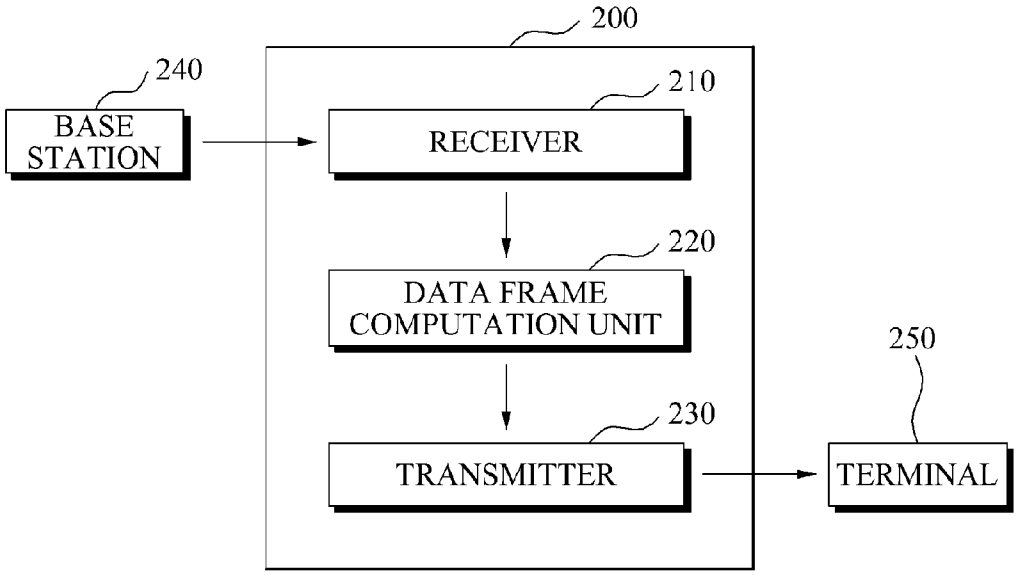
computing a fourth data frame to transmit the map information to the terminal; and

transmitting the data to the terminal using the map information when the third data frame is the same as the fourth data frame.

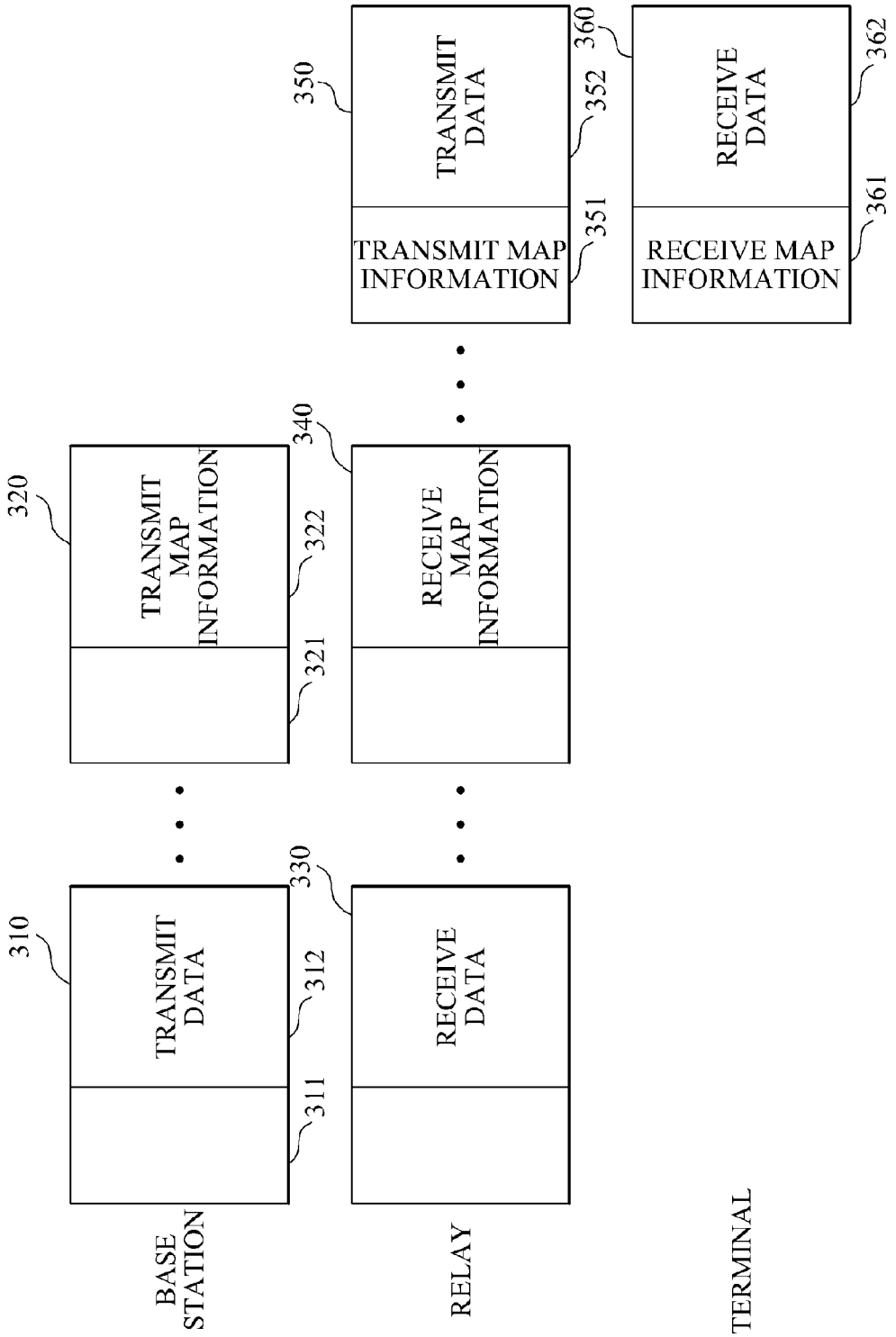
[Fig. 1]


130
121
TERMINAL
122
TERMINAL
140
110
BASE STATION
150
RELAY
124
TERMINAL
123
TERMINAL

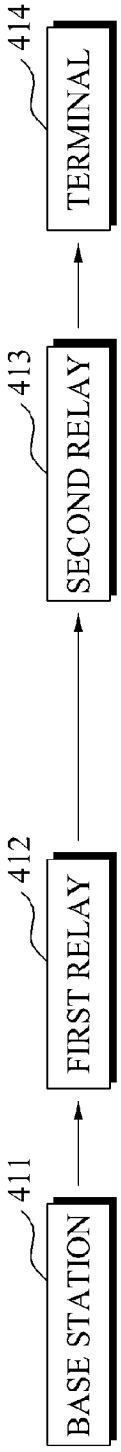
[Fig. 2]


200
240
BASE STATION
210
RECEIVER
220
DATA FRAME COMPUTATION UNIT
250
230
TRANSMITTER
TERMINAL

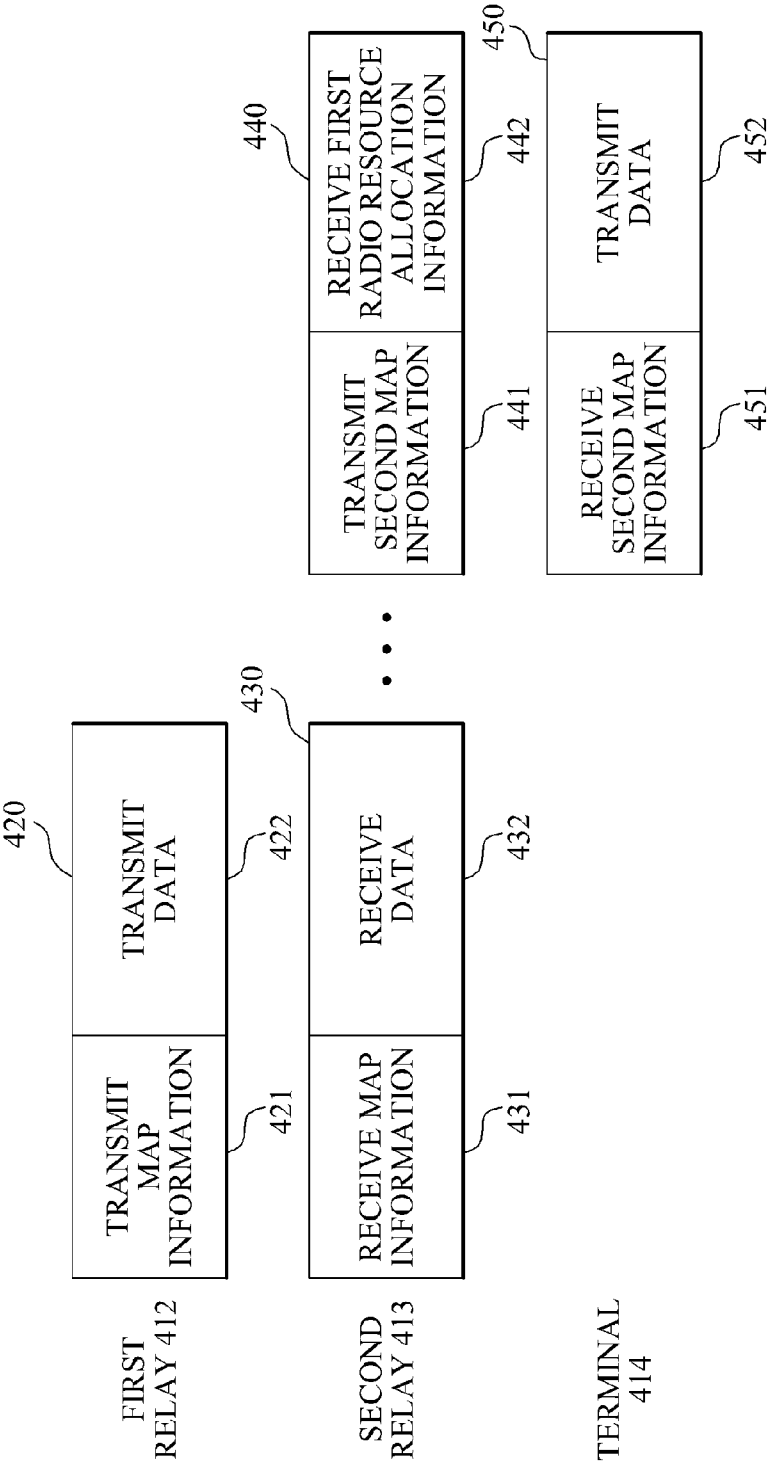
[Fig. 3]


BASE STATION
RELAY
TERMINAL
310
TRANSMIT DATA
311
312
330
RECEIVE DATA
320
TRANSMIT MAP INFORMATION
321
322
340
RECEIVE MAP INFORMATION
350
TRANSMIT DATA
351
TRANSMIT MAP INFORMATION
352
360
RECEIVE DATA
361
RECEIVE MAP INFORMATION
362

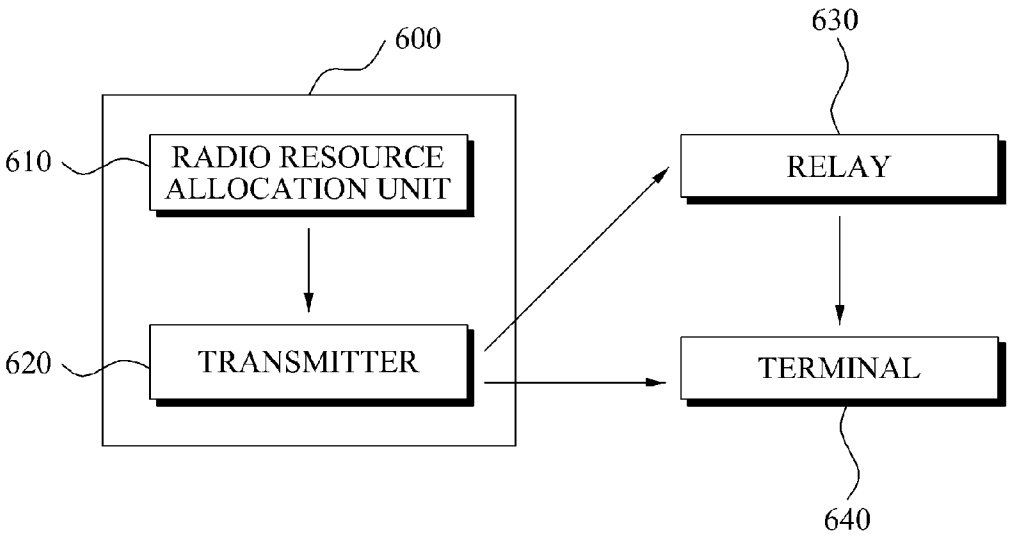
[Fig. 4]


411
BASE STATION
412
FIRST RELAY
413
SECOND RELAY
414
TERMINAL

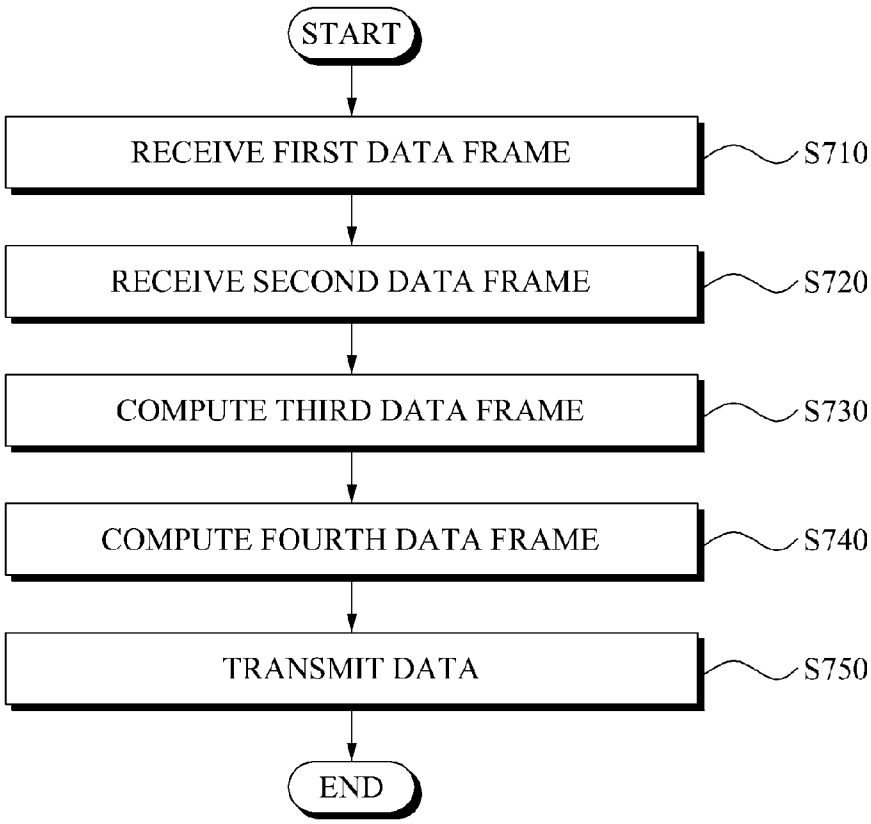
[Fig. 5]


FIRST RELAY 412
SECOND RELAY 413
TERMINAL 414
TRANSMIT MAP INFORMATION
421
TRANSMIT DATA
422
420
RECEIVE MAP INFORMATION
431
RECEIVE DATA
432
430
TRANSMIT SECOND MAP INFORMATION
441
RECEIVE FIRST RADIO RESOURCE ALLOCATION INFORMATION
442
440
RECEIVE SECOND MAP INFORMATION
451
TRANSMIT DATA
452
450

[Fig. 6]


600
630
610
RADIO RESOURCE ALLOCATION UNIT
RELAY
620
TRANSMITTER
TERMINAL
640

[Fig. 7]


START
RECEIVE FIRST DATA FRAME
S710
RECEIVE SECOND DATA FRAME
S720
COMPUTE THIRD DATA FRAME
S730
COMPUTE FOURTH DATA FRAME
S740
TRANSMIT DATA
S750
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2008/001338

A. CLASSIFICATION OF SUBJECT MATTER

H04B 7/14(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 : H04B 7/14, H04B 7/155

Documentation 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 since 1975

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

eKIPASS(KIPO internal) "relay", "map information"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2007-0038651 A (SAMSUNG ELECTRONICS CO.,LTD.) 11 April 2007 See abstract and claims 1, 4, 8 and 11	1-25
A	US 6342777 B1 (SUNAO TAKAHASHI) 29 January 2002 See abstract, and fig. 4	1-25

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"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	Date of mailing of the international search report
24 JUNE 2008 (24.06.2008)	**24 JUNE 2008 (24.06.2008)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer LEE, JEONG SU Telephone No. 82-42-481-5684

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2008/001338

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
KR102007038651A	11.04.2007	NONE	
US06342777B1	29.01.2002	JP10247874A2	14.09.1998