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(54) **WIRELESS RELAY DEVICE AND COMMUNICATION METHOD**

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(57) **ABSTRACT**

A wireless relay device includes: a communication unit that receives signaling including control information related to a relay function from a base station; a control unit that controls the relay function based on the control information; and a relay unit that executes the relay function of receiving a first signal from the base station, transmitting the first signal to a terminal, receiving a second signal from the terminal, and transmitting the second signal to the base station, in which the control unit enables or disables transmission and reception of the first signal and transmission and reception of the second signal based on the control information.

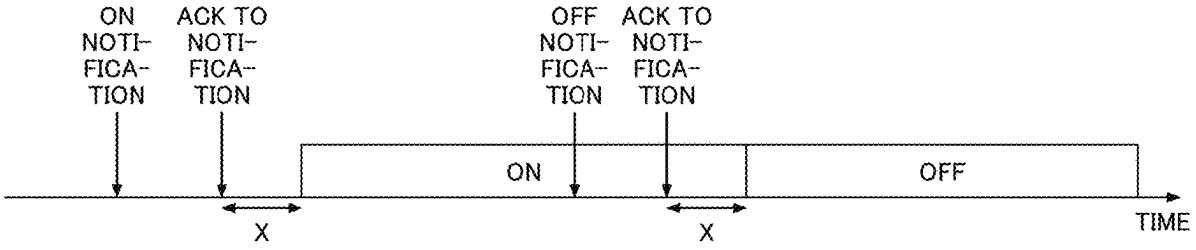


FIG.1

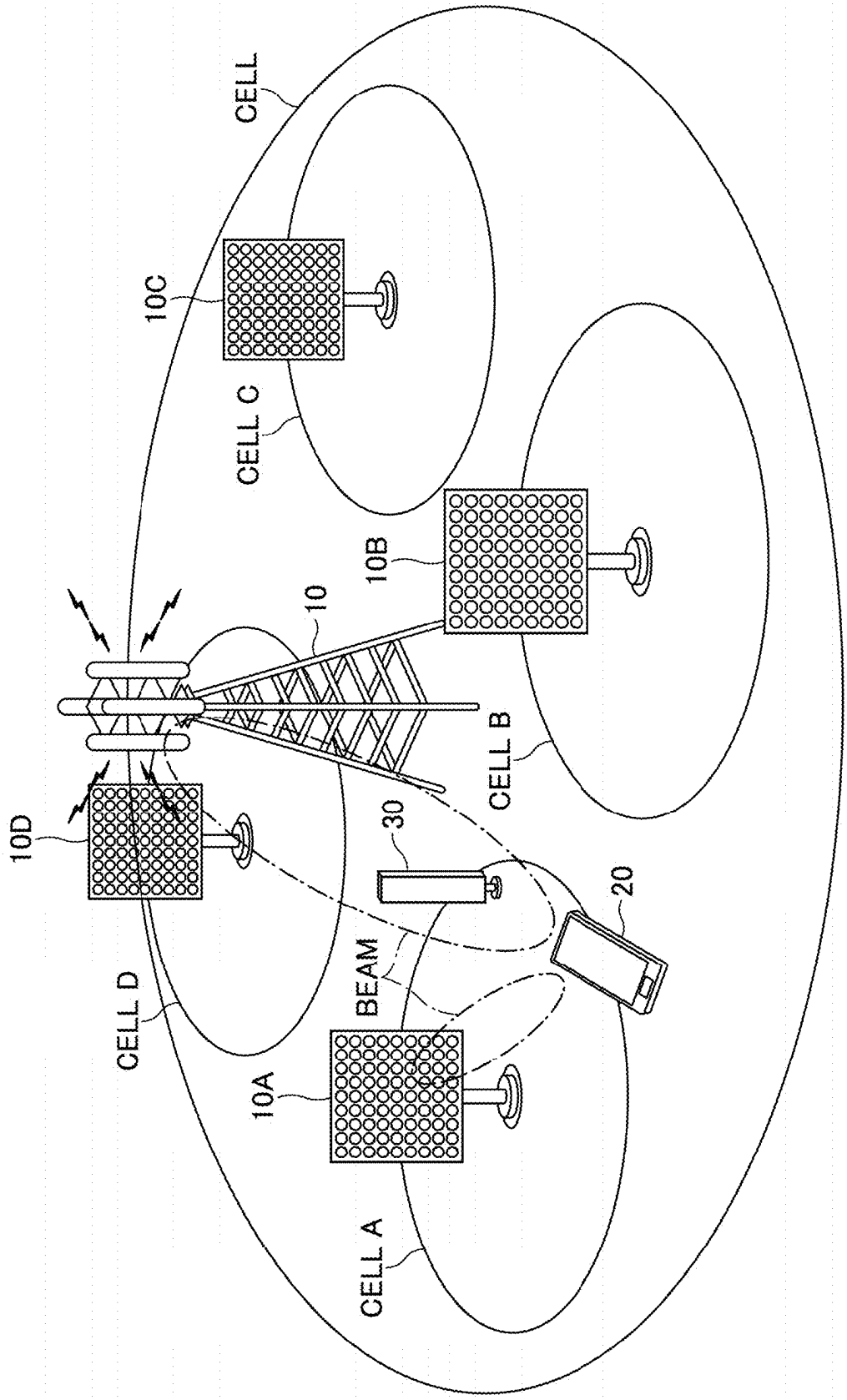


FIG.2

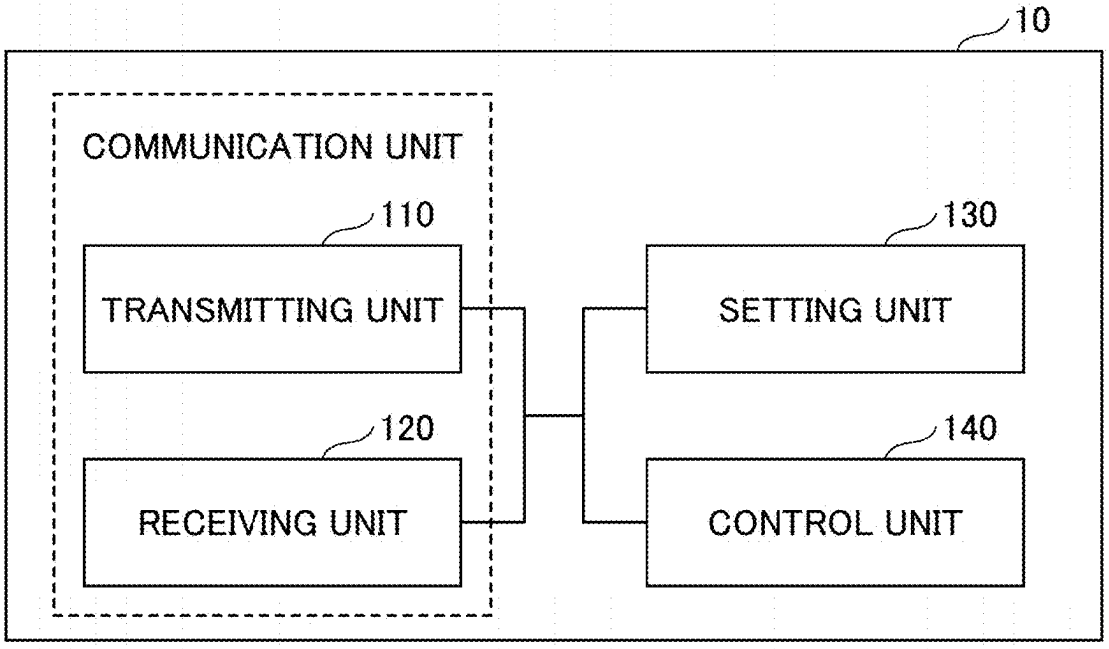

10
COMMUNICATION UNIT
110
TRANSMITTING UNIT
120
RECEIVING UNIT
130
SETTING UNIT
140
CONTROL UNIT

FIG.3

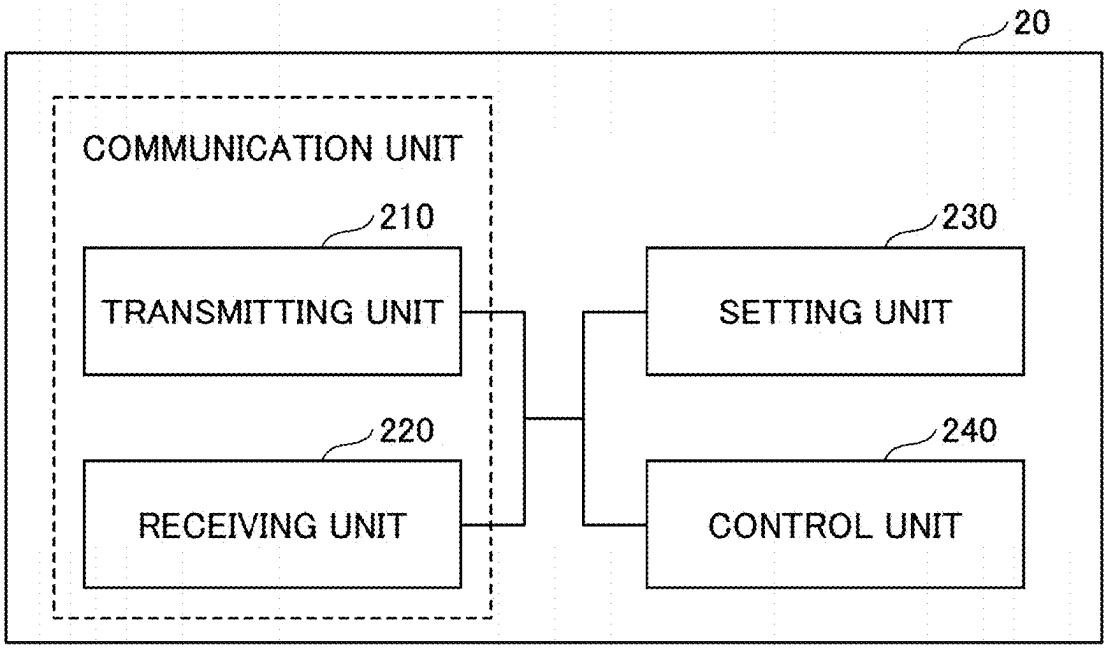

20
COMMUNICATION UNIT
210
TRANSMITTING UNIT
220
RECEIVING UNIT
230
SETTING UNIT
240
CONTROL UNIT

FIG.4

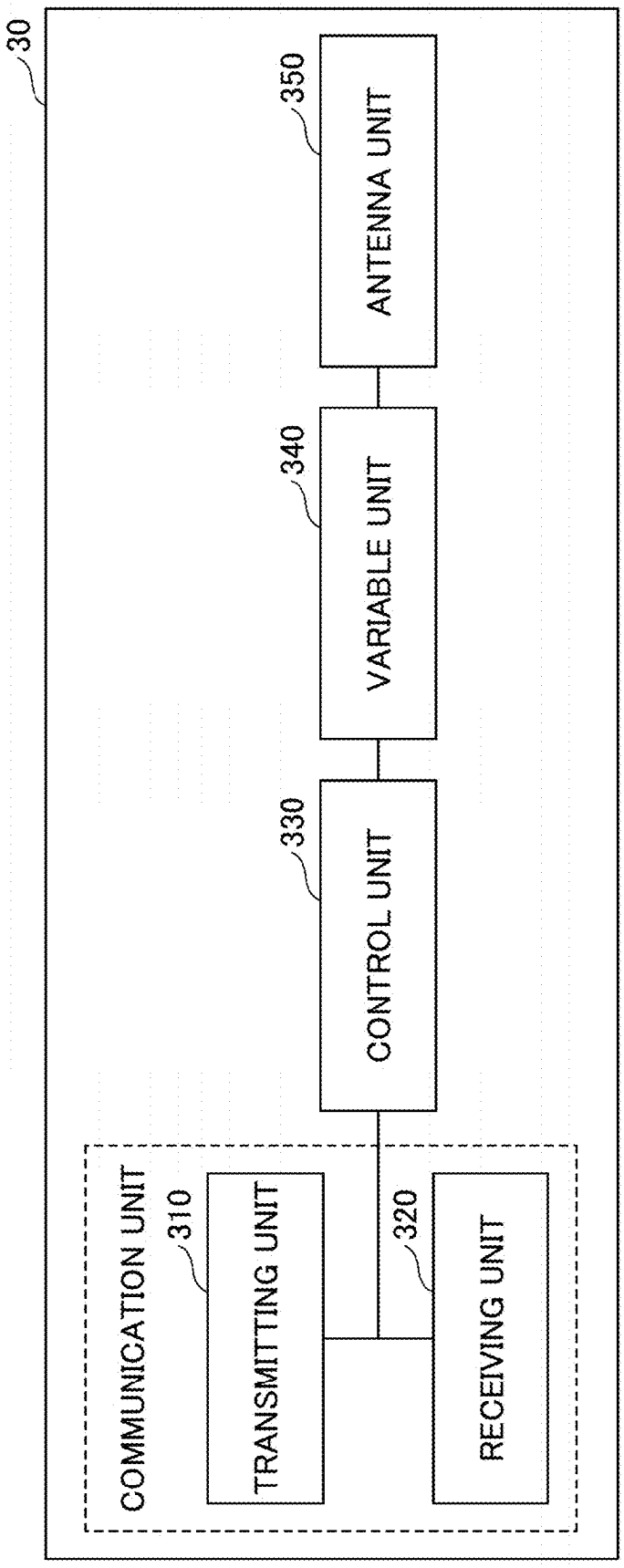

30
350
ANTENNA UNIT
340
VARIABLE UNIT
330
CONTROL UNIT
COMMUNICATION UNIT
310
TRANSMITTING UNIT
320
RECEIVING UNIT

FIG.5

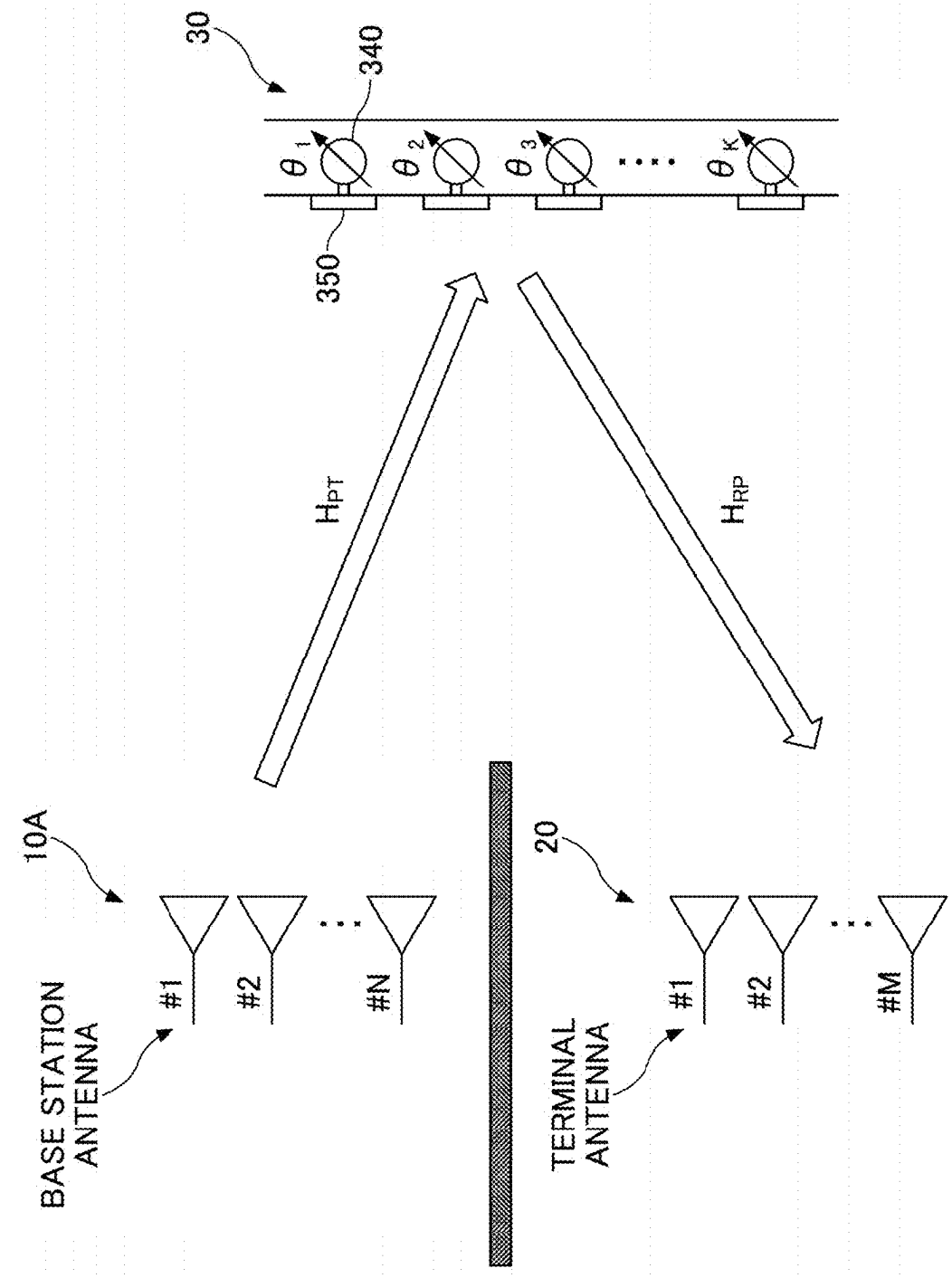

30
340
θ1
θ2
θ3
θK
350
HPT
HRP
10A
BASE STATION ANTENNA
#1
#2
#N
20
TERMINAL ANTENNA
#1
#2
#M

FIG.6

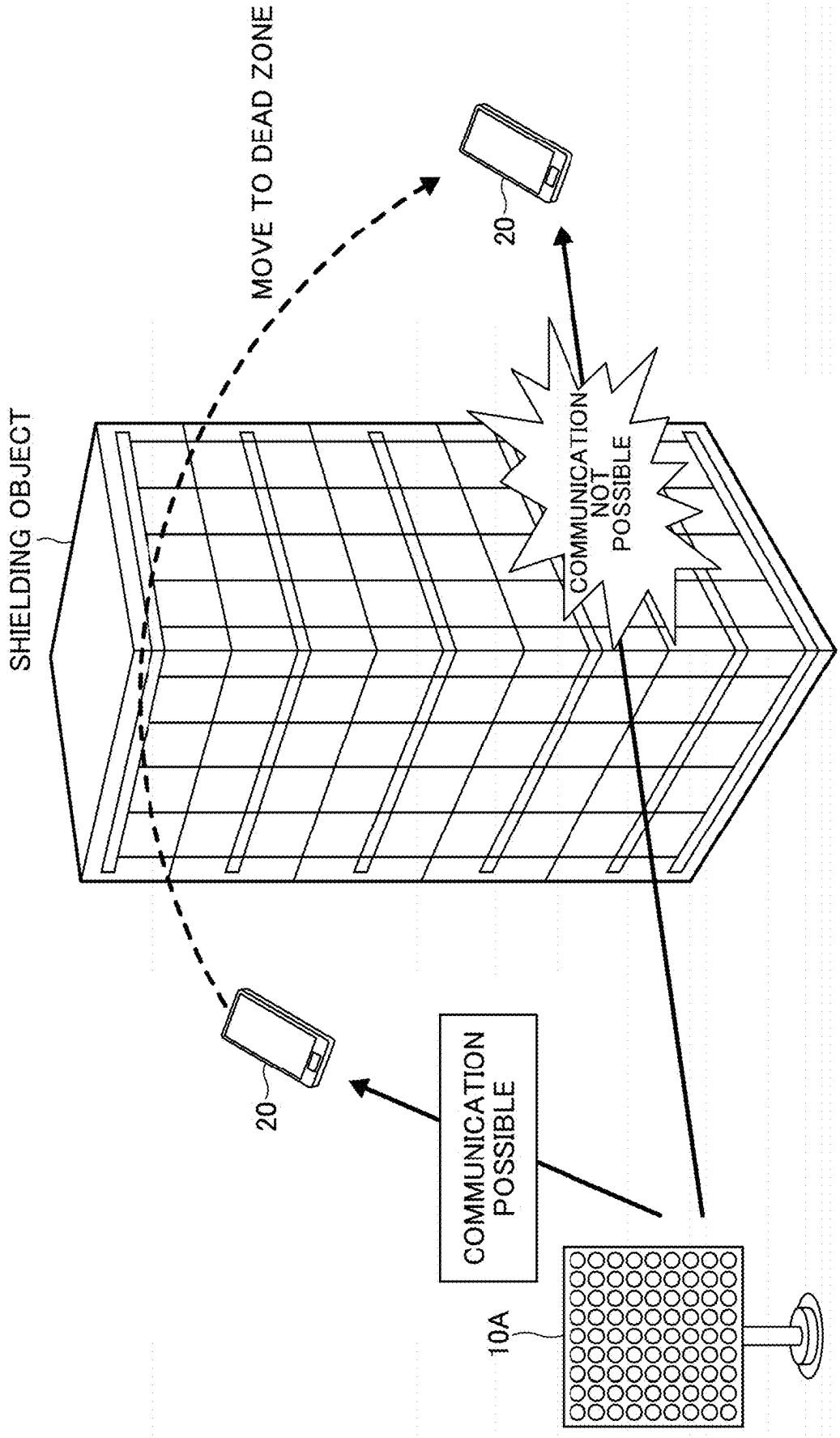

MOVE TO DEAD ZONE
20
SHIELDING OBJECT
COMMUNICATION NOT POSSIBLE
20
COMMUNICATION POSSIBLE
10A

FIG.7

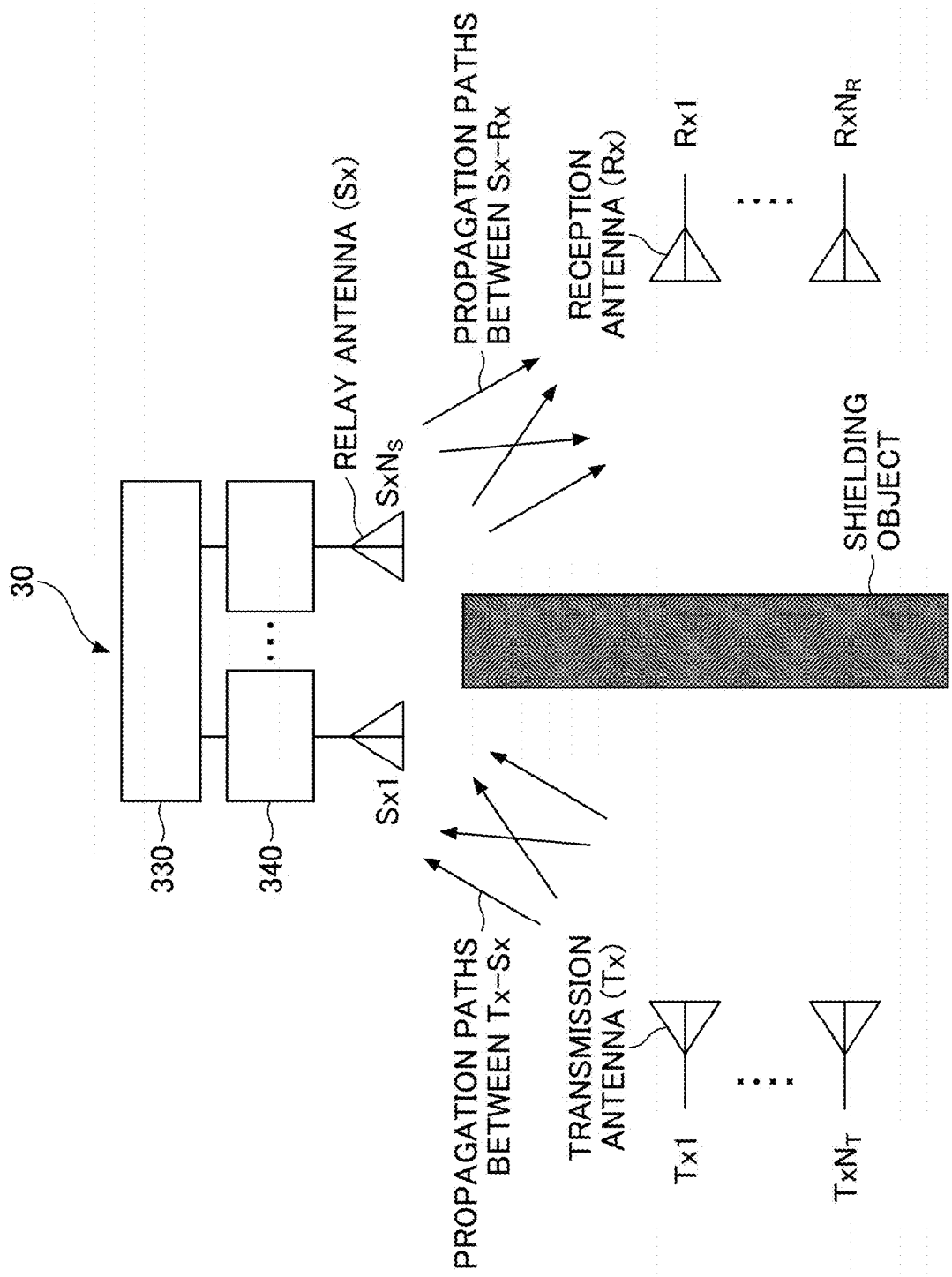

30
330
340
Sx1
SxNS
RELAY ANTENNA (Sx)
PROPAGATION PATHS BETWEEN Tx-Sx
PROPAGATION PATHS BETWEEN Sx-Rx
SHIELDING OBJECT
TRANSMISSION ANTENNA (Tx)
RECEPTION ANTENNA (Rx)
Tx1
TxNT
Rx1
RxNR

FIG.8

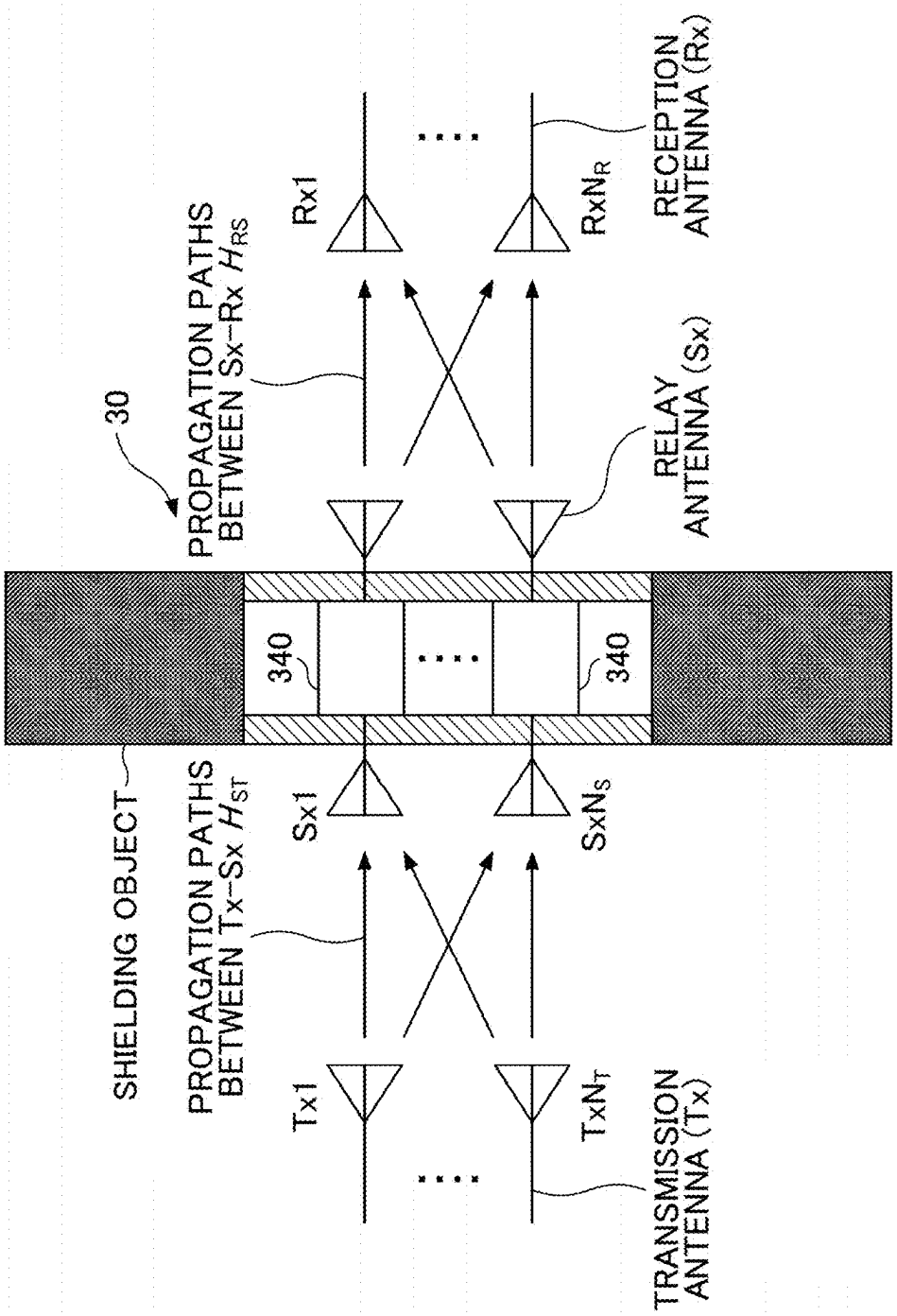

30
PROPAGATION PATHS BETWEEN Sx–Rx H_{RS}
Rx1
RxN$_R$
RECEPTION ANTENNA (Rx)
RELAY ANTENNA (Sx)
340
340
SHIELDING OBJECT
PROPAGATION PATHS BETWEEN Tx–Sx H_{ST}
Sx1
SxN$_S$
Tx1
TxN$_T$
TRANSMISSION ANTENNA (Tx)

FIG.9

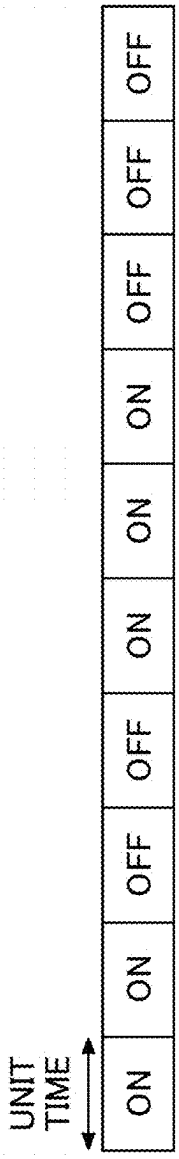


FIG.10

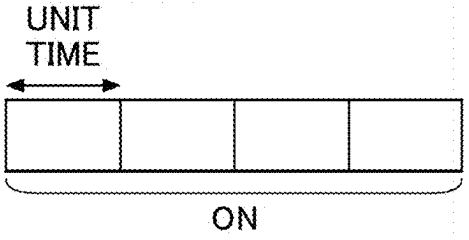


FIG.11

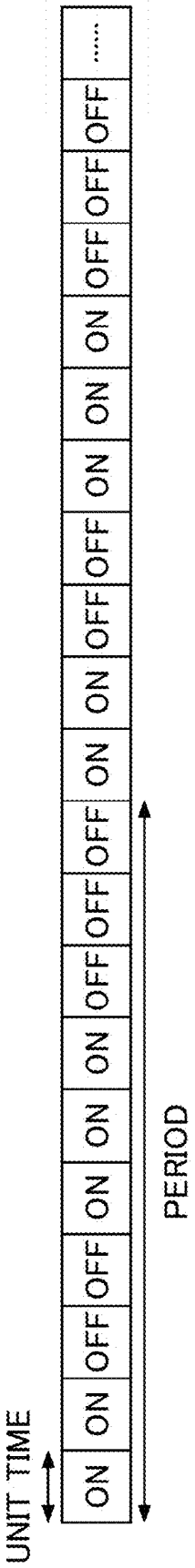

ON
ON
OFF
OFF
ON
ON
OFF
OFF
ON
ON
OFF
OFF
ON
ON
OFF
OFF
OFF
OFF
.....
UNIT TIME
PERIOD

FIG.12

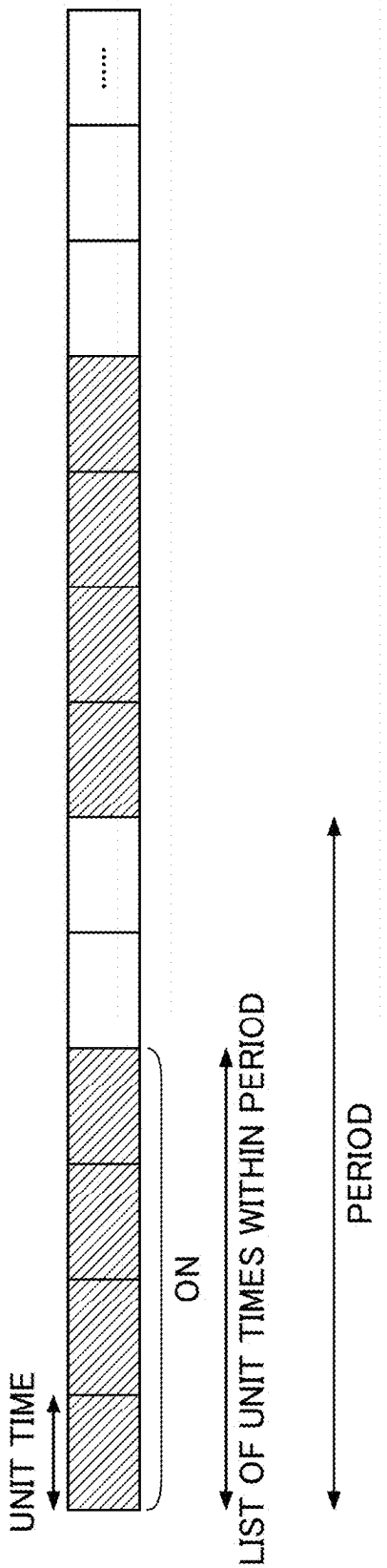


FIG.13

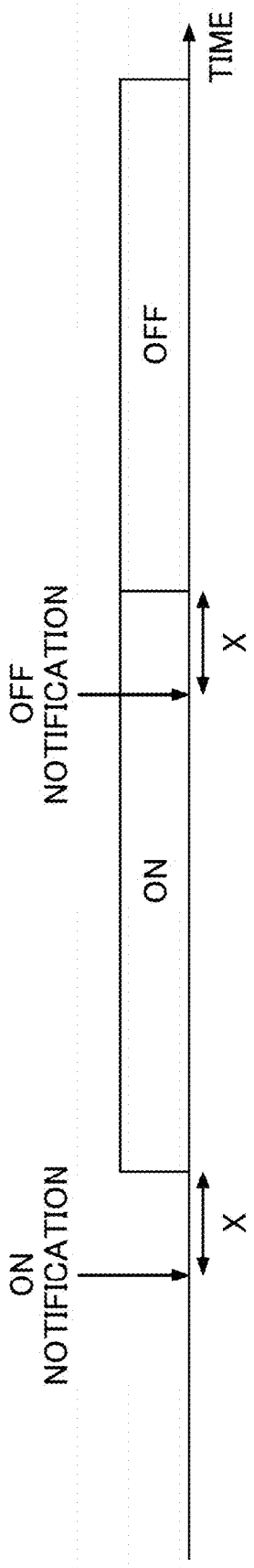


FIG.14

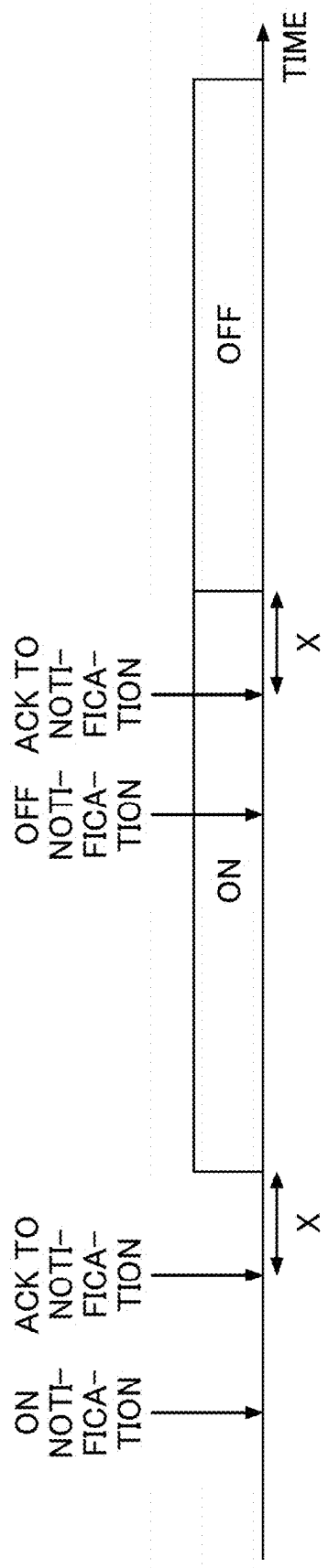
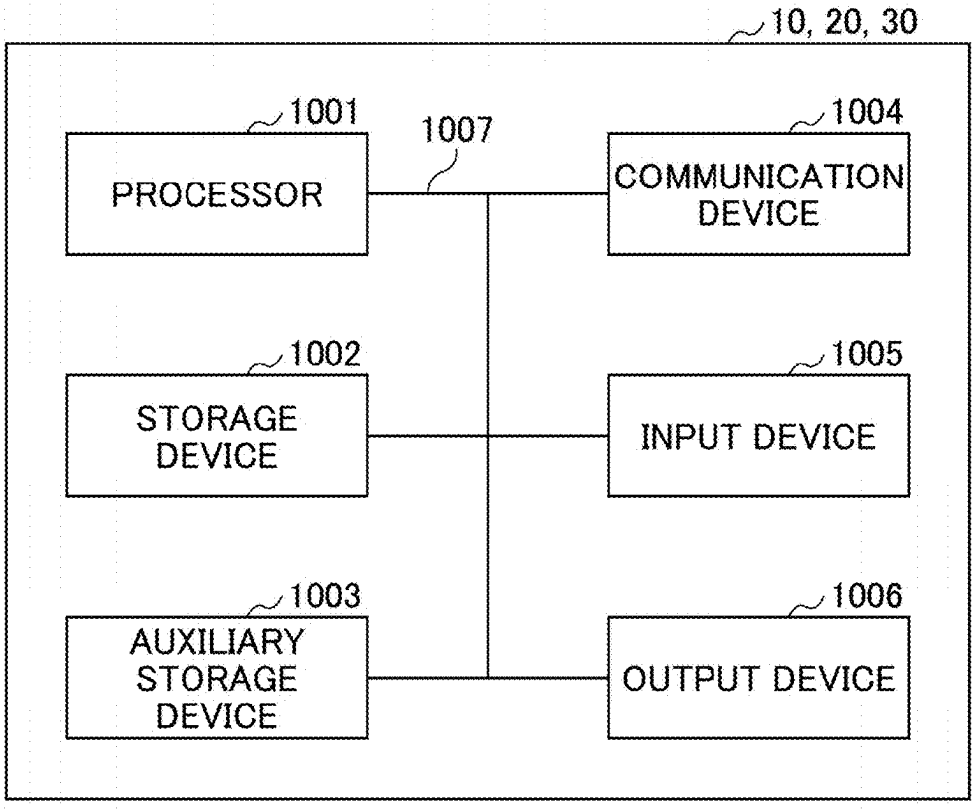

TIME
OFF
ON
OFF NOTI-FICA-TION
ACK TO NOTI-FICA-TION
X
ON NOTI-FICA-TION
ACK TO NOTI-FICA-TION
X

FIG.15


10, 20, 30
1001
PROCESSOR
1007
1004
COMMUNICATION DEVICE
1002
STORAGE DEVICE
1005
INPUT DEVICE
1003
AUXILIARY STORAGE DEVICE
1006
OUTPUT DEVICE

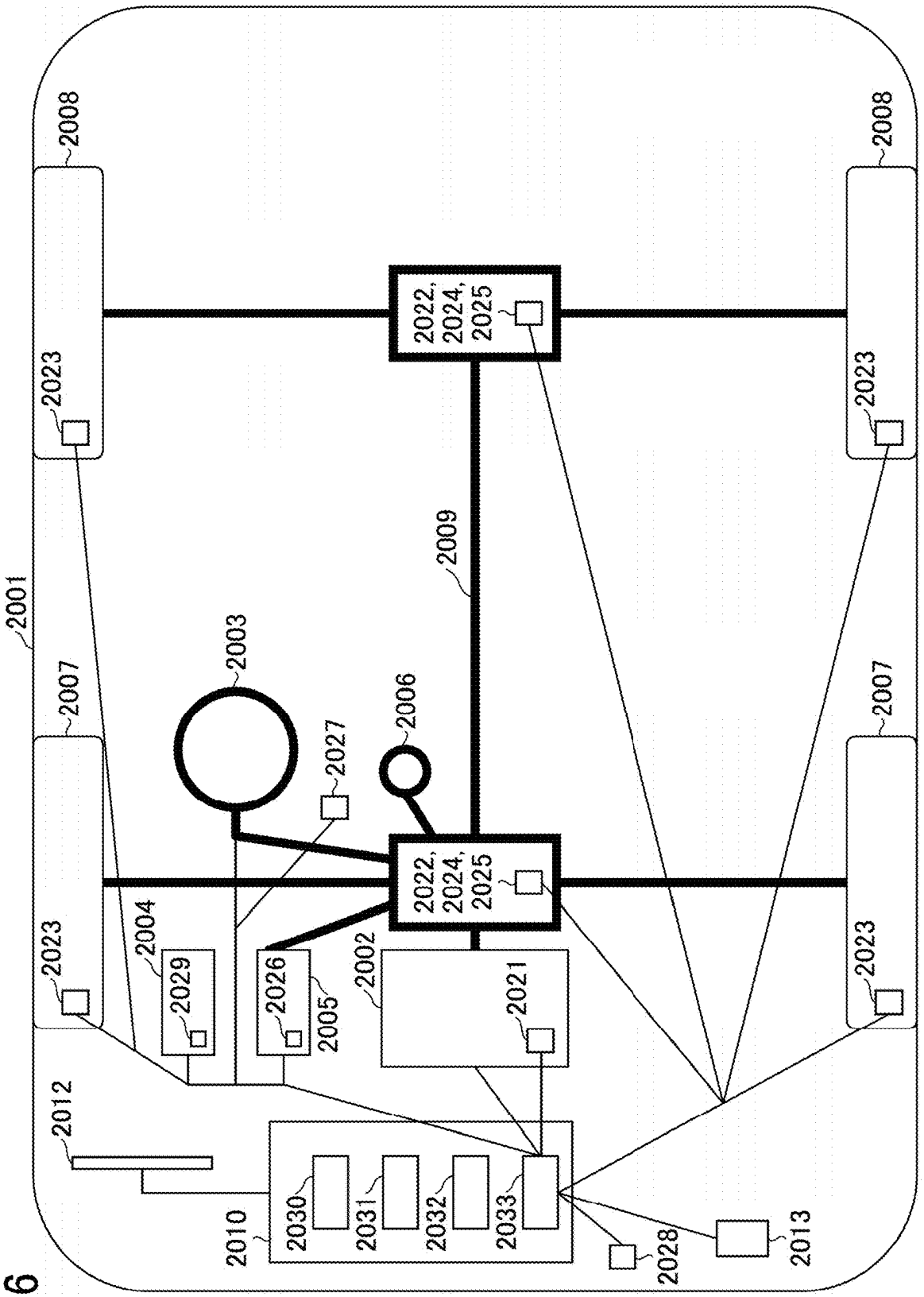

2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2012
2013
2021
2022, 2024, 2025
2023
2026
2027
2028
2029
2030
2031
2032
2033

FIG.16

WIRELESS RELAY DEVICE AND COMMUNICATION METHOD

TECHNICAL FIELD

[0001] The present invention relates to a wireless relay device and a communication method in a wireless communication system.

BACKGROUND ART

[0002] In the 3rd generation partnership project (3GPP), to achieve further increase in system capacity, further increase in data transmission speed, further reduction in delay in a radio section, and the like, a wireless communication system called 5G or new radio (NR) (hereinafter, the wireless communication method is referred to as "NR") has been studied. In 5G, to satisfy a requirement that a delay of a radio section is 1 ms or less while achieving a throughput of 10 Gbps or more, various wireless technologies and network architectures have been studied (for example, Non-Patent Literature 1).

[0003] In the next generation communication, use of a high frequency band is expected. Improvement in communication quality is required from the viewpoint of a decrease in the number of scatterers, a decrease in the shadowing effect, an increase in distance attenuation, and the like due to the characteristics of the high frequency band. It is assumed that beam control, environment, and the like that ensure communication quality are required.

[0004] For example, in a high frequency band, there is a problem that a dead zone is likely to occur due to strong rectilinearity of radio waves or the like. Therefore, a method of improving communication quality in a multipath environment using a passive repeater or an active reflector (reconfigurable intelligent surface (RIS)); a smart repeater that receives, amplifies, and re-radiates a signal; or the like has been tried (for example, Non-Patent Literature 2).

CITATION LIST

Non-Patent Literature

[0005] Non-Patent Literature 1: 3GPP TS 38.300 V16.8.0 (2021 December) Non-Patent Literature 2: NTT DOCOMO, "White Paper 5G Acceleration and 6G" (2021 February, 3.0 edition) Internet <URL: https://www.nttdocomo.co.jp/binary/pdf/corporate/technology/whitepaper_6g/DOCOMO_6G_White_PaperJP_20210203.pdf>

[0006] Non-Patent Literature 3: 3GPP TS 38.213 V16.8.0 (2021 December)

SUMMARY OF INVENTION

Technical Problem

[0007] As described above, a wireless relay device such as a reflector or a smart repeater that reflects or transmits a radio wave from a radio wave generation source such as a base station to a radio wave receiving destination such as a terminal and relays the radio wave has been studied. Here, in particular, it is necessary to clarify how the wireless relay device controlled by the network controls when enabling or disabling the relay of the radio signal between a base station and a terminal.

[0008] The present invention has been made in view of the above points, and an object thereof is to enable or disable the relay of a radio signal by a wireless relay device in a wireless communication system.

Solution to Problem

[0009] According to the disclosed technology, provided is a wireless relay device including: a communication unit that receives signaling including control information related to a relay function from a base station; a control unit that controls the relay function based on the control information; and a relay unit that executes the relay function of receiving a first signal from the base station, transmitting the first signal to a terminal, receiving a second signal from the terminal, and transmitting the second signal to the base station, in which the control unit enables or disables transmission and reception of the first signal and transmission and reception of the second signal based on the control information.

Advantageous Effects of Invention

[0010] According to the disclosed technology, in the wireless communication system, it is possible to enable or disable the relay of the radio signal by the wireless relay device.

BRIEF DESCRIPTION OF DRAWINGS

[0011] FIG. **1** is a diagram illustrating a wireless communication system according to an embodiment of the present invention.

[0012] FIG. **2** is a diagram illustrating an example of a functional configuration of a base station **10** according to the embodiment of the present invention.

[0013] FIG. **3** is a diagram illustrating an example of a functional configuration of a terminal **20** according to the embodiment of the present invention.

[0014] FIG. **4** is a diagram illustrating an example of a functional configuration of a wireless relay device **30** according to the embodiment of the present invention.

[0015] FIG. **5** is a diagram illustrating an example of an operation example of the wireless relay device **30** according to the embodiment of the present invention.

[0016] FIG. **6** is a diagram illustrating an example of communication in a high frequency band.

[0017] FIG. **7** is a diagram illustrating an example of a reflective wireless relay device **30** according to the embodiment of the present invention.

[0018] FIG. **8** is a diagram illustrating an example of a transmissive wireless relay device **30** according to the embodiment of the present invention.

[0019] FIG. **9** is a diagram illustrating an example (1) of ON/OFF notification according to the embodiment of the present invention.

[0020] FIG. **10** is a diagram illustrating an example (2) of ON/OFF notification according to the embodiment of the present invention.

[0021] FIG. **11** is a diagram illustrating an example (3) of ON/OFF notification according to the embodiment of the present invention.

[0022] FIG. **12** is a diagram illustrating an example (4) of ON/OFF notification according to the embodiment of the present invention.

[0023] FIG. **13** is a diagram illustrating an example (5) of ON/OFF notification according to the embodiment of the present invention.

[0024] FIG. **14** is a diagram illustrating an example (6) of ON/OFF notification according to the embodiment of the present invention.

[0025] FIG. **15** is a diagram illustrating an example of a hardware configuration of the base station **10**, the terminal **20**, or the wireless relay device **30** according to the embodiment of the present invention.

[0026] FIG. **16** is a diagram illustrating an example of a configuration of a vehicle **2001** according to the embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0027] Hereinafter, embodiments of the present invention will be described with reference to the drawings. Note that the embodiment described below is an example, and the embodiment to which the present invention is applied is not limited to the following embodiment.

[0028] In the operation of a wireless communication system of the embodiment of the present invention, existing technologies are appropriately used. Note that the existing technology is, for example, existing LTE, but is not limited to existing LTE. In addition, the term "LTE" used in the present specification has a broad meaning including LTE-Advanced or later systems (for example, NR) unless otherwise specified.

[0029] In the embodiments of the present invention described below, terms such as a synchronization signal (SS), a primary SS (PSS), a secondary SS (SSS), a physical broadcast channel (PBCH), a physical random access channel (PRACH), a physical downlink control channel (PDCCH), a physical downlink shared channel (PDSCH), a physical uplink control channel (PUCCH), and a physical uplink shared channel (PUSCH) used in existing LTE are used. This is for convenience of description, and similar signals, functions, and the like may be referred to by other names. In addition, the above-described term in NR corresponds to NR-SS, NR-PSS, NR-SSS, NR-PBCH, NR-PRACH, and the like. However, even when a signal is used for NR, the signal is not necessarily specified as "NR-".

[0030] In the exemplary embodiment of the present invention, a duplex system may be a time division duplex (TDD) system, a frequency division duplex (FDD) system, or other (for example, flexible duplex or the like) systems.

[0031] In addition, in the embodiment of the present invention, "configuring" a radio parameter and the like may mean that a predetermined value is pre-configured, or that the radio parameter notified from a base station **10** or a terminal **20** is set.

[0032] FIG. **1** is a diagram illustrating a wireless communication system according to an embodiment of the present invention. As illustrated in FIG. **1**, the wireless communication system in the embodiment of the present invention includes a base station **10** and a terminal **20**. A plurality of base stations **10** and a plurality of terminals **20** may be provided.

[0033] The base station **10** is a communication device that provides one or more cells and performs wireless communication with the terminal **20**. The physical resources of the radio signal are defined in a time domain and a frequency domain, the time domain may be defined by the number of orthogonal frequency division multiplexing (OFDM) symbols, and the frequency domain may be defined by the number of subcarriers or the number of resource blocks. In addition, a transmission time interval (TTI) in the time domain may be a slot or a subslot, or the TTI may be a subframe.

[0034] The base station **10** can perform carrier aggregation of bundling a plurality of cells (a plurality of CCs (component carriers)) and performing communication with the terminal **20**. In carrier aggregation, one primary cell (PCell) and one or more secondary cells (SCell) are used.

[0035] The base station **10** transmits a synchronization signal, system information, and the like to the terminal **20**. The synchronization signal is, for example, NR-PSS and NR-SSS. The system information is transmitted through, for example, NR-PBCH or PDSCH, and is also referred to as broadcast information. As illustrated in FIG. **1**, the base station **10** transmits a control signal or data to the terminal **20** through downlink (DL) and receives a control signal or data from the terminal **20** through uplink (UL). Note that, here, a signal transmitted on a control channel such as PUCCH or PDCCH is referred to as a control signal, and a signal transmitted on a shared channel such as PUSCH or PDSCH is referred to as data, but these naming conventions are merely examples.

[0036] The terminal **20** is a communication device having a wireless communication function such as a smartphone, a mobile phone, a tablet, a wearable terminal, or a machine-to-machine (M2M) communication module. As illustrated in FIG. **1**, the terminal **20** uses various communication services provided by the wireless communication system by receiving a control signal or data from the base station **10** through DL and transmitting a control signal or data to the base station **10** through UL. Note that the terminal **20** may be referred to as UE, and the base station **10** may be referred to as gNB.

[0037] The terminal **20** can perform carrier aggregation for bundling a plurality of cells (a plurality of CCs) and performing communication with the base station **10**. In carrier aggregation, one primary cell and one or more secondary cells are used. In addition, a PUCCH-SCell having PUCCH may be used.

[0038] In addition, in the wireless communication system according to the embodiment of the present invention, the base station **10** is a radio base station operated in 5G or 6G as an example, and forms a cell. Note that the cell is a cell having a relatively large size and is called a macro cell.

[0039] The base station **10**A to the base station **10**D are base stations operated in 5G or 6G. The base station **10**A to the base station **10**D respectively form a cell CA to a cell D having a size smaller than that of the macro cell. The cell A to the cell D may be referred to as a small cell, a macro cell, or the like. As illustrated in FIG. **1**, the cell A to the cell D may be formed to be included in the macro cell.

[0040] A macro cell may be generally interpreted as a communicable area with a radius of several hundred meters to several tens of kilometers covered by one base station. In addition, the small cell may be interpreted as a generic name of a cell that has small transmission power and covers an area smaller than that of the macro cell.

[0041] Note that the base station **10** and the base station OA to the base station **10**D may be expressed as gNodeB (gNB), BS (base station), or the like. Furthermore, the terminal **20** may be described as UE, MS, or the like. Furthermore, the specific configuration of the wireless com-

munication system including the number and types of base stations and terminals is not limited to the example illustrated in FIG. **1**.

[0042] In addition, the wireless communication system is not necessarily limited to a wireless communication system according to 5G or 6G. For example, the wireless communication system may be a wireless communication system of the next generation of 6G or a wireless communication system according to LTE.

[0043] As an example, the base station **10** and the base station **10**A to the base station **10**D execute wireless communication with the terminal **20** according to 5G or 6G. The base station **10**, the base station **10**A to the base station **10**D, and the terminal **20** may support massive MIMO that generates a beam with higher directivity by controlling radio signals transmitted from a plurality of antenna elements, carrier aggregation (CA) that uses a plurality of component carriers (CCs) in a bundle, dual connectivity (DC) that simultaneously communicates between the terminal **20** and each of two NG-RAN nodes, integrated access and backhaul (IAB) in which a radio backhaul between wireless communication nodes such as a gNB and radio access to the terminal **20** are integrated, and the like.

[0044] The wireless communication system may also support a high frequency band higher than the following frequency range (FR) defined in 3GPP Release 15. For example, FR1 may correspond to 410 MHz to 7.125 GHz, and FR2 may correspond to 24.25 GHz to 52.6 GHz. Further, the wireless communication system may support frequency bands above 52.6 GHz and up to 114.25 GHz. The frequency band may be referred to as a millimeter wave band.

[0045] Here, the base station **10** supporting massive MIMO can transmit beams. Massive MIMO generally means MIMO communication using an antenna having 100 or more antenna elements, and wireless communication with a higher speed than that of the related art can be performed due to a multiplexing effect of a plurality of streams or the like. In addition, advanced beamforming is also possible. The beam width can be dynamically changed according to a frequency band to be used, a state of the terminal **20**, or the like. In addition, it is possible to increase reception signal power due to a beamforming gain by using a narrow beam. Furthermore, effects such as reduction of interference and effective use of radio resources are expected.

[0046] Furthermore, the wireless communication system may include a wireless relay device **30**. In the embodiment of the present invention, as an example, the wireless relay device **30** may be a reflector (RIS), a phase control reflector, a passive repeater, an intelligent reflecting surface (IRS), or the like. As a specific example of the reflector (reconfigurable intelligent surface (RIS)), there may be what is called a metamaterial reflector, a dynamic meta-surface, a meta-surface lens, or the like (for example, Non-Patent Literature 2).

[0047] In the embodiment of the present invention, the wireless relay device **30** relays, for example, a radio signal transmitted from the base station **10**A. In the description of the embodiments of the present invention, "relay" may refer to at least one of "reflection", "transmission", "aggregation (concentration of radio waves at substantially one point)", and "diffraction". The terminal **20** can receive the radio signal relayed by the wireless relay device **30**. Further, the wireless relay device **30** may relay a radio signal transmitted from the terminal **20** or may relay a radio signal transmitted from the base station **10**.

[0048] As an example, the wireless relay device **30** can change the phase of the radio signal to be relayed toward the terminal **20**. From such a viewpoint, the wireless relay device **30** may be referred to as a phase variable reflector. In the present embodiment, the wireless relay device **30** may have a function of changing a phase of a radio signal and relaying the radio signal, but is not limited thereto. Furthermore, the wireless relay device **30** may be referred to as a repeater, a relay device, a reflect array, an IRS, a transmitter array, or the like.

[0049] Furthermore, in the embodiment of the present invention, the wireless relay device **30** such as the RIS may be referred to as a batteryless device, a metamaterial function device, an intelligent reflecting surface, a smart repeater, or the like. As an example, the wireless relay device **30** such as the RIS or the smart repeater may be defined as having the functions described in the following 1) to 5).

[0050] 1) A function of receiving a signal transmitted from the base station **10** may be included. The signal may be SS/PBCH block (SSB), PDCCH, PDSCH, a demodulation reference signal (DM-RS), a phase tracking reference signal (PT-RS), a channel status information reference signal (CSI-RS), a RIS dedicated signal, or the like, which is a DL signal. A function of receiving a signal carrying information related to the metamaterial function may be included. Note that a transmission function of transmitting the signal to the terminal **20** may be included. The SSB may be a signal including a synchronization signal and notification information.

[0051] 2) A function of transmitting a signal to the base station **10** may be included. The signal may be PRACH, PUCCH, PUSCH, DM-RS, PT-RS, SRS, a RIS dedicated signal, or the like, which is a UL signal. A function of transmitting information related to the metamaterial function may be included. Note that a reception function of receiving the signal from the terminal **20** may be included.

[0052] 3) A function of frame synchronization with the base station **10** may be included. Note that a function of frame synchronization with the terminal **20** may be included.

[0053] 4) A function of reflecting a signal transmitted from the base station **10** or the terminal **20** may be included. For example, the reflection function may be a function related to phase change or a function related to beam control (for example, functions related to transmission configuration indication (TCI)-state and quasi co location (QCL) control, selection and application of beam, and selection and application of spatial filter/precoding weight).

[0054] 5) A function of changing power of a signal transmitted from the base station **10** or the terminal **20** may be included. For example, the power change function may be power amplification.

[0055] In addition, "receive and transmit" and "relay" in the wireless relay device **30** such as the RIS or the smart repeater may mean that transmission is performed while the following function A is performed but the following function B is not performed.

[0056] Function A: apply phase shifter.

[0057] Function B: no compensation circuit (for example, amplification, filter) is involved.

[0058] As another example,

[0059] Function A: apply phase shifter and compensation circuit.

[0060] Function B: no frequency conversion is involved.

[0061] Note that, in the wireless relay device **30** such as the RIS, the amplitude may be amplified when the phase is changed. Furthermore, the "relay" in the wireless relay device **30** such as the RIS may mean that the received signal is transmitted as it is without performing the layer **2** or layer **3** level processing, the received signal at the physical layer level is transmitted as it is, or the received signal is transmitted as it is without interpreting the signal (then, phase change, amplitude amplification, or the like may be performed).

(Device Configuration)

[0062] Next, functional configuration examples of the base station **10**, the terminal **20**, and the wireless relay device **30** that execute processes and operations in the embodiments of the present invention will be described. The base station **10**, the terminal **20**, and the wireless relay device **30** include a function of executing an embodiment described later. However, each of the base station **10**, the terminal **20**, and the wireless relay device **30** may include only any one of the functions of the embodiments.

<Base Station **10**>

[0063] FIG. **2** is a diagram illustrating an example of a functional configuration of the base station **10**. As illustrated in FIG. **2**, the base station **10** includes a transmitting unit **110**, a receiving unit **120**, a setting unit **130**, and a control unit **140**. The functional configuration illustrated in FIG. **2** is merely an example. As long as the operation according to the embodiment of the present invention can be executed, the functional classification and the name of the functional unit may be anything. The transmitting unit **110** and the receiving unit **120** may be referred to as a communication unit.

[0064] The transmitting unit **110** has a function of generating a signal to be transmitted to the terminal **20** side and wirelessly transmitting the signal. The receiving unit **120** has a function of receiving various signals transmitted from the terminal **20** and acquiring, for example, information of an upper layer from the received signals. In addition, the transmitting unit **110** has a function of transmitting NR-PSS, NR-SSS, NR-PBCH, a DL/UL control signal, DL data, and the like to the terminal **20**. Furthermore, the transmitting unit **110** transmits setting information and the like described in the embodiment.

[0065] The setting unit **130** stores setting information set in advance and various types of setting information to be transmitted to the terminal **20** in a storage device, and reads the setting information from the storage device as necessary. The control unit **140** performs, for example, resource allocation, control of the entire base station **10**, and the like. Note that a functional unit related to signal transmission in the control unit **140** may be included in the transmitting unit **110**, and a functional unit related to signal reception in the control unit **140** may be included in the receiving unit **120**. Furthermore, the transmitting unit **110** and the receiving unit **120** may be referred to as a transmitter and a receiver, respectively.

<Terminal **20**>

[0066] FIG. **3** is a diagram illustrating an example of a functional configuration of the terminal **20**. As illustrated in FIG. **3**, the terminal **20** includes a transmitting unit **210**, a receiving unit **220**, a setting unit **230**, and a control unit **240**. The functional configuration illustrated in FIG. **3** is merely an example. As long as the operation according to the embodiment of the present invention can be executed, the functional classification and the name of the functional unit may be anything. The transmitting unit **210** and the receiving unit **220** may be referred to as a communication unit.

[0067] The transmitting unit **210** generates a transmission signal from transmission data and wirelessly transmits the transmission signal. The receiving unit **220** wirelessly receives various signals and acquires a signal of an upper layer from the received signal of the physical layer. Furthermore, the transmitting unit **210** transmits HARQ-ACK, and the receiving unit **220** receives setting information and the like described in the embodiment.

[0068] The setting unit **230** stores various types of setting information received from the base station **10** by the receiving unit **220** in the storage device, and reads the various types of setting information from the storage device as necessary. The setting unit **230** also stores setting information set in advance. The control unit **240** performs control of the entire terminal **20**, and the like. Note that a functional unit related to signal transmission in the control unit **240** may be included in the transmitting unit **210**, and a functional unit related to signal reception in the control unit **240** may be included in the receiving unit **220**. Furthermore, the transmitting unit **210** and the receiving unit **220** may be referred to as a transmitter and a receiver, respectively.

<Wireless Relay Device **30**>

[0069] FIG. **4** is a diagram illustrating an example of a functional configuration of the wireless relay device **30** according to the embodiment of the present invention. As illustrated in FIG. **4**, the wireless relay device **30** includes a transmitting unit **310**, a receiving unit **320**, a control unit **330**, a variable unit **340**, and an antenna unit **350**. As long as the operation according to the embodiment of the present invention can be executed, the functional classification and the name of the functional unit may be anything. The transmitting unit **310** and the receiving unit **320** may be referred to as a communication unit.

[0070] The antenna unit **350** includes at least one antenna connected to the variable unit **340**. For example, the antenna unit **350** may be arranged as an array antenna. In the embodiment of the present invention, the antenna unit **350** may be particularly referred to as a relay antenna. Note that the variable unit **340** and the antenna unit **350** may be referred to as a relay unit.

[0071] The variable unit **340** is connected to the antenna unit **350**, and can change a phase, a load, an amplitude, and the like. For example, the variable unit **340** may be a variable phase shifter, a phase shifter, an amplifier, or the like. For example, the direction, beam, or the like of the radio wave can be changed by changing the phase of the radio wave reaching the relay antenna from the radio wave generation source.

[0072] The control unit **330** is a control unit that controls the variable unit **340**. In the embodiment of the present invention, the control unit **330** functions as a control unit

that controls a relay state when a radio wave from the base station **10** or the terminal **20** is relayed without interpreting the signal. Here, the control unit **330** may change the relay state based on the control information received from the base station **10** or the terminal **20** via the communication unit, or may change the relay state based on the reception state of the radio wave from the base station **10** or the terminal **20**. For example, the control unit **330** may select (the direction of) an appropriate reception beam and transmission beam based on control information such as SSB and control the variable unit **340**. Similarly, the control unit **330** may select an appropriate combination of the reception direction and the transmission direction from the reception state based on a criterion such as the largest reception quality or the largest reception power and control the variable unit **340**.

[0073] Furthermore, in the embodiment of the present invention, the control unit **330** can control the variable unit **340** based on, for example, information regarding a propagation path between the terminal **20** or the base station **10**A and the antenna unit **350** (information estimated by the reception state and control information are included, and the same applies hereinafter). For example, the control unit **330** can relay a radio wave received from the base station **10**A in a specific direction such as a radio wave receiving destination (here, the terminal **20**) by changing the phase without using transmission power, using a known method such as an active repeater or RIS. Specifically, the control unit **330** controls the phase of the radio signal to relay toward the terminal **20** or the base station **10**A based on estimated propagation path information H_{PT} and H_{RP}. That is, radio waves can be relayed in a specific direction by changing the phase of an array antenna or the like on the same principle as beamforming or the like. Note that the wireless relay device **30** may control (change) only the phase of the radio signal (radio wave) by the control unit **330**, and relay the radio signal without power supply and without amplifying the power of the radio signal to be relayed or the like.

[0074] Furthermore, in the embodiment of the present invention, the control unit **330** may acquire information by a reception state. Furthermore, the receiving unit **320** may acquire control information from the base station **10**A or the terminal **20**. For example, the receiving unit **320** may receive various signals (including various signals exemplified in the above-described functions) such as the SSB transmitted from the base station **10**A or the terminal **20** as the control information.

[0075] Furthermore, the control unit **330** may estimate propagation path information (H_{PT} and H_{RP}) between the radio wave generation source (for example, the base station **10**A or the terminal **20**) and the antenna unit **350** based on a reception state (for example, a change in reception power or the like) at the time of control of the variable unit **340**.

[0076] Specifically, the propagation path information (propagation channel information) regarding each propagation path is information such as amplitude or phase, and is information estimated regarding the propagation path of the radio wave arriving at the antenna unit **350** in the embodiment of the present invention. As an example, the control unit **330** may estimate the propagation path information of the antenna unit **350** based on a change in reception power when the phase of the variable unit **340** of the antenna unit **350** having an array shape is orthogonally switched on a principle similar to that of in-phase/quadrature (I/Q) detection.

[0077] FIG. **5** is a diagram illustrating an example of an operation example of the wireless relay device **30** according to the embodiment of the present invention. As illustrated in FIG. **5**, as an example, the wireless relay device **30** is interposed between the base station **10**A (or another base station **10** or the like) and the terminal **20**, and relays (reflects, transmits, aggregates, diffracts, or the like) a radio signal transmitted and received between the base station **10**A and the terminal **20**.

[0078] As a specific example, when the radio quality is good, the base station **10**A and the terminal **20** directly transmit and receive a radio signal without passing through the wireless relay device **30**. On the other hand, when the radio quality deteriorates, for example, when there is a shielding object between the base station **10**A and the terminal **20**, the wireless relay device **30** relays a radio signal transmitted and received between the base station **10**A and the terminal **20**.

[0079] Specifically, the wireless relay device **30** estimates propagation path information H_{PT} and H_{RT} between a radio wave generation source such as the base station **10**A or the terminal **20** and a relay antenna based on a change in reception power at the time of control of the variable unit **340** such as the variable phase shifter, and relays a radio signal toward a radio wave receiving destination such as the terminal **20** by controlling the variable unit **340** such as the variable phase shifter based on the estimated propagation path information. Note that the embodiment is not limited to estimating the propagation path information H_{PT} and H_{RT}, and the wireless relay device **30** may relay a radio signal to a radio wave receiving destination such as the base station **10**A or the terminal **20** by controlling the variable unit **340** such as the variable phase shifter based on control information received from the base station **10**A or the terminal **20**.

[0080] Here, the propagation path or the propagation channel is an individual communication path of wireless communication, and here, is a communication path between transmission/reception antennas (a base station antenna, a terminal antenna, and the like in the drawing).

[0081] As an example, the wireless relay device **30** includes the antenna unit **350** having a small multi-element antenna compatible with massive MIMO, and the variable unit **340** having the variable phase shifter or the phase shifter that changes a radio wave, substantially a phase of a radio signal to a specific phase, and controls the phase of the radio wave relayed to the terminal **20** or the base station **10**A using the variable unit **340**.

[0082] FIG. **6** is a diagram illustrating an example of communication in a high frequency band. As illustrated in FIG. **6**, when a high-frequency band of several GHz to several tens of GHz or more is used, a dead zone is likely to occur due to strong rectilinearity of radio waves. When there is a clear line of sight between the base station **10**A and the terminal **20**, the wireless communication between the base station **10**A and the terminal **20** is not affected even when the high frequency band is used. On the other hand, for example, when the line of sight between the base station **10**A and the terminal **20** is shielded by a shielding object such as a building or a tree, the radio quality is greatly deteriorated.

That is, when the terminal **20** moves to the dead zone shielded by the shielding object, communication may be interrupted.

[0083] Considering the presence of applications utilizing high-speed, high-capacity, and low-delay characteristics (remote operation or the like), it is important to eliminate a dead zone and secure connection between the base station and the terminal without interruption of communication in the wireless communication system.

[0084] Therefore, a technology capable of relaying a radio wave between the base station **10**A and the terminal **20**, such as a radio wave propagation control device such as a RIS or a smart repeater, has been developed. As described above, the communication characteristics can be improved by controlling the propagation characteristics of the base station signal, coverage can be expanded without a signal source, and installation and operation costs due to increase in the number of base stations can be reduced.

[0085] In the radio wave propagation control device in the related art, there are a passive type and an active type. The passive type has an advantage that control information is unnecessary, but cannot follow a moving body, an environmental change, or the like. On the other hand, although the active type has a disadvantage that the control information is required and an overhead increases, the active type can variably control the propagation characteristic of the radio wave by changing the load (phase) state of the control antenna, and can also follow the moving body, the environmental change, and the like.

[0086] There are two types of active radio wave propagation control devices and control methods: a feedback (FB) standard and a propagation path information standard. In the FB standard, the variable radio wave propagation control device causes the terminal **20** or the like to feed back a communication state when a load (phase) state is randomly changed, and searches for an optimum condition. On the other hand, in the propagation path information standard, the load state is determined based on the propagation path information between the base station and the radio wave propagation control device, and optimal radio wave propagation control can be performed. In the embodiments of the present invention, any type is applicable.

[0087] In addition, examples of the relay method include reflection, transmission, diffraction, aggregation, and the like, and in the present embodiment, as an example, configuration examples of a reflection type and a transmission type will be described below (see Non-Patent Literature 2 and the like for a diffraction type and an aggregation type).

[0088] FIG. **7** is a diagram illustrating an example of the reflective wireless relay device **30** according to the embodiment of the present invention. An example of a system configuration of the reflective wireless relay device **30** will be described with reference to FIG. **7**. FIG. **7** is a diagram illustrating a relationship among a transmission antenna Tx of the base station **10**A and the like, a relay antenna Sx of the transmissive wireless relay device **30**, and a reception antenna Rx of the terminal **20** and the like. As illustrated in FIG. **7**, in the embodiment of the present invention, MIMO is exemplified, a plurality of propagation paths between Tx and Sx and a plurality of propagation paths between Sx and Rx exist, and the wireless relay device **30** controls the variable unit **340** including a variable phase shifter or the like of the relay antenna Sx to relay radio waves.

[0089] As illustrated in FIG. **7**, in the case of the reflection type, the relay antennas having an array shape are arranged to be oriented in the same direction. As a result, the propagation path of the relay antenna can be estimated based on the reception state observed when a plurality of phase conditions of the relay antenna are changed.

[0090] FIG. **8** is a diagram illustrating an example of the transmissive wireless relay device **30** according to the embodiment of the present invention. An example of a system configuration of the transmissive wireless relay device **30** will be described with reference to FIG. **8**. FIG. **8** is a diagram illustrating a relationship among the transmission antenna Tx of the base station **10**A and the like, the relay antenna Sx of the transmissive wireless relay device **30**, and the reception antenna Rx of the terminal **20** and the like. As illustrated in FIG. **8**, in the embodiment of the present invention, MIMO is exemplified, a plurality of propagation paths between Tx and Sx and a plurality of propagation paths between Sx and Rx exist, and the wireless relay device **30** relays a radio wave arriving from one side to the other side via the variable unit **340** such as a variable phase shifter of the relay antenna Sx as illustrated. As described above, in the case of the transmission type, the reference antenna on the left side in the drawing and the relay antenna on the right side in the drawing are arranged to be directed in opposite directions as a pair so that the radio wave arriving from one side can be relayed to the other side. The reception state may be measured by a power detector or the like configured to be able to detect the power that reached the relay antenna regardless of the transmission type or the reflection type. Further, the propagation path of the relay antenna can be estimated based on the received signal observed when a plurality of phase conditions of the relay antenna are changed.

[0091] For example, in a future network such as 6G, even higher quality is required as compared with 5G. For example, ultra-high speed of tera-bps order, high reliability and low delay at an optical communication level, and the like are required. In addition, a design considering ultra coverage enhancement, ultra long range communication, ultra reliable communication, virtual cell, flexible network, mesh network, sidelink enhancement, RIS or smart repeater is required.

[0092] To achieve such quality, use of a very high frequency, for example, a terahertz wave is assumed. For example, when a very high frequency such as a terahertz wave is used, a high speed due to ultra-wide band use and a low delay due to a short symbol length are assumed as advantages, while disadvantages such as a narrow coverage due to a magnitude of an attenuation rate and a decrease in reliability due to high rectilinearity are also assumed. For each point where 6G communication is required, it is required to consider how to ensure redundancy, that is, how to increase transmission points of communication.

[0093] As described above, the RIS reflects or transmits a beam transmitted from the base station **10** or the terminal **20** in a predetermined direction, and delivers the beam to the terminal **20** or the base station **10**. The passive RIS is a device that does not change control of a reflection angle, a beam width, or the like according to a position of a mobile station, and control information is unnecessary, but precise beam control is difficult. The active RIS is a device that changes control of a reflection angle, a beam width, and the like according to a position of a mobile station, and precise

beam control is possible, but overhead increases because control information is required. The RIS can increase a transmission point of communication.

[0094] Note that RIS may be the name shown in the following 1) to 5), and is not limited thereto.

[0095] 1) Batteryless device

[0096] 2) Metamaterial functional device

[0097] 3) Intelligent reflecting surface

[0098] 4) Smart repeater

[0099] 5) Network-controlled repeater

[0100] The RIS may be any device having a predetermined function, and the predetermined function may be, for example, at least one of functions 1) and 2) described below.

1) UE Function

[0101] A reception function of a signal transmitted from the base station **10** (for example, DL signal, SSB, PDCCH, PDSCH, DM-RS, PT-RS, CSI-RS, RIS dedicated signal). Information related to the following 2) Metamaterial function may be received by the reception function. A transmission function of a signal to the base station **10** (for example, UL signal, PRACH, PUCCH, PUSCH, DM-RS, PT-RS, SRS, RIS dedicated signal). Information related to the following 2) Metamaterial function may be transmitted by the transmission function. Frame synchronization function with the base station **10**.

2) Metamaterial Function

[0102] A reflection function of a signal transmitted from the base station **10** or the terminal **20** (for example, phase change). The reflection of the signal may be performed by changing the phase for each of the plurality of reflective elements included in the RIS, or the reflection of the signal may be performed by performing phase change common to the plurality of reflective elements. Function related to beam control (for example, function related to the control of the TCI-state and QCL, selection and application of beams, and selection and application of spatial filters/precoding weights). Power change function (for example, power amplification) of a signal transmitted from the base station **10** or the terminal **20**. Different power changes may be performed for each reflective element included in the RIS, or common power changes may be performed for a plurality of reflective elements.

[0103] "Receive and transmit" in the RIS may mean to reflect radio waves/signals. Hereinafter, the terms "base station" and "terminal" are used, but are not limited thereto, and may be replaced with a communication device. The RIS may be replaced with a smart repeater, a repeater, or the like.

[0104] For example, the RIS may operate on the assumption shown in 1) to 6) below.

[0105] 1) A network operator sets RIS

[0106] 2) RIS is fixed and does not move

[0107] 3) RIS relays signal from only one base station

[0108] 4) Capable of receiving and transmitting control signal

[0109] 5) Operate in half-duplex communication

[0110] 6) Single RIS environment

[0111] Here, a network controlled repeater that is a wireless relay device controlled by a network has been studied. Unlike an amplifying and transferring repeater in the related art, a network controlled repeater can control, for example, beam, timing, DL or UL, ON or OFF, and transmission power from a network. Hereinafter, the "network controlled repeater" is also referred to as a "repeater".

[0112] A network controlled repeater is used as an in-band RF repeater to expand coverage in the FR1 and FR2 bands. In particular, the use of FR2 in outdoor scenarios and outdoor to indoor (O2I) scenarios is assumed. For example, a single-hop and non-moving environment may be assumed as the environment of the network controlled repeater. The network controlled repeater may also be transmissive to UE. In addition, the network controlled repeater can simultaneously maintain a link between gNB and the repeater and a link between the repeater and UE.

[0113] The following studies have been conducted on side control information for controlling a network controlled repeater from the network.

[0114] Information on beamforming

[0115] Information on timing of transmission or reception

[0116] Information on UL-DL TDD setting

[0117] ON-OFF information for interference control and power saving

[0118] Power control for interference control

[0119] In addition, side control information by L1 and L2 signaling has been studied. In addition, identification and authentication of a network controlled repeater have been studied.

[0120] To avoid unnecessary interference in the network, the network controlled repeater is enabled when amplification of a signal between gNB and UE is required, and is disabled when amplification of the signal is not required. Hereinafter, how to enable or disable signal amplification by the network controlled repeater will be described.

[0121] The network controlled repeater being "ON (enabled)" in a certain slot, symbol, or unit time may mean that the signal from gNB to UE and the signal from UE to gNB are amplified and transferred in the certain slot, symbol, or unit time.

[0122] The network controlled repeater being "OFF (disabled)" in a certain slot, symbol, or unit time may mean that the signal from gNB to UE and the signal from UE to gNB are not transferred without being amplified in the certain slot, symbol, or unit time.

[0123] Control related to ON/OFF of the network controlled repeater may be executed as in Option 1) to Option 9) described below. Hereinafter, "/" may be replaced with "or" or "and/or".

[0124] Option 1) List of ON/OFF for time resource is notified

[0125] Option 2) ON/OFF for time resource is notified

[0126] Option 3) List of periodic ON/OFF for time resource is notified

[0127] Option 4) Periodic ON/OFF for time resource is notified

[0128] Option 5) Notification of hard (H)/soft(S)/not available (NA) is used for integrated access and backhaul (IAB)

[0129] Option 6) DCI format 2_5 is used for IAB

[0130] Option 7) DCI that schedules PDSCH/PUSCH is used

[0131] Option 8) SPS/CG-PUSCH setting/activation is used

[0132] Option 9) Notification of ON/OFF is applied after next slot/symbol or after X slot/symbol

[0133] Hereinafter, "Option 1) List of ON/OFF for time resource is notified" will be described.

[0134] FIG. **9** is a diagram illustrating an example (1) of ON/OFF notification according to the embodiment of the present invention. As illustrated in FIG. **9**, the network controlled repeater may be notified of a list of unit times indicating ON or OFF. Each ON/OFF indicator notifies each unit time. The notification may be executed by RRC signaling, MAC-CE, or DCI.

[0135] As another example, ON, OFF, or Soft may be notified. Soft indicates that the unit time is ON or OFF. In the unit time in which Soft is notified, ON or OFF may be further notified by other signaling.

[0136] The list of the unit times may be notified as the number of consecutive unit times depending on the start time and the time length. Alternatively, the list of the unit times may be notified as a list of identifiers (IDs) of the unit times.

[0137] The list of unit times may be predefined. For example, the start time and/or the time length may be predefined.

[0138] A plurality of ON/OFF patterns described above may be notified to the network controlled repeater by gNB. One pattern from the plurality of ON/OFF patterns may be notified to the network controlled repeater by gNB. Each pattern may be configured by ON/OFF, may be configured by ON/OFF/Soft, or may be configured by a disclosure time and the time length. The notification may be executed by RRC signaling, MAC-CE, or DCI.

[0139] Hereinafter, "Option 2) ON/OFF for time resource is notified" will be described.

[0140] FIG. **10** is a diagram illustrating an example (2) of ON/OFF notification according to the embodiment of the present invention. As illustrated in FIG. **10**, one ON/OFF may be notified to the network controlled repeater as a list of unit times indicating ON or OFF. The one ON/OFF indicator is a notification for a plurality of unit times. The notification may be executed by RRC signaling, MAC-CE, or DCI.

[0141] As another example, ON, OFF, or Soft may be notified. Soft indicates that the unit time is ON or OFF. In the unit time in which Soft is notified, ON or OFF may be further notified by other signaling.

[0142] The list of the unit times may be notified as the number of consecutive unit times depending on the start time and the time length. Alternatively, the list of the unit times may be notified as a list of identifiers (IDs) of the unit times.

[0143] The list of unit times may be predefined. For example, the start time and/or the time length may be predefined.

[0144] ON or OFF may be predefined. For example, ON may be predefined to mean signaling in which a plurality of unit times are turned on when signaling of a notification is received, or OFF may be predefined to mean signaling in which a plurality of unit times are turned off. That is, ON/OFF may not be explicitly notified.

[0145] A plurality of ON/OFF patterns described above may be notified to the network controlled repeater by gNB. One pattern from the plurality of ON/OFF patterns may be notified to the network controlled repeater by gNB. Each pattern may be configured by ON/OFF, may be configured by ON/OFF/Soft, or may be configured by a disclosure time and the time length. The notification may be executed by RRC signaling, MAC-CE, or DCI.

[0146] Hereinafter, "Option 3) List of periodic ON/OFF for time resource is notified" will be described.

[0147] FIG. **11** is a diagram illustrating an example (3) of ON/OFF notification according to the embodiment of the present invention. As illustrated in FIG. **11**, the periodic pattern of ON/OFF may be notified from gNB to the network controlled repeater. The period and the offset may be notified. Each ON/OFF indicator notifies each unit time in one period. The notification may be executed by RRC signaling, MAC-CE, or DCI. The granularity of the period and the offset may be a subframe, a slot, or a symbol.

[0148] As another example, ON, OFF, or Soft may be notified. Soft indicates that the unit time is ON or OFF. In the unit time in which Soft is notified, ON or OFF may be further notified by other signaling.

[0149] In addition, the period and the offset may be predefined.

[0150] A plurality of periodic ON/OFF patterns described above may be notified to the network controlled repeater by gNB. One pattern from the plurality of periodic ON/OFF patterns may be notified to the network controlled repeater by gNB. Each periodic pattern may be configured by ON/OFF, may be configured by ON/OFF/Soft, or may be configured by a disclosure time and the time length. The notification may be executed by RRC signaling, MAC-CE, or DCI.

[0151] Hereinafter, "Option 4) Periodic ON/OFF for time resource is notified" will be described.

[0152] FIG. **12** is a diagram illustrating an example (4) of ON/OFF notification according to the embodiment of the present invention. As illustrated in FIG. **12**, the periodic pattern of ON/OFF may be notified from gNB to the network controlled repeater. The period and the offset may be notified. A list of unit times within the period may be notified. One ON/OFF indicator may be notified. The one ON/OFF indicator is applied to one or a plurality of unit times in the period. In the example of FIG. **12**, ON is applied to four unit times. The unit time during which ON is not applied in the period may be OFF.

[0153] The notification may be executed by RRC signaling, MAC-CE, or DCI. The granularity of the period and the offset may be a subframe, a slot, or a symbol. The list of the unit times may be notified as the number of consecutive unit times depending on the start time and the time length. Alternatively, the list of the unit times may be notified as a list of identifiers (IDs) of the unit times.

[0154] As another example, ON, OFF, or Soft may be notified. Soft indicates that the unit time is ON or OFF. In the unit time in which Soft is notified, ON or OFF may be further notified by other signaling.

[0155] In addition, the period and the offset may be predefined. In addition, the list of unit times may be predefined. For example, the start time and/or the time length may be predefined.

[0156] ON or OFF may be predefined. For example, ON may be predefined to mean signaling in which a plurality of unit times are turned on when signaling of a notification is received, or OFF may be predefined to mean signaling in which a plurality of unit times are turned off. That is, ON/OFF may not be explicitly notified.

[0157] A plurality of periodic ON/OFF patterns described above may be notified to the network controlled repeater by

gNB. One pattern from the plurality of periodic ON/OFF patterns may be notified to the network controlled repeater by gNB. Each periodic pattern may be configured by ON/OFF, may be configured by ON/OFF/Soft, or may be configured by a disclosure time and the time length. The notification may be executed by RRC signaling, MAC-CE, or DCI.

[0158] Hereinafter, "Option 5) Notification of hard (H)/soft(S)/not available (NA) is used for integrated access and backhaul (IAB)" will be described.

[0159] gNB may notify the network controlled repeater of ON/OFF using signaling similar to an HSNA slot setting of a gNB-DU cell resource setting for IAB. The notification may be executed by RRC signaling, MAC-CE, or DCI.

[0160] When hard (H) is notified to a certain symbol, it may mean that ON is notified to the certain symbol. When not available (NA) is notified to a certain symbol, it may mean that OFF is notified to the certain symbol. The network controlled repeater may assume that H or NA is notified and may not assume that S is notified.

[0161] Note that, regarding the HSNA slot setting, notification of a certain H/S/NA may be performed for each DL-UL-flexible (D-U-F) resource type for each slot within a certain period. H/S/NA notification may occur via F1-AP signaling from CU to IAB-DU and may not be supported by the network controlled repeater. For example, the network controlled repeater may receive the H/S/NA notification by new RRC signaling having a configuration similar to that of the H/S/NA notification.

[0162] Hereinafter, "Option 6) DCI format 2_5 is used for IAB" will be described.

[0163] The network controlled repeater may be notified ON/OFF by gNB using DCI format 2_5 that is used to notify whether Soft resources are available for IAB nodes.

[0164] When "available (Available, IA)" is notified to a certain symbol by the DCI format 2_5, it may mean that ON is notified to the certain symbol. When "no notification of availability (No notification of availability, INA)" is notified to a certain symbol by the DCI format 2_5, it may mean that OFF is notified to the certain symbol. When "no notification of availability" is notified to a certain symbol by the DCI format 2_5, the network controlled repeater may mean that the certain symbol is not explicitly notified of ON.

[0165] Note that, for the DCI format 2_5, the following may be assumed.

[0166] A plurality of available combinations (AvailabilityCombinations) may be set by RRC signaling.

[0167] Each available combination may include resource

[0168] availability (resourceAvailability).Each available combination may be associated with an ID of the available combination.

[0169] The ID of the available combination may be notified by DCI.

[0170] Certain resource availability may notify whether one or a plurality of slots are available.

[0171] For each slot, an index may be notified from the table. Each index of the table may be mapped to an IA or INA pattern for each D-U-F resource type of a certain slot. The resource availability mapping table for IAB (see Non-Patent Literature 3) may be used for ON/OFF notification of the network controlled repeater, a new table may be defined, or a table including some of the entries of the resource availability mapping table for IAB may be notified.

[0172] A new DCI format having a similar configuration to the DCI format 2_5 may be introduced. The available combination, the ID of the available combination, and the resource availability may be replaced with a new information element having a similar function. For example, gNB and the network controlled repeater may perform the operation shown in the following 1) to 6).

[0173] 1) A plurality of ON/OFF combinations may be set by RRC signaling.

[0174] 2) Each ON-OFF combination may include one ON-OFF pattern.

[0175] 3) Each ON-OFF combination may be associated with an ID of one ON-OFF combination.

[0176] 4) The ID of ON-OFF combination may be notified by DCI.

[0177] 5) One ON-OFF pattern may notify availability for one or a plurality of slots.

[0178] 6) ON/OFF may be notified to each slot. For each slot, an index may be notified from the table. Each index in the table may be mapped to an ON/OFF pattern for each symbol in the slot.

[0179] The slot may be replaced with another unit time. The symbol may be replaced with another unit time.

[0180] Hereinafter, "Option 7) DCI that schedules PDSCH/PUSCH is used" will be described.

[0181] Using DCI that schedules the PDSCH/PUSCH, that is, DCI format 1_X/0_X, gNB may notify the network controlled repeater of ON/OFF.

[0182] One ON/OFF indicator may be notified from gNB to the network controlled repeater by DCI. The ON/OFF indicator may be applied to a slot and/or a symbol notified by time domain resource assignment of DCI.

[0183] A new DCI format may be introduced. The new DCI format may include one ON-OFF indicator. The new DCI format may include a field similar to the time domain resource allocation field of DCI for scheduling PDSCH/PUSCH that notifies the time at which the ON-OFF indicator is applied (for example, slot offset, in-slot symbol position).

[0184] Note that ON or OFF may be predefined. For example, when signaling is received, the notified unit time may be predefined as ON signaling. That is, an explicit notification of ON or OFF may be unnecessary.

[0185] Hereinafter, "Option 8) SPS/CG-PUSCH setting/activation is used" will be described.

[0186] The ON-OFF indicator may be notified from gNB to the network controlled repeater by a semi-persistent scheduling (SPS) setting, a configured grant (CG) setting, SPS-enabled DCI or CG-enabled DCI. The ON/OFF indicator may be applied to a slot and/or a symbol notified by the SPS setting, the CG setting, the SPS-enabled DCI, or the CG-enabled DCI.

[0187] The SPS setting or the CG setting may be notified periodically by RRC signaling. Type 1 CG setting by RRC signaling may notify the offset in the time domain and the in-slot symbol position. The time domain resource allocation field included in the SPS-enabled DCI or the Type 2 CG-enabled DCI may notify the slot offset and the in-slot symbol position.

[0188] New RRC setting and enabled DCI that has a configuration similar to the SPS setting, CG setting, SPS-enabled DCI or CG-enabled DCI may be introduced. The

new RRC setting or DCI may include a field of an ON-OFF indicator. The new RRC setting or DCI may include a period set by the SPS setting or the CG setting, an offset of the CG setting (timeDomainOffset), a symbol position in a slot of the CG setting (timeDomainAllocation), and a time domain allocation field of the SPS-enabled DCI or the CG-enabled DCI, and such fields indicate a period of time domain, a slot offset, and a symbol position in the slot to which the ON-OFF indicator is applied.

[0189] Note that ON or OFF may be predefined. For example, when signaling is received, the notified unit time may be predefined as ON signaling. That is, an explicit notification of ON or OFF may be unnecessary.

[0190] Hereinafter, "Option 9) Notification of ON/OFF is applied after next slot/symbol or after X slot/symbol" will be described.

[0191] FIG. **13** is a diagram illustrating an example (5) of ON/OFF notification according to the embodiment of the present invention. As illustrated in FIG. **13**, when ON/OFF is notified, application of ON/OFF may be started from the first slot or symbol after X slot or after X symbol from the last or first slot or symbol of the notification.

[0192] FIG. **14** is a diagram illustrating an example (6) of ON/OFF notification according to the embodiment of the present invention. As illustrated in FIG. **14**, when ON/OFF is notified, application of ON/OFF may be started from the first slot or symbol after X slot or after X symbol from the last or first slot or symbol of HARQ-ACK feedback for the notification.

[0193] The notified ON/OFF may be applied for a set or predefined period of time. Alternatively, the notified ON/OFF may be applied until a new ON/OFF is received. X may be predefined, set, or determined based on repeater capability. Note that X may be zero.

[0194] Note that, when a unit time is set for a cell-specific, semi-static signal or channel, the setting may be equivalent to a notification of ON. For example, the cell-specific, semi-static signal or channel may be SSB, SIB1 (PDCCH for Type 0-common search space (CSS) set by pdcchConfigSIB1), periodic CSI-RS, PRACH, or scheduling request (SR).

[0195] Note that different options described above may be applied to different signals or channels. For example, the different signal or channel may be an SSB, a periodic, semi-persistent, or aperiodic RS, a CSI-RS or SRS, a PRACH, a semi-static or dynamic PUCCH, a PUCCH of a different UCI type, a PDCCH of a different search space type, a PDCCH of a cell-specific search space, a PDCCH of a UE-specific search space, a PDCCH of a dynamic or configuration grant PUSCH, or a PDSCH of a dynamic grant or SPS.

[0196] The options applied to the signals or channels may be set or predefined. For example, Option 1), Option 2), Option 6) and Option 7) may be applied to dynamic signals or channels. For example, the dynamic signal or dynamic channel may be a dynamic grant PUSCH or a dynamic grant PDSCH. For example, Option 3), Option 4), Option 5) and Option 8) may be applied to periodic or semi-persistent channels or signals. For example, the periodic or semi-persistent channel or signal may be a periodic RS, a semi-static PUCCH, a CG-PUSCH, or an SPS-PDSCH.

[0197] ON-OFF and DL-UL may be connected and notified to the network controlled repeater. DL, UL, or OFF may be notified to a unit time. When DL or UL is notified to a unit time, it means that ON is notified to the unit time. When DL is notified to a unit time, the network controlled repeater may turn on the relay of DL in the unit time. When UL is notified to a unit time, the network controlled repeater may turn on the relay of UL in the unit time.

[0198] ON-OFF may not be explicitly notified. When it is notified that a certain unit time is DL or UL by DL-UL control signaling, the network controlled repeater may assume that the unit time is ON. Another unit time, that is, a unit time in which DL or UL is not notified may be assumed as OFF by the network controlled repeater.

[0199] When Flexible is notified in a unit time, the network controlled repeater may assume that the unit time is OFF. When the network controlled repeater is notified of Flexible, it may be interpreted that neither DL transfer nor UL transfer is instructed, and the unit time may be interpreted as OFF.

[0200] Further, when Flexible is notified in a unit time, the network controlled repeater may assume that the unit time is ON. When the network controlled repeater is notified of Flexible, it may be interpreted that either DL transfer or UL transfer is instructed, and the unit time may be interpreted as ON.

[0201] In addition, the notification regarding ON-OFF and the beam may be connected and notified to the network controlled repeater. The valid beam or OFF may be notified for a unit time. When a valid beam is notified for a unit time, the network controlled repeater may assume that the unit time is ON. ON-OFF may not be explicitly notified. In beam control signaling, when a valid beam is notified at a certain unit time, the network controlled repeater may assume that the certain unit time is ON. The network controlled repeater may assume that another unit time, for example, a unit time for which a valid beam is not notified is OFF.

[0202] Furthermore, the notification regarding ON-OFF and the power may be connected and notified to the network controlled repeater. Active power (for example, non-zero power) or OFF may be notified for a unit time. When an active power is notified for a unit time, the network controlled repeater may assume that the unit time is ON. ON-OFF may not be explicitly notified. In power control signaling, when active power is notified at a certain unit time, the network controlled repeater may assume that the certain unit time is ON. The network controlled repeater may assume that another unit time, for example, a unit time for which active power is not notified or a unit time for which zero power is notified is OFF.

[0203] In the foregoing example, the unit time may be a subframe, a slot, a symbol, a subframe group, a slot group, a symbol group, a DL-UL-Flexible resource type in a slot, or a DL-UL resource type in a slot.

[0204] In the above-described embodiment, when the unit time is a DL-UL-Flexible resource type in a slot and ON/OFF is notified to the DL-UL-Flexible resource type in the slot, it may mean that all DL-UL-Flexible symbols in the slot are notified.

[0205] In the above example, the DL-UL-Flexible resource type may be the DL-UL-Flexible resource type notified to the network controlled repeater, or may be the cell-specific DL-UL-Flexible resource type notified to all UEs in the cell (for example, notification by RRC signaling tdd-UL-DL-ConfigurationCommon).

[0206] The ON/OFF signaling may be separated by the following Link A and Link B. The above option may be

applied to either or both of Link A and Link B. Different options may be applied for Link A or Link B.

[0207] Link A: DL transfer, amplification and transfer from gNB to UE

[0208] Link B: UL transfer, amplification and transfer from UE to gNB

[0209] An indicator distinguishing the two links may further be signaled in the above embodiment.

[0210] The ability to indicate whether a network controlled repeater supports reception of ON/OFF control signaling from gNB may be defined. The ability to indicate whether a network controlled repeater supports reception of semi-static or dynamic ON/OFF control signaling from gNB may be defined. The ability to indicate a time when a network controlled repeater switches from ON to OFF may be defined. The ability to indicate a time when a network controlled repeater switches from OFF to ON may be defined. The above examples may be applied when corresponding abilities are supported.

[0211] According to the above-described embodiment, the network controlled repeater can set enable or disable of the relay of the radio signal for the time resource based on the control from the network.

[0212] That is, in the wireless communication system, it is possible to enable or disable the relay of the radio signal by the wireless relay device.

(Hardware Configuration)

[0213] The block diagram (FIGS. **2**, **3**, and **4**) used for the description of the above embodiment shows a block of a functional unit. The functional blocks (configuration units) are implemented by any combination of at least one of hardware and software. A method for implementing each functional block is not particularly limited. That is, each functional block may be implemented by using one physically or logically combined device, or may be implemented by directly or indirectly (for example, by using wired, wireless, or the like) connecting two or more physically or logically separated devices and using a plurality of the devices. The functional block may be implemented by combining software with the one device or the plurality of devices.

[0214] The functions include, but are not limited to, determining, determining, judging, calculating, computing, processing, deriving, investigating, searching, checking, receiving, transmitting, outputting, accessing, resolving, selecting, choosing, establishing, comparing, assuming, expecting, considering, broadcasting, notifying, communicating, forwarding, configuring, reconfiguring, allocating, mapping, assigning, and the like. For example, a functional block (configuration unit) that functions to transmit is referred to as a transmitting unit or a transmitter. In any case, as described above, the implementation method is not particularly limited.

[0215] For example, the base station **10**, the terminal **20**, the wireless relay device **30**, and the like in the embodiment of the present disclosure may function as a computer that performs processing of the wireless communication method of the present disclosure. FIG. **15** is a diagram illustrating an example of hardware configurations of the base station **10**, the terminal **20**, and the wireless relay device **30** according to the embodiment of the present disclosure. The base station **10**, the terminal **20**, and the wireless relay device **30** described above may be physically configured as a computer device including a processor **1001**, a storage device **1002**, an auxiliary storage device **1003**, a communication device **1004**, an input device **1005**, an output device **1006**, a bus **1007**, and the like.

[0216] In the following description, the term "apparatus" can be replaced with a circuit, a device, a unit, or the like. The hardware configuration of the base station **10**, the terminal **20**, and the wireless relay device **30** may be configured to include one or a plurality of each device illustrated in the drawing, or may be configured without including some devices.

[0217] Each function in the base station **10**, the terminal **20**, and the wireless relay device **30** is implemented by causing predetermined software (program) to be loaded on hardware such as the processor **1001** and the storage device **1002** so that the processor **1001** performs calculation to control communication by the communication device **1004** and control at least one of reading and writing of data in the storage device **1002** and the auxiliary storage device **1003**.

[0218] The processor **1001** operates, for example, an operating system to control the entire computer. The processor **1001** may include a central processing unit (CPU) including an interface with a peripheral device, a control device, an operation device, a register, and the like. For example, the control unit **140**, the control unit **240**, and the like described above may be implemented by the processor **1001**.

[0219] In addition, the processor **1001** reads a program (program code), a software module, data, or the like from at least one of the auxiliary storage device **1003** and the communication device **1004** to the storage device **1002**, and executes various processes according to the read program or the like. As the program, a program that causes a computer to execute at least part of the operations described in the above-described embodiments is used. For example, the control unit **140** of the base station **10** illustrated in FIG. **2** may be implemented by a control program stored in the storage device **1002** and operated by the processor **1001**. Furthermore, for example, the control unit **240** of the terminal **20** illustrated in FIG. **3** may be implemented by a control program stored in the storage device **1002** and operated by the processor **1001**. Although it is described that the above-described various processes are executed by one processor **1001**, the various processes may be executed simultaneously or sequentially by two or more processors **1001**. The processor **1001** may be implemented by one or more chips. The program may be transmitted from a network via an electric communication line.

[0220] The storage device **1002** is a computer-readable recording medium, and may be configured of, for example, at least one of a read only memory (ROM), an erasable programmable ROM (EPROM), an electrically erasable programmable ROM (EEPROM), a random access memory (RAM), and the like. The storage device **1002** may be referred to as a register, a cache, a main memory (main storage device), or the like. The storage device **1002** can store a program (program code), a software module, and the like that can be executed to implement the communication method according to the embodiment of the present disclosure.

[0221] The auxiliary storage device **1003** is a computer-readable recording medium, and may be configured of, for example, at least one of an optical disk such as a compact disk ROM (CD-ROM), a hard disk drive, a flexible disk, a magneto-optical disk (for example, a compact disc, a digital

versatile disk, or a Blu-ray (registered trademark) disk), a smart card, a flash memory (for example, a card, a stick, or a key drive), a floppy (registered trademark) disk, a magnetic strip, and the like. The above-described storage medium may be, for example, a database, a server, or another appropriate medium including at least one of the storage device **1002** and the auxiliary storage device **1003**.

[0222] The communication device **1004** is hardware (transmission/reception device) for performing communication between computers via at least one of a wired network and a wireless network, and is also referred to as, for example, a network device, a network controller, a network card, a communication module, or the like. The communication device **1004** may include a high-frequency switch, a duplexer, a filter, a frequency synthesizer, and the like to implement, for example, at least one of frequency division duplex (FDD) and time division duplex (TDD). For example, a transmission/reception antenna, an amplifier unit, a transmitting/receiving unit, a transmission/reception path interface, and the like may be implemented by the communication device **1004**. The transmitting/receiving unit may be physically or logically separated into the transmitting unit and the receiving unit.

[0223] The input device **1005** is an input device (for example, a keyboard, a mouse, a microphone, a switch, a button, a sensor, or the like) that receives an input from the outside. The output device **1006** is an output device (for example, a display, a speaker, an LED lamp, and the like) that performs output to the outside. Note that the input device **1005** and the output device **1006** may be integrated (for example, a touch panel).

[0224] In addition, each device such as the processor **1001** and the storage device **1002** are connected by the bus **1007** for communicating information. The bus **1007** may be configured using a single bus or may be configured using different buses between the devices.

[0225] Furthermore, the base station **10**, the terminal **20**, and the wireless relay device **30** may be configured to include hardware such as a microprocessor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a programmable logic device (PLD), and a field programmable gate array (FPGA), and some or all of the functional blocks may be implemented by the hardware. For example, the processor **1001** may be implemented using at least one of the pieces of hardware.

[0226] Furthermore, the wireless relay device **30** may include a variable phase shifter, a phase shifter, an amplifier, an antenna, an array antenna, and the like as necessary as hardware configuring the variable unit **340** and the antenna unit **350**.

[0227] FIG. **16** illustrates a configuration example of a vehicle **2001**. As illustrated in FIG. **16**, the vehicle **2001** includes a drive unit **2002**, a steering unit **2003**, an accelerator pedal **2004**, a brake pedal **2005**, a shift lever **2006**, a front wheel **2007**, a rear wheel **2008**, an axle **2009**, an electronic control unit **2010**, various sensors **2021** to **2029**, an information service unit **2012**, and a communication module **2013**. Each aspect/embodiment described in the present disclosure may be applied to a communication device mounted on the vehicle **2001**, and for example, may be applied to the communication module **2013**.

[0228] The drive unit **2002** is configured of, for example, an engine, a motor, or a hybrid of an engine and a motor. The steering unit **2003** includes at least a steering wheel (also referred to as a handle), and is configured to steer at least one of the front wheel and the rear wheel based on an operation of the steering wheel operated by the user.

[0229] The electronic control unit **2010** includes a microprocessor **2031**, a memory (ROM, RAM) **2032**, and a communication port (IO port) **2033**. Signals from various sensors **2021** to **2029** provided in the vehicle **2001** are input to the electronic control unit **2010**. The electronic control unit **2010** may be referred to as an electronic control unit (ECU).

[0230] Examples of the signals from the various sensors **2021** to **2029** include a current signal from a current sensor **2021** that senses the current of the motor, a rotation speed signal of the front wheel and the rear wheel acquired by a rotation speed sensor **2022**, an air pressure signal of the front wheel and the rear wheel acquired by an air pressure sensor **2023**, a vehicle speed signal acquired by a vehicle speed sensor **2024**, an acceleration signal acquired by an acceleration sensor **2025**, a depression amount signal of the accelerator pedal acquired by an accelerator pedal sensor **2029**, a depression amount signal of the brake pedal acquired by a brake pedal sensor **2026**, an operation signal of the shift lever acquired by a shift lever sensor **2027**, and a detection signal for detecting an obstacle, a vehicle, a pedestrian, and the like acquired by an object detection sensor **2028**.

[0231] The information service unit **2012** is configured of various devices such as a car navigation system, an audio system, a speaker, a television, and a radio, in which the various devices provide (output) various types of information such as driving information, traffic information, and entertainment information, and one or more ECUs that control the devices. The information service unit **2012** provides various types of multimedia information and multimedia services to the occupant of the vehicle **2001** using information acquired from an external device via the communication module **2013** or the like. The information service unit **2012** may include an input device (for example, a keyboard, a mouse, a microphone, a switch, a button, a sensor, a touch panel, or the like) that receives an input from the outside, or may include an output device (for example, a display, a speaker, an LED lamp, a touch panel, or the like) that performs output to the outside.

[0232] A driving assistance system unit **2030** is configured of various devices for providing functions for preventing an accident in advance and reducing a driver's driving load, such as a millimeter wave radar, light detection and ranging (LiDAR), a camera, a positioning locator (For example, GNSS or the like), map information (for example, a high definition (HD) map, an autonomous vehicle (AV) map, and the like), a gyro system (for example, an inertial measurement unit (IMU), an inertial navigation system (INS), or the like), an artificial intelligence (AI) chip, and an AI processor, and one or more ECUs for controlling the devices. The driving assistance system unit **2030** also transmits and receives various types of information via the communication module **2013** to implement a driving assistance function or an autonomous driving function.

[0233] The communication module **2013** can communicate with the microprocessor **2031** and components of the vehicle **2001** via the communication port. For example, the communication module **2013** transmits and receives data to and from the drive unit **2002**, the steering unit **2003**, the accelerator pedal **2004**, the brake pedal **2005**, the shift lever

2006, the front wheel 2007, the rear wheel 2008, the axle 2009, the microprocessor 2031 and the memory (ROM, RAM) 2032 in the electronic control unit 2010, and the sensor 2021 to 29 provided in the vehicle 2001 via the communication port 2033.

[0234] The communication module 2013 is a communication device that can be controlled by the microprocessor 2031 of the electronic control unit 2010 and can communicate with an external device. For example, various types of information are transmitted and received to and from an external device via wireless communication. The communication module 2013 may be either inside or outside the electronic control unit 2010. The external device may be, for example, a base station, a mobile station, or the like.

[0235] The communication module 2013 may transmit at least one of the above-described signals from the various sensors 2021 to 2028 input to the electronic control unit 2010, information obtained based on the signals, and information based on an input from the outside (user) obtained via the information service unit 2012 to the external device via wireless communication. The electronic control unit 2010, the various sensors 2021 to 2028, the information service unit 2012, and the like may be referred to as input units that receive inputs. For example, PUSCH transmitted by the communication module 2013 may include information based on the above input.

[0236] The communication module 2013 receives various types of information (traffic information, signal information, inter-vehicle information, and the like) transmitted from an external device, and displays the information on the information service unit 2012 provided in the vehicle 2001. The information service unit 2012 may be called an output unit that outputs information (for example, information is output to a device such as a display or a speaker based on PDSCH (or data/information decoded from PDSCH) received by the communication module 2013). The communication module 2013 also stores various types of information received from external devices in the memory 2032 available by the microprocessor 2031. The microprocessor 2031 may control the drive unit 2002, the steering unit 2003, the accelerator pedal 2004, the brake pedal 2005, the shift lever 2006, the front wheel 2007, the rear wheel 2008, the axle 2009, the sensors 2021 to 2029, and the like included in the vehicle 2001 based on the information stored in the memory 2032.

SUMMARY OF EMBODIMENTS

[0237] As described above, according to the embodiment of the present invention, provided is a wireless relay device including: a communication unit that receives signaling including control information related to a relay function from a base station; a control unit that controls the relay function based on the control information; and a relay unit that executes the relay function of receiving a first signal from the base station, transmitting the first signal to a terminal, receiving a second signal from the terminal, and transmitting the second signal to the base station, in which the control unit enables or disables transmission and reception of the first signal and transmission and reception of the second signal based on the control information.

[0238] According to the above-described configuration, the network controlled repeater can set enable or disable of the relay of the radio signal for the time resource based on the control from the network. That is, in the wireless communication system, it is possible to enable or disable the relay of the radio signal by the wireless relay device.

[0239] The control unit may enable or disable transmission and reception of the first signal and transmission and reception of the second signal for a certain unit time based on the control information. With such configuration, the network controlled repeater can set enable or disable of the relay of the radio signal for the time resource based on the control from the network.

[0240] The control unit may enable or disable transmission and reception of the first signal and transmission and reception of the second signal for a period indicated by a start time and a time length based on the control information. With such configuration, the network controlled repeater can set enable or disable of the relay of the radio signal for the time resource based on the control from the network.

[0241] The control unit may enable or disable transmission and reception of the first signal and transmission and reception of the second signal for each unit time of a period including a plurality of unit times instructed to be enabled or disabled based on the control information. With such configuration, the network controlled repeater can set enable or disable of the relay of the radio signal for the time resource based on the control from the network.

[0242] The control unit may enable transmission and reception of the first signal or transmission and reception of the second signal in a certain unit time when the control information indicates a downlink or an uplink for the unit time. With such configuration, the network controlled repeater can set enable or disable of the relay of the radio signal for the time resource based on the control from the network.

[0243] Furthermore, according to the embodiment of the present invention, provided is a communication method executed by a wireless relay device, the method including: a communication procedure of receiving signaling including control information related to a relay function from a base station; a control procedure of controlling the relay function based on the control information; a relay procedure of executing the relay function of receiving a first signal from the base station, transmitting the first signal to a terminal, receiving a second signal from the terminal, and transmitting the second signal to the base station; and a procedure of enabling or disabling transmission and reception of the first signal and transmission and reception of the second signal based on the control information.

[0244] According to the above-described configuration, the network controlled repeater can set enable or disable of the relay of the radio signal for the time resource based on the control from the network. That is, in the wireless communication system, it is possible to enable or disable the relay of the radio signal by the wireless relay device.

SUPPLEMENT TO EMBODIMENT

[0245] Although the embodiments of the present invention are described above, the disclosed invention is not limited to such embodiments, and those skilled in the art will understand various modifications, changes, alternatives, substitutions, and the like. Although the description is given using specific numerical examples to facilitate understanding of the invention, the numerical values are merely examples, and any appropriate value may be used unless otherwise specified. The classification of items in the above description is not essential to the present invention, and details described

in two or more items may be used in combination as necessary, or a detail described in a certain item may be applied to a detail described in another item (as long as there is no contradiction). A boundary of a functional unit or a processing unit in the functional block diagram does not necessarily correspond to a boundary of a physical component. The operation of a plurality of functional units may be physically performed by one component, or the operation of one functional unit may be physically performed by a plurality of components. In the processing procedure described in the embodiment, the order of the processing may be changed as long as there is no contradiction. For convenience of processing description, the base station **10** and the terminal **20** are described using a functional block diagram, but such a device may be implemented in hardware, software, or a combination thereof. The software operated by the processor included in the base station **10** according to the embodiments of the present invention and the software operated by the processor included in the terminal **20** according to the embodiments of the present invention may be stored in any appropriate storage medium such as a random access memory (RAM), a flash memory, a read only memory (ROM), an EPROM, an EEPROM, a register, a hard disk (HDD), a removable disk, a CD-ROM, a database, or a server.

[0246] Furthermore, notification of information is not limited to the aspects/embodiments described in the present disclosure, and may be performed using other methods. For example, the notification of information may be performed by physical layer signaling (for example, downlink control information (DCI) and uplink control information (UCI)), upper layer signaling (for example, radio resource control (RRC) signaling and medium access control (MAC) signaling), broadcast information (master information block (MIB) and system information block (SIB)), other signals, or a combination thereof. Furthermore, RRC signaling may be referred to as RRC message, and may be, for example, RRC connection setup message, RRC connection reconfiguration message, or the like.

[0247] Each aspect/embodiment described in the present disclosure may be applied to at least one of systems using Long Term Evolution (LTE), LTE-Advanced (LTE-A), SUPER 3G, IMT-Advanced, 4th generation mobile communication system (4G), 5th generation mobile communication system (5G), 6th generation mobile communication system (6G), x-th generation mobile communication system (xG) (xG (x is, for example, an integer or a decimal)), future radio access (FRA), new radio (NR), new radio access (NX), future generation radio access (FX), W-CDMA (registered trademark), GSM (registered trademark), CDMA2000, ultra mobile broadband (UMB), IEEE 802.11 (Wi-Fi (registered trademark)), IEEE 802.16 (WiMAX (registered trademark)), IEEE 802.20, Ultra-WideBand (UWB), Bluetooth (registered trademark), other appropriate systems, and next-generation systems extended, modified, created, and specified based on such systems. Also, a plurality of systems may be applied in combination (for example, a combination of at least one of LTE and LTE-A and 5G, and the like).

[0248] The order of the processing procedure, sequence, flowchart, and the like of each aspect/embodiment described in the present specification may be changed as long as there is no contradiction. For example, for the methods described in the present disclosure, elements of various steps are presented using an example order, and are not limited to the particular order presented.

[0249] The specific operation described as being performed by the base station **10** in the present specification may be performed by an upper node thereof in some cases. It is obvious that in a network including one or a plurality of network nodes having the base station **10**, various operations performed for communication with the terminal **20** may be performed by at least one of the base station **10** and other network nodes (for example, MME, S-GW, or the like is conceivable, but is not limited thereto) other than the base station **10**. Although a case where there is one other network node other than the base station **10** is exemplified above, the other network node may be a combination of a plurality of other network nodes (for example, MME and S-GW).

[0250] Information, a signal, or the like described in the present disclosure can be output from an upper layer (or a lower layer) to a lower layer (or an upper layer). Input and output may be performed via a plurality of network nodes.

[0251] The input/output information and the like may be stored in a specific position (for example, memory) or may be managed using a management table. The input/output information and the like can be overwritten, updated, or additionally written. The output information and the like may be deleted. The input information and the like may be transmitted to another device.

[0252] The judgment in the present disclosure may be made by a value represented by one bit (0 or 1), may be made by a true/false value (Boolean: true or false), or may be made by comparison of numerical values (for example, comparison with a predetermined value).

[0253] Software, whether referred to as software, firmware, middleware, microcode, hardware description language, or other names, should be construed broadly to mean instructions, instruction sets, code, code segments, program code, programs, subprograms, software modules, applications, software applications, software packages, routines, subroutines, objects, executable files, execution threads, procedures, functions, and the like.

[0254] In addition, software, instruction, information, and the like may be transmitted and received via a transmission medium. For example, when software is transmitted from a website, server, or other remote source using at least one of a wired technology (a coaxial cable, an optical fiber cable, a twisted pair, a digital subscriber line (DSL), or the like) and a wireless technology (infrared rays, microwaves, or the like), at least one of the wired technology and the wireless technology is included within the definition of the transmission medium.

[0255] Information, a signal, and the like described in the present disclosure may be represented using any of a variety of different techniques. For example, data, instructions, commands, information, signals, bits, symbols, chips, and the like that may be mentioned throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or magnetic particles, optical fields or optical photons, or any combination thereof.

[0256] Note that the terms described in the present disclosure and the terms necessary for understanding the present disclosure may be replaced with terms having the same or similar meanings. For example, at least one of a channel and a symbol may be a signal (signaling). A signal may also

be a message. In addition, a component carrier (CC) may be referred to as a carrier frequency, a cell, a frequency carrier, or the like.

[0257] The terms "system" and "network" used in the present disclosure are used interchangeably.

[0258] In addition, information, parameter, and the like described in the present disclosure may be represented using an absolute value, may be represented using a relative value from a predetermined value, or may be represented using another piece of corresponding information. For example, a radio resource may be indicated by an index.

[0259] The names used for parameters described above are not limited in any respect. Furthermore, expressions and the like using the parameters may be different from those explicitly disclosed in the present disclosure. Since various channels (for example, PUCCH, PDCCH, and the like) and information elements can be identified by any suitable name, various names assigned to various channels and information elements are not in any way limitative names.

[0260] In the present disclosure, terms such as "base station (BS)", "radio base station", "base station", "fixed station", "NodeB", "eNodeB (eNB)", "gNodeB (gNB)", "access point", "transmission point", "reception point", "transmission/reception point", "cell", "sector", "cell group", "carrier", and "component carrier" can be used interchangeably. A base station may also be referred to as a macro cell, a small cell, a femto cell, a pico cell, or the like.

[0261] A base station may accommodate one or a plurality of (for example, three) cells. When a base station accommodates a plurality of cells, an entire coverage area of the base station may be divided into a plurality of smaller areas, and each smaller area may also provide a communication service by a base station subsystem (for example, a small base station for indoor use (remote radio head (RRH))). The term "cell" or "sector" refers to a part or the whole of a coverage area of at least one of a base station and a base station subsystem that performs communication service in the coverage.

[0262] In the present disclosure, when a base station transmits information to a terminal, it may be read as that the base station instructs the terminal to perform control and operation based on the information.

[0263] In the present disclosure, terms such as "mobile station (MS)", "user terminal", "user equipment (UE)", and "terminal" can be used interchangeably.

[0264] The mobile station may also be referred to by those skilled in the art as a subscriber station, a mobile unit, a subscriber unit, a wireless unit, a remote unit, a mobile device, a wireless device, a wireless communication device, a remote device, a mobile subscriber station, an access terminal, a mobile terminal, a wireless terminal, a remote terminal, a handset, a user agent, a mobile client, a client, or some other suitable term.

[0265] At least one of a base station and a mobile station may be referred to as a transmission device, a reception device, a communication device, or the like. Note that at least one of a base station and a mobile station may be a device mounted on a moving object, the mobile object itself, or the like. A moving object refers to a movable object, and a moving speed is arbitrary. In addition, a case where a moving object is stopped is naturally included. A moving object includes, for example, a vehicle, a transport vehicle, an automobile, a motorcycle, a bicycle, a connected car, an excavator, a bulldozer, a wheel loader, a dump truck, a forklift, a train, a bus, a rear car, a human-powered vehicle, a ship and other watercraft, an airplane, a rocket, an artificial satellite, a drone (registered trademark), a multicopter, a quadcopter, a balloon, and objects mounted thereon, and is not limited thereto. Further, a moving object may be a moving object that autonomously travels based on an operation command. A moving object may be a vehicle (for example, a car, an airplane, or the like), a moving object moving unmanned (for example, a drone, an autonomous-driving vehicle, or the like), or a robot (manned type or unmanned type). Note that at least one of a base station and a mobile station includes a device that does not necessarily move during communication operation. For example, at least one of a base station and a mobile station may be an internet of things (IoT) device such as a sensor.

[0266] In addition, a base station in the present disclosure may be read as a user terminal. For example, each aspect/embodiment of the present disclosure may be applied to a configuration in which communication between a base station and a user terminal is replaced with communication between a plurality of terminals **20** (for example, the communication may be referred to as device-to-device (D2D), vehicle-to-everything (V2X), or the like). Here, the terminal **20** may have the function of the base station **10** described above. In addition, words such as "up" and "down" may be read as words corresponding to terminal-to-terminal communication (for example, "side"). For example, an uplink channel, a downlink channel, and the like may be replaced with a side channel.

[0267] Similarly, a user terminal in the present disclosure may be read as a base station. Here, the base station may have the function of the user terminal described above.

[0268] The terms "determining" and "determining" used in the present disclosure may encompass a wide variety of actions. The terms "determining" and "determining" may include, for example, a case in which "judging", "calculating", "computing", "processing", "deriving", "investigating", "looking up, search, inquiry" (for example, looking up, searching, or inquiring a table, a database, or another data structure), and "ascertaining" is deemed as "determining". Furthermore, the terms "determining" and "determining" may include a case in which "receiving" (for example, receiving information), "transmitting" (for example, transmitting information), "input", "output", and "accessing" (for example, accessing data in a memory) is deemed as "determining". Further, the terms "determining" and "determining" may include a case in which "resolving", "selecting", "choosing", "establishing", "comparing", and the like is deemed as "determining". In other words, the terms "determining" and "determining" may include a case in which a certain action or operation is deemed as "determining". Further, the term "determining (determining)" may be read as "assuming", "expecting", "considering", or the like.

[0269] The term "connected" or "coupled" or any variation thereof means any direct or indirect connection or coupling between two or more elements and may include the presence of one or more intermediate elements between two elements "connected" or "coupled" with each other. The coupling or connection between the elements may be physical, logical, or a combination thereof. For example, "connection" may be read as "access". As used in the present disclosure, two elements can be considered to be "connected" or "coupled" to each other using at least one of one or more wires, cables, and printed electrical connections

and, as a number of non-limiting and non-inclusive examples, electromagnetic energy having wavelengths in a radio frequency region, a microwave region, and a light (both visible and invisible) region.

[0270] The reference signal may be abbreviated as RS (reference signal), or may be referred to as a pilot according to an applied standard.

[0271] As used in the present disclosure, the description "based on" does not mean "based only on" unless explicitly stated otherwise. In other words, the description "based on" means both "based only on" and "based at least on".

[0272] As used in the present disclosure, any reference to elements using designations such as "first", "second", and the like does not generally limit the amount or order of the elements. Such designations may be used in the present disclosure as a convenient way to distinguish between two or more elements. Thus, references to first and second elements do not imply that only two elements may be adopted or that the first element must in any way precede the second element.

[0273] The term "means" in the configuration of each device described above may be replaced with "unit", "circuit", "device", or the like.

[0274] Where the present disclosure uses the terms "include", "including", and variations thereof, the terms are intended to be inclusive in a manner similar to the term "comprising". Furthermore, the term "or" used in the present disclosure is intended not to be an exclusive OR.

[0275] A radio frame may be configured by one or a plurality of frames in a time domain. Each of one or a plurality of frames in the time domain may be referred to as a subframe. The subframe may further be configured by one or a plurality of slots in the time domain. The subframe may be a fixed time length (for example, 1 ms) that does not depend on numerology.

[0276] Numerology may be a communication parameter applied to at least one of transmission and reception of a certain signal or channel. Numerology may indicate at least one of, for example, a subcarrier spacing (SCS), a bandwidth, a symbol length, a cyclic prefix length, a transmission time interval (TTI), a number of symbols per TTI, a radio frame configuration, a particular filtering process performed by a transceiver in a frequency domain, a particular windowing process performed by a transceiver in a time domain, and the like.

[0277] A slot may be configured by one or a plurality of symbols (orthogonal frequency division multiplexing (OFDM) symbol, single carrier frequency division multiple access (SC-FDMA) symbol, and the like) in the time domain. A slot may be a time unit based on numerology.

[0278] A slot may include a plurality of mini-slots. Each mini-slot may be configured by one or a plurality of symbols in the time domain. Further, a mini-slot may be referred to as a sub-slot. A mini-slot may include a smaller number of symbols than a slot. PDSCH (or PUSCH) transmitted in a time unit larger than a mini-slot may be referred to as PDSCH (or PUSCH) mapping type A. PDSCH (or PUSCH) transmitted using a mini-slot may be referred to as PDSCH (or PUSCH) mapping type B.

[0279] Each of a radio frame, a subframe, a slot, a mini-slot, and a symbol represents a time unit when a signal is transmitted. Different names corresponding to a radio frame, a subframe, a slot, a mini-slot, and a symbol may be used.

[0280] For example, one subframe may be referred to as a transmission time interval (TTI), a plurality of consecutive subframes may be referred to as a TTI, and one slot or one mini-slot may be referred to as a TTI. That is, at least one of a subframe and a TTI may be a subframe (1 ms) in existing LTE, a period shorter than 1 ms (for example, 1 to 13 symbols), or a period longer than 1 ms. Note that a unit representing TTI may be referred to as a slot, a mini-slot, or the like instead of a subframe.

[0281] Here, TTI refers to, for example, a minimum time unit of scheduling in wireless communication. For example, in an LTE system, a base station performs scheduling of allocating radio resources (frequency bandwidth, transmission power, and the like that can be used in each terminal **20**) to each terminal **20** in units of TTIs. Note that the definition of TTI is not limited thereto.

[0282] TTI may be a transmission time unit such as a channel coded data packet (transport block), a code block, or a code word, or may be a processing unit such as scheduling or link adaptation. Note that, when TTI is given, a time interval (for example, the number of symbols) in which a transport block, a code block, a code word, or the like is actually mapped may be shorter than TTI.

[0283] Note that, when one slot or one mini-slot is referred to as TTI, one or more TTIs (that is, one or more slots or one or more mini-slots) may be the minimum time unit of scheduling. Furthermore, the number of slots (the number of mini-slots) configuring the minimum time unit of scheduling may be controlled.

[0284] TTI with a time length of 1 ms may be referred to as normal TTI (TTI in LTE Rel. 8-12), normal TTI, long TTI, a general subframe, a normal subframe, a long subframe, a slot, or the like. TTI shorter than normal TTI may be referred to as shortened TTI, short TTI, partial TTI (partial or fractional TTI), a shortened subframe, a short subframe, a mini-slot, a sub-slot, a slot, or the like.

[0285] Note that long TTI (for example, normal TTI, a subframe, or the like) may be read as TTI having a time length exceeding 1 ms, and short TTI (for example, shortened TTI or the like) may be read as TTI having TTI length less than TTI length of long TTI and equal to or greater than 1 ms.

[0286] A resource block (RB) is a resource allocation unit in the time domain and the frequency domain, and may include one or a plurality of consecutive subcarriers in the frequency domain. The number of subcarriers included in RB may be the same regardless of numerology, for example, may be 12. The number of subcarriers included in RB may be determined based on numerology.

[0287] In addition, the time domain of RB may include one or a plurality of symbols, and may be a length of one slot, one mini-slot, one subframe, or one TTI. Each of one TTI, one subframe, and the like may be configured by one or a plurality of resource blocks.

[0288] Note that one or a plurality of RBs may be referred to as a physical resource block (PRB), a sub-carrier group (SCG), a resource element group (REG), a PRB pair, an RB pair, or the like.

[0289] Furthermore, the resource block may be configured of one or a plurality of resource elements (REs). For example, one RE may be a radio resource area of one subcarrier and one symbol.

[0290] A bandwidth part (BWP) (may also be referred to as partial bandwidth or the like) may represent a subset of

consecutive common resource blocks (RBs) for a certain numerology on a certain carrier. Here, the common RB may be specified by an index of RB based on a common reference point of the carrier. PRB may be defined by a certain BWP and numbered within the certain BWP.

[0291] BWP may include BWP for UL (UL BWP) and BWP for DL (DL BWP). One or a plurality of BWPs may be set in one carrier for the terminal **20**.

[0292] At least one of the set BWPs may be active, and the terminal **20** may not assume that a predetermined signal/channel is transmitted and received outside the active BWPs. Note that "cell", "carrier", and the like in the present disclosure may be read as "BWP".

[0293] The above-described structures such as a radio frame, a subframe, a slot, a mini-slot, and a symbol are merely examples. For example, configurations such as the number of subframes included in a radio frame, the number of slots per subframe or radio frame, the number of mini-slots included in a slot, the number of symbols and RBs included in a slot or mini-slot, the number of subcarriers included in an RB, the number of symbols in a TTI, a symbol length, a cyclic prefix (CP) length, and the like can be variously changed.

[0294] In the present disclosure, for example, when articles such as "a", "an", and "the" in English are added by translation, the present disclosure may include a case where a noun following the articles is a plural form. In the present disclosure, the term "A and B are different" may mean "A and B are different from each other". Note that the term may mean that "A and B are different from C". Terms such as "separated", "coupled" and the like may also be interpreted in the same manner as "different".

[0295] Each aspect/embodiment described in the present disclosure may be used alone, may be used in combination, or may be switched with execution. Furthermore, notification of predetermined information (for example, notification of "being X") is not limited to being performed explicitly, and may be performed implicitly (for example, the predetermined information is not notified). Note that, in the present disclosure, the variable unit **340** and the antenna unit **350** are an example of a relay unit.

[0296] Although the present disclosure is described in detail above, it is apparent to those skilled in the art that the present disclosure is not limited to the embodiments described in the present disclosure. The present disclosure can be implemented as modifications and variations without departing from the spirit and scope of the present disclosure defined by the claims. Therefore, the description of the present disclosure is for the purpose of illustration and does not have any restrictive meaning to the present disclosure.

REFERENCE SIGNS LIST

[0297] **10** Base station
[0298] **110** Transmitting unit
[0299] **120** Receiving unit
[0300] **130** Setting unit
[0301] **140** Control unit
[0302] **20** Terminal
[0303] **210** Transmitting unit
[0304] **220** Receiving unit
[0305] **230** Setting unit
[0306] **240** Control unit
[0307] **30** Wireless relay device
[0308] **310** Transmitting unit
[0309] **320** Receiving unit
[0310] **330** Control unit
[0311] **340** Variable unit
[0312] **350** Antenna unit
[0313] **1001** Processor
[0314] **1002** Storage device
[0315] **1003** Auxiliary storage device
[0316] **1004** Communication device
[0317] **1005** Input device
[0318] **1006** Output device
[0319] **2001** Vehicle
[0320] **2002** Drive unit
[0321] **2003** Steering unit
[0322] **2004** Accelerator pedal
[0323] **2005** Brake pedal
[0324] **2006** Shift lever
[0325] **2007** Front wheel
[0326] **2008** Rear wheel
[0327] **2009** Axle
[0328] **2010** Electronic control unit
[0329] **2012** Information service unit
[0330] **2013** Communication module
[0331] **2021** Current sensor
[0332] **2022** Rotation speed sensor
[0333] **2023** Air pressure sensor
[0334] **2024** Vehicle speed sensor
[0335] **2025** Acceleration sensor
[0336] **2026** Brake pedal sensor
[0337] **2027** Shift lever sensor
[0338] **2028** Object detection sensor
[0339] **2029** Accelerator pedal sensor
[0340] **2030** Driving assistance system unit
[0341] **2031** Microprocessor
[0342] **2032** Memory (ROM, RAM)
[0343] **2033** Communication port (IO port)

1. A wireless relay device comprising:

a communication unit that receives signaling including control information related to a relay function from a base station;

a control unit that controls the relay function based on the control information; and

a relay unit that executes the relay function of receiving a first signal from the base station, transmitting the first signal to a terminal, receiving a second signal from the terminal, and transmitting the second signal to the base station, wherein

the control unit enables or disables transmission and reception of the first signal and transmission and reception of the second signal based on the control information.

2. The wireless relay device according to claim **1**, wherein the control unit enables or disables transmission and reception of the first signal and transmission and reception of the second signal for a certain unit time based on the control information.

3. The wireless relay device according to claim **1**, wherein the control unit enables or disables transmission and reception of the first signal and transmission and reception of the second signal for a period indicated by a start time and a time length based on the control information.

4. The wireless relay device according to claim **1**, wherein the control unit enables or disables transmission and reception of the first signal and transmission and reception of the second signal for each unit time of a period including a

plurality of unit times instructed to be enabled or disabled based on the control information.

5. The wireless relay device according to claim **1**, wherein the control unit enables transmission and reception of the first signal or transmission and reception of the second signal in a certain unit time when the control information indicates a downlink or an uplink for the unit time.

6. A communication method executed by a wireless relay device, the method comprising:

a communication procedure of receiving signaling including control information related to a relay function from a base station;

a control procedure of controlling the relay function based on the control information;

a relay procedure of executing the relay function of receiving a first signal from the base station, transmitting the first signal to a terminal, receiving a second signal from the terminal, and transmitting the second signal to the base station; and

a procedure of enabling or disabling transmission and reception of the first signal and transmission and reception of the second signal based on the control information.

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