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Inventor(s)	Ohara; Tomoya

Terminal and communication method

Abstract

A terminal includes: a receiving unit configured to receive an indication indicating an active state or an inactive state from a base station for each of one or more search space sets included in a search space set group; and a control unit configured to monitor a search space set for which the indication is an active state, and does not monitor a search space set for which the indication is an inactive state, among the search space sets included in the search space set group.

Inventors:	Ohara; Tomoya (Tokyo, JP)
Applicant:	NTT DOCOMO, INC. (Tokyo, JP)
Family ID:	1000008748628
Assignee:	NTT DOCOMO, INC. (Tokyo, JP)
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References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
7194752	12/2006	Kenyon	725/19	G10L 25/48
2020/0112917	12/2019	Nam	N/A	H04W 52/0235
2020/0351784	12/2019	Tsai	N/A	H04L 5/0094
2020/0413412	12/2019	Kim	N/A	H04W 24/08
2021/0337504	12/2020	Gao	N/A	H04L 1/1819
2021/0360674	12/2020	Lim	N/A	H04W 52/0216
2022/0210739	12/2021	Yi	N/A	H04L 5/0037
2022/0368468	12/2021	Xiong	N/A	H04L 1/1819

OTHER PUBLICATIONS

International Search Report issued in corresponding International Application No. PCT/JP2020/030516, mailed on Mar. 23, 2021 (5 pages). cited by applicant
Written Opinion issued in corresponding International Application No. PCT/JP2020/030516, mailed on Mar. 23, 2021 (3 pages). cited by applicant
3GPP TS 38.300 V16.0.0; “3rd Generation Partnership Project; Technical Specification Group Radio Access Network; NR; NR and NG-RAN Overall Description; Stage 2 (Release 16)”; Dec. 2019 (101 pages). cited by applicant

Primary Examiner: Rego; Dominic E

Attorney, Agent or Firm: Osha Bergman Watanabe & Burton LLP

Background/Summary

TECHNICAL FIELD

(1) The present invention relates to a terminal and a communication method in a radio communication system.

BACKGROUND ART

(2) In NR (New Radio) (also referred to as “5G”) that is a successor system to LTE (Long Term Evolution), a technology satisfying a large-capacity system, a high-speed data transmission rate, low delay, simultaneous connection of a large number of terminals, low cost, power saving, and the like as requirements has been discussed (for example, Non-Patent Document 1).

(3) In NR Release 17, a technology for further power saving in the connected mode UE to

minimize an impact on system performance has been studied. For example, enhancements such as a DCI (Downlink control information)-based power saving operation during a DRX (discontinuous reception) active period in active BWP (Bandwidth part) and reduction of PDCCH (Physical Downlink Control Channel) monitoring during C (Connected)-DRX are being discussed.

CITATION LIST

Non-Patent Document

(4) Non-Patent Document 1: 3GPP TS 38.300 V16.0.0 (2019-12)

SUMMARY OF THE INVENTION

Problem to be Solved by the Invention

(5) In the conventional configurations related to the search space, only the switching for each search space set group can be configured, and the configuration inside the search space set group cannot be configured. In addition, the occasions for switching the search space set group are limited. Accordingly, flexible search space switching cannot be performed, and unnecessary monitoring may occur, which has been an obstacle to power saving.

(6) The invention has been made in view of the above points, and it is an object of the invention to reduce power consumption when monitoring a search space in a radio communication system.

Means for Solving Problem

(7) According to the disclosed technique, there is provided a terminal including: a receiving unit configured to receive an indication indicating an active state or an inactive state from a base station for each of one or more search space sets included in a search space set group; and a control unit configured to monitor a search space set for which the indication is an active state, and not to monitor a search space set for which the indication is an inactive state, among the search space sets included in the search space set group.

Effect of the Invention

(8) According to the disclosed technique, it is possible to reduce the power consumption when monitoring the search space in the radio communication system.

Description

BRIEF DESCRIPTION OF DRAWINGS

(1) FIG. 1 A drawing illustrating a configuration example of a radio communication system according to an embodiment of the invention.

(2) FIG. 2 A drawing illustrating an example of a search space.

(3) FIG. 3 A flowchart illustrating a configuration related to the search space in the embodiment of the invention.

(4) FIG. 4 A drawing illustrating an example (1) of the search space in the embodiment of the invention.

(5) FIG. 5 A drawing illustrating an example (2) of the search space in the embodiment of the invention.

(6) FIG. 6 A drawing illustrating an example of CDRX.

(7) FIG. 7 A drawing illustrating an example of CDRX in the embodiment of the invention.

(8) FIG. 8 A drawing illustrating an example (3) of the search space in the embodiment of the invention.

(9) FIG. 9 A drawing illustrating an example of the functional configuration of a base station **10** in the embodiment of the invention.

(10) FIG. 10 A drawing illustrating an example of the functional configuration of a terminal **20** in the embodiment of the invention.

(11) FIG. 11 A drawing illustrating an example of the hardware configuration of the base station **10** or the terminal **20** in the embodiment of the invention.

(12) Hereinafter, an embodiment of the invention will be described with reference to the drawings. In addition, the embodiment described below is an example, and the embodiment to which the invention is applied is not limited to the following embodiment.

(13) In the operation of the radio communication system according to the embodiment of the invention, conventional technologies are appropriately used. The conventional technologies include, for example, conventional LTE, but is not limited to the conventional LTE. In addition, the term “LTE” used in this specification has a broad meaning including LTE-Advanced and systems (for example, NR) after LTE-Advanced unless otherwise specified.

(14) In addition, in the embodiment of the invention described below, terms such as SS (Synchronization signal), PSS (Primary SS), SSS (Secondary SS), PBCH (Physical broadcast channel), PRACH (Physical random access channel), PDCCH (Physical Downlink Control Channel), PDSCH (Physical Downlink Shared Channel), PUCCH (Physical Uplink Control Channel), and PUSCH (Physical Uplink Shared Channel) used in the conventional LTE are used. Using such terms is for convenience of description, and signals, functions, and the like similar to these terms may be referred to as other names. In addition, the above-described terms in NR correspond to NR-SS, NR-PSS, NR-SSS, NR-PBCH, NR-PRACH, and the like. However, even a signal used in NR is not necessarily expressed as “NR-”.

(15) In addition, in the embodiment of the invention, a duplex method may be a TDD (Time Division Duplex) method, an FDD (Frequency Division Duplex) method, or any other method (for example, Flexible Duplex).

(16) In addition, in the embodiment of the invention, “configure” a radio parameter or the like may mean pre-configure a predetermined value or configure a radio parameter indicated by a base station **10** or a terminal **20**.

(17) FIG. **1** is a drawing illustrating a configuration example of a radio communication system according to the embodiment of the invention. As shown in FIG. **1**, the radio communication system according to the embodiment of the invention includes the base station **10** and the terminal **20**. FIG. **1** shows one base station **10** and one terminal **20**, but this is an example, and a plurality of base stations **10** and a plurality of terminals **20** may be provided.

(18) The base station **10** is a communication device that provides one or more cells and performs radio communication with the terminal **20**. The physical resource of a radio signal is defined in a time domain and a frequency domain, and the time domain may be defined by the number of OFDM (Orthogonal Frequency Division Multiplexing) symbols, and the frequency domain may be defined by the number of subcarriers or the number of resource blocks. The base station **10** transmits a synchronization signal and system information to the terminal **20**. The synchronization signal is, for example, NR-PSS and NR-SSS. The system information is transmitted through the NR-PBCH, for example, and is also referred to as broadcast information. As shown in FIG. **1**, the base station **10** transmits a control signal or data to the terminal **20** by DL (Downlink), and receives a control signal or data from the terminal **20** by UL (Uplink). Both the base station **10** and the terminal **20** can perform beam forming to transmit and receive signals. In addition, both the base station **10** and the terminal **20** can apply MIMO (Multiple Input Multiple Output) communication to DL or UL. In addition, both the base station **10** and the terminal **20** may communicate with each other through SCell (Secondary Cell) and PCell (Primary Cell) by using CA (Carrier Aggregation). In addition, the terminal **20** may perform communication through the primary cell of the base station **10** and a primary secondary cell group cell (PSCell) of another base station **10** by using DC (Dual Connectivity).

(19) The terminal **20** is a communication device having a radio communication function, such as a smartphone, a mobile phone, a tablet, a wearable terminal, and a communication module for M2M (Machine-to-Machine). As shown in FIG. **1**, the terminal **20** uses various communication services provided by the radio communication system by receiving a control signal or data from the base

station **10** by DL and transmitting a control signal or data to the base station **10** by UL.

(20) Here, in NR Release 17, a technology for further power saving in the connected mode UE to minimize an impact on system performance has been discussed. For example, enhancements such as a DCI (Downlink control information)-based power saving operation during a DRX (discontinuous reception) active period in active BWP (Bandwidth part) and reduction of PDCCH (Physical Downlink Control Channel) monitoring during C (Connected)-DRX are being discussed.

(21) FIG. 2 is a drawing illustrating an example of a search space. A plurality of search space set groups can be configured in the terminal **20**, and the search space set group to be used can be switched. The search space set group includes one or more search space sets. The search space set is a configuration for monitoring PDCCH, for example, a period, a monitoring position, and the like.

(22) In the example shown in FIG. 2, a search space set group #0 includes a search space set #0 and a search space set #1, and a search space set group #1 includes a search space set #2 and a search space set #3. Examples of a method of switching the search space set to be used include methods shown in the following 1) to 3). 1) Indication by DCI (Downlink control information) format 2_0 (field "Search space set group switching flag") 2) When the configured timer expires (can be reset by indication by DCI) 3) Change in response to PDCCH detection (for example, switch from search space set #0 to search space set #1 in response to PDCCH detection)

(23) As shown in FIG. 2, in a case of DCI indication or PDCCH detection, the switching may be performed from the search space set #0 to the search space set #1, or from the search space set #1 to the search space set #0, in response to DCI indication or timer expiration. In the example shown in FIG. 2, the power consumption of the search space set #0 may be configured to be smaller than that of the search space set #1.

(24) However, in the conventional method, because it is not possible to individually cause each search space set in the search space set to be active or inactive, it is not possible to flexibly control the power consumption.

(25) Therefore, the base station **10** may indicate, to the terminal **20**, activation or deactivation for each search space set in each search console group. "The search space set is active" corresponds to performing PDCCH monitoring based on the search space set, and "the search space set is inactive" corresponds to not performing PDCCH monitoring based on the search space set.

(26) FIG. 3 is a flowchart illustrating a configuration related to the search space in the embodiment of the invention. In step S1, the base station **10** indicates, to the terminal **20**, activation or deactivation for each search space set in the search space set group. In the subsequent step S2, based on the indication in step S1, the terminal **20** activates each search space set to configure the search space set to active or deactivates each search space set to configure the search space set to inactive.

(27) FIG. 4 is a drawing illustrating an example (1) of the search space in the embodiment of the invention. In the example shown in FIG. 4, the search space set #0 in the search space set group #0 is configured to active, and the search space set #1 is configured to inactive. In addition, the search space set #2 in the search space set group #1 is configured to inactive, and the search space set #3 is configured to active.

(28) In addition, when switching the search space set group, the active or inactive state in the currently unused search space set group may be maintained or reset. For example, when the search space set group to be used is switched from the search space set group #0 to the search space set group #1, the active state or the inactive state of each search space set in the search space set group #0 may be maintained until the switching to the search space set group #0 occurs again.

Alternatively, for example, when the search space set group to be used is switched from the search space set group #0 to the search space set group #1, the state of each search space set in the search space set group #0 may be reset. For example, according to the reset, all the search space sets may be configured to the active state or all the search space sets may be configured to the inactive state.

(29) FIG. 5 is a drawing illustrating an example (2) of the search space in the embodiment of the invention. When indication of activation or deactivation for each search space set in the search space set group is provided, the active state or the inactive state may be shared by the corresponding search space sets between the search space set groups.

(30) For example, as shown in FIG. 5, the sharing may be performed between the search space set #0 and the search space set #2, and the sharing may be performed between the search space set #1 and the search space set #3. In the example of FIG. 5, the active state is configured in common between the search space set #0 and the search space set #2, and the inactive state is configured in common between the search space set #1 and the search space set #3. In a case where there is switching between the active state and the inactive state, the sharing search space sets may switch their states at the same time.

(31) Regarding the sharing search space sets, which search space sets are to perform sharing may be configured by the network. In addition, search space sets that automatically perform sharing according to the search space set configuration may be defined. For example, the sharing may be performed in each search space set group in order from the smallest numbering for identifying the search space set. For example, when the search space set group #0 includes the search space set #0, the search space set #1, and the search space set #2 and the search space set group #1 includes the search space set #3, the search space set #4, the search space set #5, the sharing may be performed between the search space set #0 and the search space set #3, the sharing may be performed between the search space set #1 and the search space set #4, and the sharing may be performed between the search space set #2 and the search space set #5.

(32) FIG. 6 is a drawing illustrating an example of CDRX. DCI format 2_6 is defined as a WUS (Wake up signal) function for the terminal 20 in the CDRX (Connected DRX) mode. For example, the DCI format 2_6 is CRC (Cyclic redundancy check) scrambled by PS-RNTI (Power Saving RNTI) configured in the terminal 20, and may have a field indicating a wake up indication, a field indicating a secondary cell dormancy indication, and the like.

(33) As shown in FIG. 6, it is possible to indicate whether or not wake up is necessary for monitoring PDCCH before on-duration of CDRX. In a case where the necessity of wake up is not indicated by DCI format 2_6, the terminal 20 does not monitor the PDCCH during on-duration after an offset. On the other hand, in a case where the necessity of wake up is indicated by the DCI format 2_6, the terminal 20 monitors the PDCCH during on-duration after an offset.

(34) FIG. 7 is a drawing illustrating an example of CDRX in the embodiment of the invention. As shown in FIG. 7, the DCI format 2_6 may include search space set group switching indication in addition to the wake up indication. For example, a field in the DCI format 2_6 may explicitly indicate the switching of the search space set group. That is, for example, a "Search space set group switching flag" may be defined as a field of the DCI format 2_6. In the DCI format 2_6, the field indicating the switching of the search space set group may be a new field or may be an existing field.

(35) In addition, indication of the switching of the search space set group may be implicitly provided based on the indication contents of the DCI format 2_6. For example, the search space set group may be switched according to the indication contents indicating whether or not the wake up is to be performed by way of the DCI format 2_6.

(36) In addition, indication of the switching of the search space set group may be implicitly provided based on whether or not the DCI format 2_6 has been detected.

(37) FIG. 8 is a drawing illustrating an example (3) of the search space in the embodiment of the invention. The search space set group may be switched at the time of transition to the CDRX state or at the time of transition to the non-CDRX state. In a case where the search space set group is configured as shown in FIG. 8, the switching may be performed from the search space set group #0 to the search space set group #1 at the time of transition to the non-CDRX state, or the switching may be performed from the search space set group #1 to the search space set group #0 at the time

of transition to the CDRX state. The search space set group may be switched in response to both the transition to the CDRX state and the transition to the non-CDRX state, or the search space set group may be switched only in response to the transition to one of the states. That is, in the example of FIG. 8, the switching may be performed from the search space set group #0 to the search space set group #1 only at the time of transition to the non-CDRX state, or the switching may be performed from the search space set group #1 to the search space set group #0 only at the time of transition to the CDRX state.

(38) According to the embodiment described above, the terminal **20** can flexibly activate or deactivate the search space set according to the necessity. In addition, the terminal **20** can switch the search space set group, based on the wake up signal or the CDRX state transition.

(39) Therefore, the terminal **20** can precisely control the monitoring. As a result, it is possible to implement the power saving operation by suppressing unnecessary monitoring.

(40) That is, it is possible to reduce the power consumption when monitoring the search space in the radio communication system.

(41) (Device Configuration)

(42) Next, functional configuration examples of the base station **10** and the terminal **20** that execute the processes and the operations described so far will be described. The base station **10** and the terminal **20** have functions for implementing the embodiment described above. However, each of the base station **10** and the terminal **20** may have only some of the functions in the embodiment.

(43) <Base Station **10**>

(44) FIG. 9 is a drawing illustrating an example of the functional configuration of the base station **10** according to an embodiment of the invention. As shown in FIG. 9, 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 shown in FIG. 9 is merely an example. As long as the operation according to the embodiment of the invention can be performed, any functional division and any name of each functional unit may be applied.

(45) The transmitting unit **110** has a function of generating a signal to be transmitted to the terminal **20** and transmitting the signal wirelessly. In addition, the transmitting unit **110** transmits an inter-network-node message to another network node. The receiving unit **120** has a function of receiving various signals transmitted from the terminal **20** and acquiring, for example, information of higher layers 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, and the like to the terminal **20**. In addition, the receiving unit **120** receives a message between network nodes from another network node.

(46) The setting unit **130** stores pre-configured setup information and various kinds of setup information to be transmitted to the terminal **20**. The content of the setup information is, for example, a setting relevant to the search space of the terminal **20**.

(47) As described in the embodiment, the control unit **140** performs control relevant to the search space. A functional unit relevant to signal transmission in the control unit **140** may be included in the transmitting unit **110**, and a functional unit relevant to signal reception in the control unit **140** may be included in the receiving unit **120**.

(48) <Terminal **20**>

(49) FIG. 10 is a drawing illustrating an example of the functional configuration of the terminal **20** according to an embodiment of the invention. As shown in FIG. 10, the terminal **20** includes a transmitting unit **210**, a receiving unit **220**, a setting unit **230**, and a control unit **240**. The functional configuration shown in FIG. 10 is merely an example. As long as the operation according to the embodiment of the invention can be performed, any functional division and any name of each functional unit may be applied.

(50) The transmitting unit **210** generates a transmission signal from transmission data, and transmits the transmission signal wirelessly. The receiving unit **220** wirelessly receives various signals, and acquires a higher-layer signal from the received physical layer signal. In addition, the

receiving unit **220** has a function of receiving NR-PSS, NR-SSS, NR-PBCH, a DL/UL/SL control signal, and the like transmitted from the base station **10**. In addition, for example, the transmitting unit **210** transmits PSCCH (Physical Sidelink Control Channel), PSSCH (Physical Sidelink Shared Channel), PSDCH (Physical Sidelink Discovery Channel), PSBCH (Physical Sidelink Broadcast Channel), and the like to another terminal **20** as D2D communication, and the receiving unit **220** receives the PSCCH, the PSSCH, the PSDCH, the PSBCH, and the like from another terminal **20**.

(51) The setting unit **230** stores various kinds of setup information received from the base station **10** by the receiving unit **220**. In addition, the setting unit **230** stores the pre-configured setup information. The content of the setup information is, for example, a setting relevant to the search space of the terminal **20**.

(52) As described in the embodiment, the control unit **240** performs control relevant to the search space. A functional unit relevant to signal transmission in the control unit **240** may be included in the transmitting unit **210**, and a functional unit relevant to signal reception in the control unit **240** may be included in the receiving unit **220**.

(53) (Hardware Configuration)

(54) The block diagrams (FIGS. **9** and **10**) used in the description of the above embodiment show blocks in functional units. These functional blocks (configuration units) are realized by any combination of at least one of hardware and software. In addition, a method of realizing each functional block is not particularly limited. That is, each functional block may be realized using one physically or logically coupled device, or may be realized by connecting two or more physically or logically separated devices directly or indirectly (for example, using a wired or radio connection) and using the plurality of devices. Each functional block may be realized by combining the above-described one device or the above-described plurality of devices with software.

(55) Functions include determining, judging, calculating, computing, processing, deriving, investigating, searching, ascertaining, receiving, transmitting, outputting, accessing, resolving, selecting, choosing, establishing, comparing, assuming, expecting, presuming, broadcasting, notifying, communicating, forwarding, configuring, reconfiguring, allocating, mapping, assigning, and the like, but are not limited thereto. For example, a functional block (configuration unit) that makes the transmission work is called a transmitting unit or a transmitter. In any case, as described above, the implementation method is not particularly limited.

(56) For example, the base station **10**, the terminal **20**, and the like according to an embodiment of the present disclosure may function as a computer that performs processing of the radio communication method according to the present disclosure. FIG. **11** is a drawing illustrating an example of the hardware configuration of the base station **10** and the terminal **20** according to an embodiment of the present disclosure. Each of the base station **10** and the terminal **20** described above may be physically configured as a computer apparatus 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.

(57) In addition, in the following description, the term “device” can be read as a circuit, a unit, and the like. The hardware configuration of each of the base station **10** and the terminal **20** may be configured to include one or more devices for each of the devices shown in the diagram, or may be configured not to include some devices.

(58) Each function in the base station **10** and the terminal **20** is realized by reading predetermined software (program) onto hardware, such as the processor **1001** and the storage device **1002**, so that the processor **1001** performs an operation and controls communication by the communication device **1004** or controls at least one of reading and writing of data in the storage device **1002** and the auxiliary storage device **1003**.

(59) The processor **1001** controls the entire computer by operating an operating system, for example. The processor **1001** may be configured by a central processing unit (CPU) including an interface with peripheral equipment, 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 realized by the processor **1001**.

(60) In addition, the processor **1001** reads a program (program code), a software module, data, and the like into the storage device **1002** from at least one of the auxiliary storage device **1003** and the communication device **1004**, and executes various kinds of processing according to these. As the program, a program causing a computer to execute at least a part of the operation described in the above embodiment is used. For example, the control unit **140** of the base station **10** shown in FIG. **9** may be realized by a control program that is stored in the storage device **1002** and operated by the processor **1001**. In addition, for example, the control unit **240** of the terminal **20** shown in FIG. **10** may be realized by a control program that is stored in the storage device **1002** and operated by the processor **1001**. Although it has been described that the various kinds of processing described above are executed by one processor **1001**, the various kinds of processing described above may be executed simultaneously or sequentially by two or more processors **1001**. The processor **1001** may be implemented by one or more chips. In addition, the program may be transmitted from a network through a telecommunication line.

(61) The storage device **1002** is a computer-readable recording medium, and may be configured by at least one of, for example, a ROM (Read Only Memory), an EPROM (Erasable Programmable ROM), an EEPROM (Electrically Erasable Programmable ROM), and a RAM (Random Access Memory). The storage device **1002** may be called a register, a cache, a main memory, and the like. The storage device **1002** can store a program (program code), a software module, and the like that can be executed to execute the communication method according to an embodiment of the present disclosure.

(62) The auxiliary storage device **1003** is a computer-readable recording medium, and may be configured by at least one of, for example, an optical disc such as a CD-ROM (Compact Disc ROM), a hard disk drive, a flexible disk, and a magneto-optical disk (for example, a compact disk, a digital versatile disk, and a Blu-ray (Registered trademark) disk), a smart card, a flash memory (for example, a card, a stick, a key drive), a floppy (registered trademark) disk, and a magnetic strip. The storage medium described above may be, for example, a database including at least one of the storage device **1002** and the auxiliary storage device **1003**, a server, or other appropriate media.

(63) The communication device **1004** is hardware (transmitting and receiving device) for performing communication between computers through at least one of a wired network and a radio network, and is also referred to as, for example, a network device, a network controller, a network card, and a communication module. The communication device **1004** may be configured to include, for example, a high-frequency switch, a duplexer, a filter, a frequency synthesizer, and the like in order to realize at least one of frequency division duplex (FDD) and time division duplex (TDD), for example. For example, a transmitting and receiving antenna, an amplifier unit, a transmitting and receiving unit, a transmission line interface, and the like may be realized by the communication device **1004**. The transmitting and receiving unit may be implemented so as to be physically or logically separated from the transmitting unit and the receiving unit.

(64) The input device **1005** is an input device (for example, a keyboard, a mouse, a microphone, a switch, a button, and a sensor) for receiving an input from the outside. The output device **1006** is an output device (for example, a display, a speaker, and an LED lamp) that performs output to the outside. In addition, the input device **1005** and the output device **1006** may be integrated (for example, a touch panel).

(65) In addition, respective devices, such as the processor **1001** and the storage device **1002**, are connected to each other by the bus **1007** for communicating information. The bus **1007** may be configured using a single bus, or may be configured using a different bus for each device.

(66) In addition, each of the base station **10** and the terminal **20** may be configured to include hardware, such as a microprocessor, a digital signal processor (DSP), an ASIC (Application

Specific Integrated Circuit), a PLD (Programmable Logic Device), and an FPGA (Field Programmable Gate Array), and some or all of the functional blocks may be realized by the hardware. For example, the processor **1001** may be implemented using at least one of these hardware components.

Summary of Embodiment

(67) As described above, according to the embodiment of the present invention, there is provided a terminal including: a receiving unit configured to receive an indication indicating an active state or an inactive state from a base station for each of one or more search space sets included in a search space set group; and a control unit configured to monitor a search space set for which the indication is an active state, and not to monitor a search space set for which the indication is an inactive state, among the search space sets included in the search space set group.

(68) With the configuration described above, the terminal **20** can flexibly activate or deactivate the search space set according to the necessity. Therefore, the terminal **20** can precisely control the monitoring. As a result, it is possible to implement the power saving operation by suppressing unnecessary monitoring. That is, it is possible to reduce the power consumption when monitoring the search space in the radio communication system.

(69) When the search space set group is switched to another search space set group, the control unit may maintain a state indicating an active state or an inactive state according to the indication in each search space set included in the search space set group. With this configuration, the terminal **20** can maintain the state of the search space set when switching the search space set group.

(70) When the search space set group is switched to another search space set group, the control unit may reset a state indicating an active state or an inactive state according to the indication in each search space set included in the search space set group. With this configuration, the terminal **20** can reset the state of the search space set when switching the search space set group.

(71) The control unit may cause a state indicating an active state or an inactive state according to the indication in each search space set included in the search space set group to be shared by each corresponding search space set, included in another search space set group. With this configuration, the terminal **20** can reduce the size of the signaling indicating the state of the search space set.

(72) The receiving unit may receive, from the base station, information indicating which search space sets are to share the state. With this configuration, the terminal **20** can flexibly configure the search space sets according to the necessity.

(73) In addition, according to the embodiment of the invention, there is provided a communication method in which a terminal executes: receiving an indication indicating an active state or an inactive state from a base station for each of one or more search space sets included in a search space set group; and monitoring a search space set for which the indication is an active state, and not monitoring a search space set for which the indication is an inactive state, among the search space sets included in the search space set group.

(74) With the configuration described above, the terminal **20** can flexibly activate or deactivate the search space sets according to the necessity. Therefore, the terminal **20** can precisely control the monitoring. As a result, it is possible to implement the power saving operation by suppressing unnecessary monitoring. That is, it is possible to reduce the power consumption when monitoring the search space in the radio communication system.

Supplement to Embodiments

(75) While the embodiments of the invention have been described above, the disclosed invention is not limited to such embodiments, and those skilled in the art will understand various variations, modifications, alternatives, substitutions, and the like. Although the description has been made using specific numerical examples to facilitate the understanding of the invention, those numerical values are merely examples and any appropriate values may be used unless otherwise specified. The division of the items in the above description is not essential to the invention, and the matters described in two or more items may be used in combination as necessary, or the matter described in

a given item may be applied to the matter described in another item (unless there is a contradiction). The boundaries between functional units or processing units in the functional block diagrams do not always correspond to the boundaries between physical components. 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. Although the base station **10** and the terminal **20** have been described using functional block diagrams for convenience of description of the processing, such equipment may be realized by hardware, software, or a combination thereof. The software operated by the processor of the base station **10** according to the embodiment of the invention and the software operated by the processor of the terminal **20** according to the embodiment of the invention may be stored in 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, a server, or any other appropriate storage media.

(76) In addition, the indication of information is not limited to the aspect/embodiment described in the present disclosure, and may be performed using other methods. For example, the indication of information may be performed using physical layer signaling (for example, DCI (Downlink Control Information), UCI (Uplink Control Information)), higher layer signaling (for example, RRC (Radio Resource Control) signaling, MAC (Medium Access Control) signaling, broadcast information (MIB (Master Information Block), SIB (System Information Block)), other signals, or a combination thereof. In addition, the RRC signaling may be called an RRC message, and may be, for example, an RRC connection setup message or an RRC connection reconfiguration message.

(77) Each aspect/embodiment described in the present disclosure may be applied to at least one of systems, which use LTE (Long Term Evolution), LTE-A (LTE-Advanced), SUPER 3G, IMT-Advanced, 4G (4th generation mobile communication system), 5G (5th generation mobile communication system), FRA (Future Radio Access), NR (new Radio), W-CDMA (registered trademark), GSM (registered trademark), CDMA2000, UMB (Ultra Mobile Broadband), IEEE 802.11 (Wi-Fi (registered trademark)), IEEE 802.16 (WiMAX (registered trademark)), IEEE 802.20, UWB (Ultra-WideBand), Bluetooth (registered trademark), and other appropriate systems, and next-generation systems expanded based on these. In addition, a plurality of systems may be combined (for example, a combination of 5G and at least one of LTE and LTE-A) to be applied.

(78) In the processing procedure, sequence, flowchart, and the like in each aspect/embodiment described in this specification, the order 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 exemplary order, and the invention is not limited to the specific order presented.

(79) The specific operation described as being performed by the base station **10** in this specification may be performed by its upper node in some cases. In a network including one or more network nodes each having the base station **10**, it is obvious that various operations performed for communication with the terminal **20** can be performed by at least one of the base station **10** and other network nodes (for example, MME, S-GW, and the like can be considered, but the network node is not limited thereto) other than the base station **10**. Although the case where the number of other network nodes other than the base station **10** is one has been exemplified above, the other network nodes may be a combination (for example, MME and S-GW) of a plurality of other network nodes.

(80) Information or signals described in the present disclosure can be output from a higher layer (or a lower layer) to a lower layer (or a higher layer). Information or signals described in the present disclosure may be input and output through a plurality of network nodes.

(81) Information or the like that is input and output may be stored in a specific place (for example, a memory) or may be managed using a management table. The information or the like that is input and output can be overwritten, updated, or added. The information or the like that is output may be

deleted. The information or the like that is input may be transmitted to another device.

(82) The judging in the present disclosure may be performed based on a value expressed by 1 bit (0 or 1), may be performed based on Boolean (true or false), or may be performed by numerical value comparison (for example, comparison with a given value).

(83) Software, regardless of whether this is called software, firmware, middleware, microcode, a hardware description language, or any other name, should be interpreted broadly to mean instructions, instruction sets, codes, code segments, program codes, programs, subprograms, software modules, applications, software applications, software packages, routines, subroutines, objects, executable files, execution threads, procedures, functions, and the like.

(84) In addition, software, instructions, information, and the like may be transmitted and received through a transmission medium. For example, in a case where software is transmitted from a website, a server, or other remote sources using at least one of a wired technology (coaxial cable, optical fiber cable, twisted pair, digital subscriber line (DSL), and the like) and a wireless technology (infrared, microwave, and the like), at least one of the wired technology and the wireless technology is included within the definition of the transmission medium.

(85) The information, signals, and the like described in the present disclosure may be expressed using any of a variety of different technologies. For example, data, instructions, commands, information, signals, bits, symbols, and chips that can be referred to throughout the above description may be represented by voltage, current, electromagnetic waves, magnetic field or magnetic particles, light field or photon, or any combination thereof.

(86) In addition, 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 meaning. For example, at least one of the channel and the symbol may be a signal (signaling). In addition, the signal may be a message. In addition, a component carrier (CC) may be called a carrier frequency, a cell, a frequency carrier, or the like.

(87) The terms “system” and “network” used in the present disclosure are used interchangeably.

(88) In addition, the information, parameters, and the like described in the present disclosure may be expressed using an absolute value, may be expressed using a relative value from a predetermined value, or may be expressed using another corresponding information. For example, the radio resource may be indicated by an index.

(89) The names used for the parameters described above are not limiting names in any way. In addition, equations and the like using these parameters may be different from those explicitly disclosed in the present disclosure. Since various channels (for example, a PUCCH and a PDCCH) and information elements can be identified by any suitable names, various names allocated to these various channels and information elements are not limiting names in any way.

(90) In the present disclosure, terms such as “base station (BS)”, “radio base station”, “base station equipment”, “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. The base station may also be referred to as terms, such as a macro cell, a small cell, a femto cell, and a pico cell.

(91) The base station can include one or more (for example, three) cells. When the base station includes a plurality of cells, the entire coverage area of the base station can be divided into a plurality of smaller areas, and each of the smaller areas can also provide a communication service using a base station subsystem (for example, a remote radio head (RRH)). The term “cell” or “sector” refers to a part or the entirety of the coverage area of at least one of a base station and a base station subsystem that provides communication services in this coverage.

(92) In the present disclosure, the terms such as “mobile station (MS)”, “user terminal”, “user equipment (UE)”, and “terminal” can be used interchangeably.

(93) The mobile station may also be called a subscriber station, a mobile unit, a subscriber unit, a wireless unit, a remote unit, a mobile device, a wireless device, a radio 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 appropriate terms depending on those skilled in the art.

(94) At least one of the base station and the mobile station may be called a transmitting device, a receiving device, a communication device, and the like. In addition, at least one of the base station and the mobile station may be a device mounted on a moving body, the moving body itself, and the like. The moving body may be a vehicle (for example, a car or an airplane), an unmanned moving body (for example, a drone or a self-driving car), or a robot (manned or unmanned). In addition, at least one of the base station and the mobile station necessarily includes a device that does not move during a communication operation. For example, at least one of the base station and the mobile station may be an IoT (Internet of Things) device, such as a sensor.

(95) In addition, the 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** (which may be called, for example, D2D (Device-to-Device) or V2X (Vehicle-to-Everything)). In this case, the terminal **20** may have the above-described function of the base station **10**. In addition, terms such as “uplink” and “downlink” may be read as terms corresponding to terminal-to-terminal communication (for example, “side”). For example, an uplink channel, a downlink channel, and the like may be read as a side channel.

(96) Similarly, the user terminal in the present disclosure may be read as a base station. In this case, the base station may have the above-described function of the user terminal.

(97) The terms “determining” used in the present disclosure may involve a wide variety of operations. For example, “determining” can include considering judging, calculating, computing, processing, deriving, investigating, looking up (search, inquiry) (for example, looking up in a table, database, or another data structure), and ascertaining as “determining”. In addition, “determining” can include considering receiving (for example, receiving information), transmitting (for example, transmitting information), input, output, and accessing (for example, accessing data in a memory) as “determining”. In addition, “determining” can include considering resolving, selecting, choosing, establishing, comparing, and the like as “determining”. In other words, “determining” can include considering any operation as “determining”. In addition, “determining” may be read as “assuming”, “expecting”, “considering”, and the like.

(98) The terms “connected” and “coupled” or variations thereof mean any direct or indirect connection or coupling between two or more elements, and can include a case where one or more intermediate elements are present between two elements “connected” or “coupled” to each other. The coupling or connection between elements may be physical, logical, or a combination thereof. For example, “connection” may be read as “access”. When 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 using some non-limiting and non-inclusive examples, such as electromagnetic energy having wavelengths in a radio frequency domain, a microwave domain, and a light (both visible and invisible) domain.

(99) The reference signal may be abbreviated as RS (Reference Signal), and may be called Pilot according to the applied standard.

(100) The description “based on” used in the present disclosure does not mean “based only on” unless otherwise specified. In other words, the description “based on” means both “based only on” and “based at least on”.

(101) Any reference to elements using designations such as “first” and “second” used in the present disclosure does not generally limit the quantity or order of the elements. These designations can be used in the present disclosure as a convenient method for distinguishing between two or more elements. Therefore, references to first and second elements do not mean that only two elements can be adopted or that the first element should precede the second element in any way.

(102) “Means” in the configuration of each device described above may be replaced with “unit”, “circuit”, “device”, and the like.

(103) When “include”, “including”, and variations thereof are used in the present disclosure, these terms are intended to be inclusive similarly to the term “comprising”. In addition, the term “or” used in the present disclosure is intended not to be an exclusive-OR.

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

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

(106) A slot may be configured by one or more symbols (OFDM (Orthogonal Frequency Division Multiplexing) symbol, SC-FDMA (Single Carrier Frequency Division Multiple Access) symbol, and the like) in the time domain. A slot may be a time unit based on numerology.

(107) A slot may include multiple mini-slots. Each mini-slot may be configured by one or more symbols in the time domain. In addition, the mini-slot may be called a subslot. A mini-slot may be configured by a smaller number of symbols than that in a slot. A PDSCH (or a PUSCH) transmitted in time units larger than the mini-slot may be referred to as PDSCH (or PUSCH) mapping type A. A PDSCH (or a PUSCH) transmitted using a mini-slot may be referred to as PDSCH (or PUSCH) mapping type B.

(108) Each of the radio frame, the subframe, the slot, the mini-slot, and the symbol indicates a time unit when transmitting a signal. The radio frame, the subframe, the slot, the mini-slot, and the symbol may have different names corresponding thereto.

(109) For example, one subframe may be called a transmission time interval (TTI), a plurality of consecutive subframes may be called a TTI, and one slot or one mini-slot may be called a TTI. That is, at least one of the subframe and the TTI may be a subframe (1 ms) in the known LTE, a period (for example, 1 to 13 symbols) shorter than 1 ms, or a period longer than 1 ms. In addition, the unit indicating the TTI may be called a slot, a mini-slot, or the like, instead of a subframe.

(110) Here, the TTI refers to, for example, a minimum time unit of scheduling in radio communication. For example, in the LTE system, the base station performs scheduling for allocating radio resources (frequency bandwidth, transmission power, and the like that can be used in each terminal **20**) to each terminal **20** in TTI units. In addition, the definition of the TTI is not limited to this.

(111) The TTI may be a transmission time unit, such as a channel-encoded data packet (transport block), a code block, and a code word, or may be a processing unit, such as scheduling and link adaptation. In addition, when a TTI is given, a time section (for example, the number of symbols) in which a transport block, a code block, a code word, and the like are actually mapped may be shorter than the TTI.

(112) In addition, when one slot or one mini-slot is called a TTI, one or more TTIs (that is, one or more slots or one or more mini-slots) may be a minimum time unit for scheduling. In addition, the number of slots (the number of mini-slots) configuring the minimum time unit of the scheduling may be controlled.

(113) A TTI having a time length of 1 ms may be called a normal TTI (TTI in LTE Rel. 8-12), a long TTI, a normal subframe, a long subframe, a slot, and the like. A TTI shorter than the normal TTI may be called a short TTI, a partial or fractional TTI, a short subframe, a mini-slot, a subslot, a slot, and the like.

(114) In addition, a long TTI (for example, a normal TTI or a subframe) may be read as a TTI having a time length exceeding 1 ms, and a short TTI may be read as a TTI shorter than the TTI length of the long TTI and equal to or longer than 1 ms.

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

(116) In addition, the time domain of the RB may include one or more symbols, and may be the length of one slot, one mini-slot, one subframe, or one TTI. One TTI, one subframe, and the like may each be configured by one or more resource blocks.

(117) In addition, one or more RBs may be called a physical resource block (PRB: Physical RB), a sub-carrier group (SCG), a resource element group (REG), a PRB pair, an RB pair, and the like.

(118) In addition, the resource block may be configured by one or more resource elements (REs). For example, one RE may be a radio resource area of one subcarrier and one symbol.

(119) A bandwidth part (BWP) (which may be called a partial bandwidth or the like) may indicate a subset of consecutive common resource blocks (RBs) for given numerology in a given carrier. Here, the common RB may be specified by an index of the RB with the common reference point of the carrier as a reference. The PRB may be defined by a given BWP and numbered within the BWP.

(120) The BWP may include a BWP for UL (UL BWP) and a BWP for DL (DL BWP). For the UE, one or more BWPs may be set in one carrier.

(121) At least one of the set BWPs may be active, and it may not be assumed that the UE transmits and receives a predetermined signal/channel outside the active BWP. In addition, “cell”, “carrier”, and the like in the present disclosure may be read as “BWP”.

(122) The structures of the radio frame, the subframe, the slot, the mini-slot, and the symbol described above are merely examples. For example, 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 the TTI, the symbol length, the cyclic prefix (CP) length, and the like can be changed in various ways.

(123) In the present disclosure, in a case where articles, for example, a, an, and the in English, are added by translation, the present disclosure may include that nouns subsequent to these articles are plural.

(124) In the present disclosure, the expression “A and B are different” may mean “A and B are different from each other”. In addition, the expression may mean that “A and B each are different from C”. Terms such as “separate” and “coupled” may be interpreted similarly to “different”.

(125) Each aspect/embodiment described in the present disclosure may be used alone, may be used in combination, or may be switched and used according to execution. In addition, the notification of predetermined information (for example, notification of “X”) is not limited to being explicitly performed, and may be performed implicitly (for example, without the notification of the predetermined information).

(126) While the present disclosure has been described in detail, 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 modified and changed aspects without departing from the spirit and scope of the present disclosure defined by the description of the claims. Therefore, the description of the present disclosure is intended for illustrative purposes, and has no restrictive meaning to the present disclosure.

EXPLANATIONS OF LETTERS OR NUMERALS

(127) **10** BASE STATION **110** TRANSMITTING UNIT **120** RECEIVING UNIT **130** SETTING

UNIT **140** CONTROL UNIT **20** TERMINAL **210** TRANSMITTING UNIT **220** RECEIVING
UNIT **230** SETTING UNIT **240** CONTROL UNIT **1001** PROCESSOR **1002** STORAGE DEVICE
1003 AUXILIARY STORAGE DEVICE **1004** COMMUNICATION DEVICE **1005** INPUT
DEVICE **1006** OUTPUT DEVICE

Claims

1. A terminal, comprising: a receiving unit configured to receive an indication indicating an active state or an inactive state from a base station for each of one or more search space sets included in a search space set group; and a control unit configured to monitor a search space set for which the indication is an active state, and not to monitor a search space set for which the indication is an inactive state, among the search space sets included in the search space set group.
 2. The terminal according to claim 1, wherein, when the search space set group is switched to another search space set group, the control unit maintains a state indicating an active state or an inactive state according to the indication in each search space set included in the search space set group.
 3. The terminal according to claim 1, wherein, when the search space set group is switched to another search space set group, the control unit resets a state indicating an active state or an inactive state according to the indication in each search space set included in the search space set group.
 4. The terminal according to claim 1, wherein the control unit causes a state indicating an active state or an inactive state according to the indication in each search space set included in the search space set group to be shared by each corresponding search space set, included in another search space set group.
 5. The terminal according to claim 4, wherein the receiving unit receives, from the base station, information indicating which search space set is to share the state.
 6. A communication method in which a terminal executes: receiving an indication indicating an active state or an inactive state from a base station for each of one or more search space sets included in a search space set group; and monitoring a search space set for which the indication is an active state, and not monitoring a search space set for which the indication is an inactive state, among the search space sets included in the search space set group.
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