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Inventor(s)	Yoshioka; Shohei et al.

TERMINAL AND POSITIONING METHOD

Abstract

A terminal includes a reception unit configured to receive a signal related to positioning in device-to-device direct communication from another terminal; a transmitter configured to transmit a signal based on the signal related to positioning in the device-to-device direct communication to the other terminal; and a control unit configured to perform control to transmit the signal based on the signal related to positioning in the device-to-device direct communication to the other terminal by a certain time point.

Inventors:	**Yoshioka; Shohei (Chiyoda-ku, Tokyo, JP), Shibaike; Naoya (Chiyoda-ku, Tokyo, JP), Nagata; Satoshi (Chiyoda-ku, Tokyo, JP)**
Applicant:	**NTT DOCOMO, INC.** (Tokyo, JP)

Family ID:	**1000008615407**
Assignee:	**NTT DOCOMO, INC. (Tokyo, JP)**
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Background/Summary

TECHNICAL FIELD

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

BACKGROUND ART

[0002] In long term evolution (LTE) and a succeeding system of LTE (for example, LTE Advanced (LTE-A) and new radio (NR) (also referred to as 5G)), a device to device (D2D) technology in which terminals perform direct communication without passing through a base station is being discussed (for example, Non Patent Literature 1).

[0003] D2D reduces traffic between the terminal and the base station, and enables communication between the terminals even when the base station becomes incommunicable at the time of disaster or the like. Note that, in the 3rd generation partnership project (3GPP), D2D is referred to as “sidelink”, but in the present specification, D2D, which is a more general term, is used. However, the term sidelink is also used as necessary in the description of the embodiment to be described later.

[0004] D2D communication is roughly divided into D2D discovery (also referred to as D2D discovery, D2D discovery) for discovering other communicable terminals and D2D communication (also referred to as D2D direct communication, D2D communication, device-to-device direct communication, and the like) for performing direct communication between the terminals. Hereinafter, the D2D communication, the D2D discovery, and the like are simply referred to as D2D when not particularly distinguished from each other. Further, a signal transmitted and received in D2D is referred to as a D2D signal. Various use cases of services related to vehicle to everything (V2X) in NR are being discussed (for example, Non-Patent Literature 2).

CITATION LIST

Non-Patent Literature

[0005] Non-Patent Literature 1: 3GPP TS 38.211 V16.8.0 (2021-12) [0006] Non-Patent Literature 2: 3GPP TR 22.886 V15.1.0 (2017-03) [0007] Non-Patent Literature 3: 3GPP TS 38.305 V16.7.0 (2021-12) [0008] Non-Patent Literature 4: 3GPP TS 38.455 V16.6.0 (2021-12) [0009] Non-Patent Literature 5: 3GPP TS 37.355 V16.7.0 (2021-12) [0010] Non-Patent Literature 6: 3GPP TS 23.032 V16.1.0 (2021-12) [0011] Non-Patent Literature 7: 3GPP TS 38.215 V16.4.0 (2020-12)

SUMMARY OF INVENTION

Technical Problem

[0012] Positioning is being discussed in scenarios of device-to-device direct communication, for example, within coverage, partial coverage, and outside coverage, or in vehicle to everything (V2X), public safety, commercial, industrial Internet of Things (IIOT), and the like. However, a measurement method and a position estimation method for acquiring position information of a device itself is not clear.

[0013] The present invention has been made in view of the above, and an object of the present invention is to acquire position information of a device itself by device-to-device direct communication.

Solution to Problem

[0014] According to the disclosed technology, a terminal is provided. The terminal includes: [0015] a reception unit configured to receive a signal related to positioning in device-to-device direct communication from another terminal; [0016] a transmitter configured to transmit a signal based on the signal related to positioning in the device-to-device direct communication to the other terminal; and [0017] a control unit configured to perform control to transmit the signal based on the signal related to positioning in the device-to-device direct communication to the other terminal by a

certain time point.
Advantageous Effects of Invention
[0018] According to the disclosed technology, position information of a device itself can be acquired by device-to-device direct communication.

Description

BRIEF DESCRIPTION OF DRAWINGS
[0019] FIG. **1** is a diagram illustrating a wireless communication system.
[0020] FIG. **2** is a diagram illustrating V2X.
[0021] FIG. **3** is a diagram illustrating an example of communication in D2D.
[0022] FIG. **4** is a diagram illustrating an example (1) of positioning.
[0023] FIG. **5** is a diagram illustrating an example of measuring DL-RSTD.
[0024] FIG. **6** is a diagram illustrating an example of measuring UL-RTOA.
[0025] FIG. **7** is a diagram illustrating an example (2) of positioning.
[0026] FIG. **8** is a diagram illustrating an example of measuring RTT.
[0027] FIG. **9** is a flowchart illustrating an example (1) of position estimation according to an embodiment of the present invention.
[0028] FIG. **10** is a diagram illustrating the example (1) of position estimation according to the embodiment of the present invention.
[0029] FIG. **11** is a diagram illustrating an arrangement example of a reference signal according to the embodiment of the present invention.
[0030] FIG. **12** is a flowchart illustrating an example (2) of position estimation according to the embodiment of the present invention.
[0031] FIG. **13** is a diagram illustrating the example (2) of position estimation according to the embodiment of the present invention.
[0032] FIG. **14** is a flowchart illustrating an example (3) of position estimation according to the embodiment of the present invention.
[0033] FIG. **15** is a diagram illustrating the example (3) of position estimation according to the embodiment of the present invention.
[0034] FIG. **16** is a flowchart illustrating an example (4) of position estimation according to the embodiment of the present invention.
[0035] FIG. **17** is a diagram illustrating the example (4) of position estimation according to the embodiment of the present invention.
[0036] FIG. **18** is a flowchart illustrating an example (5) of position estimation according to the embodiment of the present invention.
[0037] FIG. **19** is a diagram illustrating the example (5) of position estimation according to the embodiment of the present invention.
[0038] FIG. **20** is a diagram illustrating an example (1) of transmission/reception timing according to the embodiment of the present invention.
[0039] FIG. **21** is a diagram illustrating an example (2) of transmission/reception timing according to the embodiment of the present invention.
[0040] FIG. **22** is a diagram illustrating an example of a functional configuration of a base station **10** according to the embodiment of the present invention.
[0041] FIG. **23** is a diagram illustrating an example of a functional configuration of a terminal **20** according to the embodiment of the present invention.
[0042] FIG. **24** is a diagram illustrating an example of a hardware configuration of the base station **10** or the terminal **20** according to the embodiment of the present invention.
[0043] FIG. **25** is a diagram illustrating an example of a configuration of a vehicle **2001** according

to the embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0044] Hereinafter, an embodiment 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.

[0045] In the operation of a wireless communication system of the embodiment of the present invention, an existing technology is appropriately used. The existing technology is, for example, existing LTE, but the present invention is not limited to the existing LTE. In addition, the term “LTE” used in the present specification has a broad meaning including LTE-Advanced, systems subsequent to LTE-Advanced (for example, NR), and a wireless local area network (LAN), unless otherwise specified.

[0046] In the embodiment of the present invention, a duplex system may be a time division duplex (TDD) system, a frequency division duplex (FDD) system, or other systems (for example, flexible duplex and the like).

[0047] In addition, in the embodiment of the present invention, meaning of a radio parameter or the like being “set (configured)” may indicate that a predetermined value is set in advance (pre-configured), or that a radio parameter indicated by a base station **10** or a terminal **20** is set.

[0048] FIG. **1** is a diagram illustrating a wireless communication system according to the embodiment of the present invention. As illustrated in FIG. **1**, the wireless communication system according to the embodiment of the present invention includes a base station **10** and a terminal **20**. Although one base station and one terminal are illustrated in FIG. **1**, the drawing is an example, and a plurality of base stations **10** and a plurality of terminals **20** may be provided.

[0049] The base station **10** is a communication device that provides one or more cells and performs wireless communication with the terminal **20**. Physical resources of a 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 sub-carriers or the number of resource blocks. In addition, a transmission time interval (TTI) in the time domain may be a slot, or the TTI may be a sub-frame.

[0050] The base station **10** transmits a synchronization signal and system information to the terminal **20**. The synchronization signal is, for example, an NR-PSS and an NR-SSS. The system information is transmitted through, for example, NR-PBCH and is also referred to as indication information. The synchronization signal and the system information may be referred to as an SS/PBCH block (SSB). As illustrated in FIG. **1**, the base station **10** transmits a control signal or data to the terminal **20** through a downlink (DL) and receives a control signal or data from the terminal **20** through an uplink (UL). Both the base station **10** and the terminal **20** can transmit and receive a signal by performing beamforming. In addition, both the base station **10** and the terminal **20** can apply communication based on multiple input multiple output (MIMO) to the DL or the UL. In addition, both the base station **10** and the terminal **20** may perform communication via a secondary cell (SCell) and a primary cell (PCell) by carrier aggregation (CA). Furthermore, the terminal **20** may perform communication via a primary cell of the base station **10** and a primary secondary cell group cell (primary SCG cell, PSCell) of another base station **10** by dual connectivity (DC).

[0051] 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 a wireless communication system by receiving a control signal or data from the base station **10** through the DL and transmitting a control signal or data to the base station **10** through the UL. In addition, the terminal **20** receives various reference signals transmitted from the base station **10** and measures a propagation path quality based on a reception result of the reference signals. Note that the terminal **20** may be referred to as UE, and the base station **10** may be referred

to as gNB.
[0052] In addition, in LTE or NR, a carrier aggregation function using a broadband to secure data resources is supported. In the carrier aggregation function, a plurality of component carriers is bundled, thereby making it possible to secure broadband data resources. For example, a 100 MHz width may be used by bundling a plurality of 20 MHz bandwidths.
[0053] FIG. **2** is a diagram illustrating V2X. In 3GPP, realization of vehicle to everything (V2X) or enhanced V2X (eV2X) by extending a D2D function is being discussed, and technical specifications are being developed. As illustrated in FIG. **1**, V2X is a part of intelligent transport systems (ITS), and is a generic name of vehicle to vehicle (V2V) meaning a communication form performed between vehicles, vehicle to infrastructure (V21) meaning a communication form performed between a vehicle and a road-side unit (RSU) installed beside a road, vehicle to network (V2N) meaning a communication form performed between a vehicle and an ITS server, and vehicle to pedestrian (V2P) meaning a communication form performed between a vehicle and a mobile terminal possessed by a pedestrian.
[0054] In addition, in 3GPP, V2X using LTE or NR cellular communication and device-to-device communication is being discussed. V2X using cellular communication is also referred to as cellular V2X. In V2X of NR, studies to realize a large capacity, a low delay, high reliability, and quality of service (QOS) control are in progress.
[0055] Regarding V2X of LTE or NR, it is assumed that studies not limited to the 3GPP specification will be conducted in the future. For example, it is assumed that consideration will be given as to securing interoperability, reducing costs by implementation of an upper layer, a method of using a plurality of radio access technologies (RATs) in parallel or switching between the plurality of RATs, regulatory compliance in each country, and a method of acquiring, distributing, managing a database of, and using data of an LTE or NR V2X platform.
[0056] In the embodiment of the present invention, a mode in which a communication device is mounted on a vehicle is mainly assumed, but the embodiment of the present invention is not limited to such mode. For example, the communication device may be a terminal held by a person, the communication device may be a device mounted on a drone or an aircraft, or the communication device may be a base station, an RSU, a relay station (a relay node), a terminal having a scheduling capability, or the like.
[0057] Note that sidelink (SL) may be distinguished based on either or a combination of uplink (UL) or downlink (DL) and the following 1) to 4). Further, SL may have another name. [0058] 1) Resource allocation in time domain [0059] 2) Resource allocation in frequency domain [0060] 3) Synchronization signal to be referred to (including sidelink synchronization signal (SLSS)) [0061] 4) Reference signal used for path loss measurement for transmission power control
[0062] In addition, regarding orthogonal frequency division multiplexing (OFDM) of SL or UL, any one of cyclic-prefix OFDM (CP-OFDM), discrete Fourier transform-spread-OFDM (DFT-S-OFDM), OFDM not subjected to transform precoding, and OFDM subjected to transform precoding may be applied.
[0063] In the SL of LTE, Mode **3** and Mode **4** are stipulated regarding resource allocation of the SL to the terminal **20**. In Mode **3**, transmission resources are dynamically allocated by downlink control information (DCI) transmitted from the base station **10** to the terminal **20**. In Mode **3**, semi persistent scheduling (SPS) is also possible. In Mode **4**, the terminal **20** autonomously selects a transmission resource from a resource pool.
[0064] A slot in the embodiment of the present invention may be replaced with a symbol, a mini-slot, a sub-frame, a radio frame, a transmission time interval (TTI), or a time resource having a predetermined width. In addition, a cell in the embodiment of the present invention may be replaced with a cell group, a carrier component, a BWP, a resource pool, a resource, a radio access technology (RAT), a system (including a wireless LAN), or the like.
[0065] Note that, in the embodiment of the present invention, the terminal **20** is not limited to the

V2X terminal, and may be any type of terminal that performs D2D communication. For example, the terminal **20** may be a terminal such as a smartphone possessed by a user, or may be an Internet of Things (IoT) device such as a smart meter.

[0066] FIG. **3** is a diagram illustrating an example of communication in D2D. As illustrated in FIG. **3**, an environment is assumed in which a plurality of UEs communicate with each other, such as a UE #A, a UE #B, a UE #C, and a UE #D. A resource pool used for transmission and reception by each of the UEs is a set of resources in the time domain and the frequency domain. The resource pool may be set or pre-set by a system or a service provider. For example, in the resource pool, several time resources based on a cycle may be available for cyclical traffic. Furthermore, for example, in the resource pool, some frequency resources may be unavailable to reduce interference to a Uu interface (a radio interface between a universal terrestrial radio access network (UTRAN) and a user equipment (UE)).

[0067] A sub-channel in the resource pool illustrated in FIG. **3** is a unit of scheduling in the frequency domain. For example, {10, 12, 15, 20, 25, 50, 75, 100} PRB may be set as one sub-channel or may be pre-set.

[0068] A slot in the resource pool illustrated in FIG. **3** is a unit of scheduling in the time domain. The scheduling in units of symbols may be too complex if the UE autonomously selects resources. However, the scheduling may not be performed in units of slots.

[0069] As illustrated in FIG. **3**, the head of the slot to be transmitted from the UE #A to the UE #B is a transient period from the viewpoint of transmitting UE. The transient period is a period necessary for adjustment of transmission power. On the other hand, the head of the slot to be transmitted from the UE #A to the UE #B is used for auto gain control (AGC) from the viewpoint of receiving UE. The reception power significantly varies between links, and a predetermined period is required to adjust a power range. By performing scheduling in units of slots, an increase in AGC opportunities can be prevented.

[0070] As illustrated in FIG. **3**, the end of the slot to be transmitted from the UE #A to the UE #B is used for a transmission/reception switching period. A certain UE may perform transmission in a slot n and then may perform reception in a slot n+1. The transmission/reception switching period is defined for each slot.

[0071] As illustrated in FIG. **3**, when the transmission from the UE #C to the UE #A and the transmission from the UE #D to the UE #C overlap each other in the same slot, the UE #C cannot simultaneously execute the transmission and the reception, and thus, it is necessary to drop one of the transmission and the reception. That is, communication in D2D is half-duplex communication.

[0072] Note that default setting when coverage is out of the coverage of the base station may be pre-set (pre-configuration). Note that RRC connection/setting between UEs that perform unicast is referred to as PC5-RRC connection/setting.

[0073] Here, positioning is being discussed in scenarios of device-to-device direct communication, for example, within coverage, partial coverage, and outside coverage, or in vehicle to everything (V2X), public safety, commercial, industrial Internet of Things (IIOT), and the like. Within coverage may mean that a plurality of UEs related to positioning are within coverage of the BS, partial coverage may mean that a part of the plurality of UEs related to positioning is within coverage of the BS, and outside coverage may mean that the plurality of UEs related to positioning are not within coverage of the BS.

[0074] Positioning of the terminal **20** by location management function (LMF) in the Uu interface of 3GPP Release 16 or 17 is executed by methods of the following 1) to 3) (refer to Non Patent Literature 3, Non Patent Literature 4, and Non patent Literature 5). [0075] 1) Method based on time DL-time difference of arrival (TDOA) [0076] 2) Method based on UL-TDOA [0077] 3) Method based on multiple round trip time (RTT)

[0078] FIG. **4** is a diagram illustrating an example (1) of positioning. As illustrated in FIG. **4**, position information of the UE may be calculated based on the DL-TDOA. The position of the UE may be estimated based on a DL-received signal time difference (RSTD) in which the UE measures DL radio signals transmitted from a plurality of NR TRPs. For the estimation, the geographical position of the TRP and the DL transmission timing at the TRP may be used. Furthermore, the position of the UE may be estimated based on reference signal received power (RSRP) of DL-positioning reference signal (PRS) in addition to DL-RSTD.

[0079] In the method based on DL-TDOA, the position of the UE may be calculated in the following procedure.

[0080] 1) The gNB transmits DL-PRS from each TRP to the UE [0081] 2) The UE reports the DL-RSTD which is the measurement result to GW and/or gNB and/or LMF via LTE positioning protocol (LPP) [0082] 3) The gNB reports timing information related to the TRP to the LMF via NR Positioning Protocol A (NRPPa) [0083] 4) Based on the above-described information reported from the UE and the gNB, the LMF calculates the UE position

[0084] For example, as illustrated in FIG. **4**, a delay between the UE and a TRP0, a delay between the UE and a TRP1, and a delay between the UE and a TRP2 may be measured, and the position of the UE may be calculated based on a geographical position and a DL transmission timing of each TRP.

[0085] FIG. **5** is a diagram illustrating an example of measuring DL-RSTD. Hereinafter, "and/or" is also referred to as "/". As illustrated in FIG. **5**, DL-RSTD may refer to a time difference measured by the UE between a reception start time point of a DL sub-frame of a reference TRP (TRP0 in FIG. **5**) and a reception start time point of a DL sub-frame of another TRP. By detecting the DL-PRS, the start of the sub-frame may be determined.

[0086] A transmission timing of each TRP may not be uniform.

[0087] Regarding the calculation of the UE position by DL-TDOA, information indicated in the following 1) to 5) may be reported from the UE to GW/gNB/LMF. [0088] 1) Physical cell ID (PCI), global cell ID (GCI), and TRP-ID in each measurement [0089] 2) DL-RSTD measurement result [0090] 3) DL-PRS-RSRP measurement result [0091] 4) Time of measurement (time stamp) [0092] 5) Quality of each measurement

[0093] Regarding the calculation of the UE position by DL-TDOA, the information indicated in the following 1) to 6) may be reported from the gNB to the LMF. [0094] 1) PCI, GCI, and TRP-ID of the TRP controlled by the gNB [0095] 2) Timing information of the TRP controlled by the gNB [0096] 3) DL-PRS setting of the TRP controlled by the gNB [0097] 4) Information related to SSB of the TRP controlled by the gNB, for example, the time and frequency resources of the SSB [0098] 5) Information related to spatial direction of DL-PRS of the TRP controlled by the gNB [0099] 6) Information related to geographic coordinates of the TRP controlled by the gNB

[0100] The DL-RSTD may be defined as a time difference measured by the UE between a reception start time point of the DL sub-frame of the reference TRP and a reception start time point of the DL sub-frame of another TRP. A plurality of DL-PRS resources may be used to determine a reception start time point of a sub-frame.

[0101] As the report of timing information related to the TRP controlled by the gNB, SFN initialization time of the TRP may be reported. The SFN initialization time is a time at which SFNO is started.

[0102] As the report of information related to the geographical coordinates of the TRP controlled by the gNB, a point on an ellipsoid having altitude and an ellipse indicating a range of error may be reported (refer to Non Patent Literature 6). For example, latitude, longitude, altitude, altitude direction, altitude error range, and the like may be reported.

[0103] As illustrated in FIG. **4**, position information of the UE may be calculated based on the UL-TDOA. The position of the UE may be estimated based on UL-relative time of arrival (RTOA) in which a plurality of NR TRPs measure UL radio signals transmitted from the UE. For the estimation, other pieces of setting information may be used. Further, the position of the UE may be estimated based on RSRP of a UL-sounding reference signal (SRS) in addition to the UL-RTOA.

[0104] In the method based on UL-TDOA, the position of the UE may be calculated in the following procedure. [0105] 1) The UE transmits SRS to a plurality of TRPs [0106] 2) The gNB reports measurement results including UL-RTOA and geographic coordinates of the TRP to the LMF via the NRPPa [0107] 3) Based on the information reported by the gNB, the LMF calculates the position of the UE

[0108] For example, as illustrated in FIG. **4**, an RTOA from the UE to the TRP0, an RTOA from the UE to the TRP1, and an RTOA from the UE to the TRP2 may be measured, and the position of the UE may be calculated based on the geographical position and a UL transmission timing of each TRP.

[0109] FIG. **6** is a diagram illustrating an example of measuring UL-RTOA. As illustrated in FIG. **6**, the UL-RTOA may refer to a time difference between a reception start time point of a UL sub-frame including the SRS of the TRP and an RTOA reference time at which the UL is transmitted.

[0110] Regarding the calculation of the UE position by the UL-TDOA, information indicated in the following 1) to 9) may be reported from the gNB to the LMF. [0111] 1) PCI, GCI, and TRP-ID of the TRP controlled by the gNB [0112] 2) Information related to the SSB of the TRP controlled by the gNB, for example, the time and frequency resources of the SSB [0113] 3) Information related to geographic coordinates of the TRP controlled by the gNB [0114] 4) NR cell global identifier (NCGI) and TRP-ID of measurement [0115] 5) UL-RTOA [0116] 6) RSRP of UL-SRS [0117] 7) Time of measurement [0118] 8) Quality of each measurement [0119] 9) Information related to beam of each measurement

[0120] The UL-RTOA may be defined as a time difference between a reception start time point of the UL sub-frame including the SRS at the TRP and an RTOA reference time at which the UL is transmitted. The gNB may report the geographical coordinates of the TRP to the LMF via the NRPPa.

[0121] FIG. **7** is a diagram illustrating an example (2) of positioning. As illustrated in FIG. **7**, the position information of the UE may be calculated based on a plurality of RTTs. The position of the UE may be estimated based on UE/gNB reception-transmission time difference measurement using DL-PRS and UL-SRS. For the estimation, DL-PRS-RSRP and UL-SRS-RSRP may be used. The LMF may determine the RTT using the UE/gNB reception-transmission time difference measurement.

[0122] In the method based on the multi-RIT, the position of the UE may be calculated in the following procedure. [0123] 1) The gNB transmits DL-PRS from each TRP to the UE [0124] 2) The UE transmits SRS to a plurality of TRPs [0125] 3) The UE reports a UE reception-transmission time difference to the GW and/or the gNB and/or the LMF via the LPP [0126] 4) The gNB reports a gNB reception-transmission time difference to the LMF via the NRPPa [0127] 5) Based on the information reported from the UE and the gNB, the LMF calculates the position of the UE

[0128] For example, as illustrated in FIG. **7**, an RTT between the UE and the TRP0, an RTT between the UE and the TRP1, and an RTT between the UE and the TRP2 may be measured, and the position of the UE may be calculated based on the geographical position of each TRP.

[0129] FIG. **8** is a diagram illustrating an example of measuring the RTT. As illustrated in FIG. **8**, the UE reception-transmission time difference may refer to a time difference between a timing of receiving the DL sub-frame from the TRP and a timing of transmitting the UL sub-frame. In addition, as illustrated in FIG. **8**, the gNB reception-transmission time difference may refer to a time difference between a timing at which the TRP receives the UL sub-frame and a timing at which the TRP transmits the DL sub-frame.

[0130] Regarding the calculation of the UE position by the plurality of RITs, information indicated in the following 1) to 5) may be reported from the UE to the GW/gNB/LMF. [0131] 1) PCI, GCI and TRP-ID in each measurement [0132] 2) DL-PRS-RSRP measurement result [0133] 3) UE reception-transmission time difference measurement result [0134] 4) Time of measurement [0135]

5) Quality of each measurement
[0136] Regarding the calculation of the UE position by the RTT, the information indicated in the following 1) to 9) may be reported from the gNB to the LMF. [0137] 1) PCI, GCI, and TRP-ID of the TRP controlled by the gNB [0138] 2) Timing information of the TRP controlled by the gNB [0139] 3) DL-PRS setting of the TRP controlled by the gNB [0140] 4) Information related to SSB of the TRP controlled by the gNB, for example, the time and frequency resources of the SSB [0141] 5) Information related to spatial direction of DL-PRS of the TRP controlled by the gNB [0142] 6) Information related to geographic coordinates of the TRP controlled by the gNB [0143] 7) NCGI and TRP-ID of measurement [0144] 8) gNB reception-transmission time difference [0145] 9) RSRP of UL-SRS [0146] 10) UL-angle of arrival (AoA), for example, azimuth and elevation [0147] 11) Time of measurement [0148] 12) Quality of measurement [0149] 13) Information related to beam of measurement
[0150] Note that definitions of the UE reception-transmission time difference and the gNB reception-transmission time difference may be referred from Non Patent Literature 7. Similar to DL-RSTD, the geographical coordinates of the TRP may be reported.
[0151] As described above, in the positioning by the Uu interface, the positioning method by DL-TDOA, UL-TDOA, and multi-RTT using RSTD, RTOA, and reception-transmission time difference indicating a propagation delay between the UE and the TRP, respectively, has been applied.
[0152] Here, to perform position estimation using a sidelink signal, it is necessary to consider a position estimation algorithm for absolute position estimation or relative position estimation, a definition and a transmission/reception procedure of a measurement sidelink signal used for position estimation, a reporting procedure of a measurement result, and the like. However, a position estimation algorithm for absolute position estimation or relative position estimation using a signal of device-to-device direct communication is not clear.
[0153] Therefore, Option 1) to Option 7) described below may be executed.
[0154] Option 1) With respect to the position estimation using the sidelink, the terminal **20** which desires to acquire the position information of the terminal **20** itself (hereinafter, referred to as a "UE-X") may transmit a predetermined signal to another terminal **20** (hereinafter, referred to as a "UE-Y") and may receive a signal based on the predetermined signal (for example, a measurement result) from the UE-Y.
[0155] FIG. **9** is a flowchart illustrating an example (1) of position estimation according to the embodiment of the present invention. FIG. **10** is a diagram illustrating the example (1) of position estimation according to the embodiment of the present invention.
[0156] As illustrated in FIGS. **9** and **10**, in step S**11**, the UE-X transmits a predetermined signal to the UE-Y. In subsequent step S**12**, the UE-Y measures a predetermined value based on the predetermined signal. Note that step S**12** may not be applied. In subsequent step S**13**, the UE-Y transmits a signal based on the predetermined signal (for example, information including a measured value and/or information based on the measured value may be included) to the UE-X. In subsequent step S**14**, the UE-X calculates the position of the UE-X itself based on the information received from the UE-Y.
[0157] For example, the UE-Y may be one or a plurality of UEs such as a UE-Y1, a UE-Y2, and a UE-Y3 illustrated in FIG. **10**. That is, the UE-X may execute step S**11** to step S**14** for one or a plurality of UEs.
[0158] For example, the predetermined signal may be an SL positioning RS (SL-PRS) or any other SL signal. Further, the signal transmitted by the UE-Y may be the SL-PRS or any other SL signal.
[0159] Hereinafter, the signal used for the position estimation will be referred to as the SL-PRS, but is not limited thereto, and may be another name. Note that the position estimation and the positioning may be replaceable with each other.
[0160] For example, the SL-PRS may be multiplexed in PSCCH and/or PSSCH transmission and

may be transmitted. Alternatively, the SL-PRS may be transmitted with a resource dedicated to the SL-PRS. Hereinafter, “PSCCH and/or PSSCH” is also referred to as “PSCCH/PSSCH”.

[0161] FIG. **11** is a diagram illustrating an arrangement example of a reference signal according to the embodiment of the present invention. The SL-PRS may be arranged as illustrated in the following 1) to 3).

[0162] 1) The SL-PRS may not be multiplexed in an RE in which a second stage SCI and/or DM-RS and/or PT-RS and/or CSI-RS are arranged. For example, an overlap between the SL-PRS and the second stage SCI, the DM-RS, the PT-RS, and the CSI-RS may not be assumed. For example, when a mapping destination of the SL-PRS is the RE in which the second stage SCI, the DM-RS, the PT-RS, or the CSI-RS are arranged, mapping of the SL-PRS to the RE may not be executed.

[0163] 2) The SL-PRS may not be multiplexed in the RE of the PSCCH. For example, an overlap between the PSCCH and the SL-PRS may not be assumed. For example, when the mapping destination of the SL-PRS is the RE in which the PSCCH is disposed, PSCCH may be prioritized and mapping of the SL-PRS to the RE may not be executed.

[0164] 3) The SL-PRS may be, or may not be multiplexed with the second stage SCI and/or the DM-RS and/or the PT-RS and/or the CSI-RS, onto the same symbol by using the frequency division multiplexing.

[0165] According to the above 1) or 2), an important signal can be prevented from being replaced with the SL-PRS. In addition, according to the above 3), flexibility of mapping when the frequency division multiplexing is applied to the SL-PRS is improved, and UE operation can be simplified when the frequency division multiplexing is not applied to the SL-PRS. Even though FIG. **11** is an example of mapping of the SL-PRS, the present invention is not limited thereto. For example, in step S**14**, the position of the UE-X itself calculated by the UE-X may be an absolute position or may be a relative position.

[0166] For example, Option 1) may be applied when the UE-X and the UE-Y are in an out-of-coverage (OoC) environment, may be applied when the UE-X and the UE-Y are in a partial-coverage (PC) environment, or may be applied when the UE-X and the UE-Y are in an in-coverage (IC) environment.

[0167] With the above-described Option 1), the terminal **20** can execute an operation for position information acquisition.

[0168] Option 2) With respect to the position estimation using the sidelink, the UE-X which desires to acquire the position information of the UE-X itself may transmit a predetermined signal to the UE-Y and/or the base station **10** (hereinafter, referred to as “BS-Y”) and may receive a signal based on the predetermined signal (for example, a measurement result) from the UE-Y and/or the BS-Y.

[0169] FIG. **12** is a flowchart illustrating an example (2) of position estimation according to the embodiment of the present invention. FIG. **13** is a diagram illustrating the example (2) of position estimation according to the embodiment of the present invention.

[0170] As illustrated in FIGS. **12** and **13**, in step S**21**, the UE-X transmits a predetermined signal to the UE-Y and/or the BS-Y. In subsequent step S**22**, the UE-Y and/or the BS-Y measure a predetermined value based on the predetermined signal. Note that step S**22** may not be applied. In subsequent step S**23**, the UE-Y and/or the BS-Y transmit a signal based on the predetermined signal (for example, information including a measured value and/or information based on the measured value may be included) to the UE-X. In subsequent step S**24**, the UE-X calculates the position of the UE-X itself based on the information received from the UE-Y and/or the BS-Y.

[0171] For example, as in a UE-Y1 and a UE-Y2 illustrated in FIG. **13**, the UE-Y may be one or a plurality of UEs. That is, the UE-X may execute step S**11** to step S**14** for one or a plurality of UEs. Further, the BS-Y may be one or a plurality of BSs.

[0172] For example, the predetermined signal for the UE-Y may be the SL-PRS or any other SL signal. For example, the predetermined signal for the BS-Y may be the SRS or any other UL signal. Further, the signal transmitted by the UE-Y may be the SL-PRS or any other SL signal. Further, the

signal transmitted by the BS-Y may be the DL-PRS or any other DL signal.
[0173] For example, in step S**24**, the position of the UE-X itself calculated by the UE-X may be an absolute position or may be a relative position.
[0174] For example, Option 2) may be applied in the case of the partial-coverage environment or the in-coverage environment. However, the case of the partial-coverage environment may be a case in which the UE-X is in the in-coverage environment and the UE-Y is in the out-of-coverage environment.
[0175] According to the above-described Option 2), the terminal **20** can be expected to acquire more accurate position information by using the base station **10**.
[0176] Option 3) The UE-X that acquired the position of the UE-X itself may transmit a request for position information transmission to the BS. For example, only the terminal **20** supporting a positioning function by the Uu interface may execute Option 3).
[0177] FIG. **14** is a flowchart illustrating an example (3) of position estimation according to the embodiment of the present invention. FIG. **15** is a diagram illustrating the example (3) of position estimation according to the embodiment of the present invention. As illustrated in FIGS. **14** and **15**, in step S**31**, the UE-X transmits a position information request to the BS. In subsequent step S**32**, the BS executes a position information acquisition operation. In subsequent step S**33**, the BS transmits position information to the UE-X.
[0178] For example, in step S**32**, the positioning function using the Uu interface described above may be applied.
[0179] For example, step S**32** may be skipped without being executed. For example, when the BS has already had the position information of the UE-X, step S**32** may not be executed. Further, for example, when the BS has already had the position information of the UE-X and the desired accuracy requirement is satisfied, step S**32** may not be executed. For example, step S**33** may be skipped without being executed. For example, when the DL-PRS is transmitted from a plurality of BS/TRPs to the UE-X and positioning is executed in the UE-X in step S**32**, step S**33** may not be executed.
[0180] For example, the position information requested by the UE-X may be an absolute position or may be a relative position.
[0181] For example, the UE-X may receive an indication indicating that the position information cannot be acquired from the BS instead of receiving the position information. After receiving the indication, the UE-X may execute another method, for example, Option 1) or Option 2) to acquire the position information.
[0182] With the above-described Option 3), the terminal **20** can execute an operation for position information acquisition. By using Uu positioning, more accurate positioning can be expected.
[0183] Option 4) Which one of Option 1), Option 2), and Option 3) is to be executed may be determined based on a predetermined condition.
[0184] For example, the predetermined condition may be any one of the out-of-coverage environment, the partial-coverage environment, and the in-coverage environment.
[0185] For example, the predetermined condition may be an accuracy requirement. That is, an option to be applied may be determined based on whether the accuracy requirement is higher or lower than a predetermined threshold value.
[0186] For example, the predetermined condition may be whether of an absolute position or a relative position is to be acquired.
[0187] For example, the predetermined condition may be a predetermined priority set for each option. For example, Option 3) may be the highest priority, Option 2) may have the next highest priority, and Option 3) may have the lowest priority. The operation of executing the option with the next highest priority when the option with the highest priority cannot be executed may be performed and repeated.
[0188] For example, the predetermined condition may be a UE capability. That is, which one of an

options is to be supported may be specified as the UE capability, and the terminal **20** may execute the option to be supported.

[0189] For example, the predetermined condition may be UE implementation. That is, the terminal **20** may determine an option to be executed based on the UE implementation.

[0190] With the above-described Option 4), the terminal **20** can determine which method is to be executed when a plurality of position acquisition methods are available.

[0191] Option 5) The terminal **20** (hereinafter, referred to as a "UE-A") which desires to acquire position information of another terminal **20** (hereinafter, referred to as a "UE-B") may transmit a request for position information transmission to the UE-B.

[0192] FIG. **16** is a flowchart illustrating an example (4) of position estimation according to the embodiment of the present invention. FIG. **17** is a diagram illustrating the example (4) of position estimation according to the embodiment of the present invention. As illustrated in FIGS. **16** and **17**, in step S**41**, the UE-A transmits a position information request to the UE-B. In subsequent step S**42**, the UE-B executes a position information acquisition operation. In subsequent step S**43**, the UE-B transmits position information of the UE-B to the UE-A.

[0193] For example, in step S**42**, Option 1), Option 2), or Option 3) may be executed. The UE-B may be a UE-X in Option 1), Option 2), or Option 3). The UE-A may or may not be included in the UE-Ys in Option 1), Option 2), or Option 3). When the UE-A is included in the UE-Ys in Option 1), Option 2), or Option 3), any step in Option 1), Option 2), or Option 3) for the UE-A may be skipped without being executed.

[0194] For example, step S**42** may be skipped without being executed. For example, when the UE-B has already had the position information of the VE-B itself, step S**42** may not be executed. Furthermore, for example, when the UE-B has already had the position information of the UE-B itself and the desired accuracy requirement is satisfied, step S**42** may not be executed.

[0195] For example, the position information requested by the UE-A may be an absolute position or a relative position.

[0196] With Option 5), it is possible to support a use case and a service which requires the position information of another UE. In addition, the operation of acquiring the position information of another UE and the operation of acquiring the position information of the UE itself can be the same.

[0197] Option 6) The terminal **20** (hereinafter, referred to as the "UE-A") which desires to acquire the position information of another terminal **20** (hereinafter, referred to as the "UE-B") may transmit a request for position information transmission related to the UE-B to the BS.

[0198] FIG. **18** is a flowchart illustrating an example (5) of position estimation according to the embodiment of the present invention. FIG. **19** is a diagram illustrating the example (5) of position estimation according to the embodiment of the present invention. As illustrated in FIGS. **18** and **19**, in step S**51**, the UE-A transmits a position information request related to the UE-B to the BS. In subsequent step S**52**, the BS executes a position information acquisition operation related to the UE-B. In subsequent step S**53**, the BS transmits position information related to the UE-B to the UE-A.

[0199] For example, in step S**52**, the positioning function of the Uu interface, for example, the positioning function of the Uu interface described above may be executed. For example, in step S**52**, the BS may indicate the UE-B to execute a positioning function of the SL, for example, Option 1) or Option 2). The UE-B may execute the positioning function of the SL, for example, Option 1) or Option 2), and may report the acquired position information of the UE-B itself to the BS.

[0200] For example, step S**52** may be skipped without being executed. For example, when the BS has already had the position information of the UE-B, step S**52** may not be executed. Furthermore, for example, when the BS a has already had the position information of the UE-B and the desired accuracy requirement is satisfied, step S**52** may not be executed.

[0201] For example, the position information requested by the UE-A may be an absolute position or a relative position.
[0202] For example, the UE-A may receive an indication indicating that the position information related to the UE-B cannot be acquired from the BS instead of receiving the position information. After receiving the indication, the UE-A may execute another method, for example, Option 5) to acquire the position information.
[0203] With the above-described Option 6), the terminal **20** can execute an operation for position information acquisition. By using Uu positioning, more accurate positioning can be expected.
[0204] Option 7) Which one of Option 5) and Option 6) is to be executed may be determined based on a predetermined condition.
[0205] For example, the predetermined condition may be any one of the out-of-coverage environment, the partial-coverage environment, and the in-coverage environment.
[0206] For example, the predetermined condition may be an accuracy requirement.
[0207] For example, the predetermined condition may be which one of an absolute position or a relative position is to be acquired.
[0208] For example, the predetermined condition may be a predetermined priority set for each option. For example, Option 6) may have a higher priority than Option 5).
[0209] For example, the predetermined condition may be a UE capability. That is, which one of options is to be supported may be specified as the UE capability, and the terminal **20** may execute the option to be supported.
[0210] For example, the predetermined condition may be UE implementation. That is, the terminal **20** may determine an option to be executed based on the UE implementation.
[0211] With the above-described Option 7), the terminal **20** can determine which method is to be executed when a plurality of position acquisition methods are available.
[0212] Here, in the sidelink communication, when the transmission and reception of the signal related to positioning are executed, it is necessary to determine a time limit for completing the transmission and reception. If the time limit is not set, the transmission and reception may be executed after a considerable time has elapsed from the time point at which the transmission and reception is triggered, and the position information may not be acquired by the time point at which the position information is required.
[0213] Therefore, the transmission and reception of the SL signal between the UE-X that desires to acquire the position of the UE-X itself and the partner (UE-Y) that transmits the SL signal for positioning may be executed by a predetermined time point. Note that the operation may be applied to any one of the above-described position estimation procedures. The UE-Y may be replaced with the BS-Y. The SL signal may be replaced with a Uu signal (DL signal or UL signal).
[0214] FIG. **20** is a diagram illustrating an example (1) of transmission/reception timing according to the embodiment of the present invention. As illustrated in FIG. **20**, a measurement signal (hereinafter referred to as “SL-PRS”) is transmitted from the UE-X to the UE-Y. When the corresponding information is transmitted from the UE-Y to the UE-X, the UE-Y may perform the information transmission by a predetermined time point.
[0215] For example, the predetermined time point may be determined based on an RRC parameter (for example, sl-LatencyBound-Pos-Report). The RRC parameter may be given by configuration or pre-configuration, or may be given by PC5-RRC configuration. The RRC parameter may be given for each predetermined condition. The predetermined condition may be, for example, a requirement related to positioning, an SL-PRS setting, or a priority. Which of the predetermined conditions given to the RRC parameter is used may be explicitly or implicitly indicated from the UE-X to the UE-Y. Thus, the delay limit can be set to an appropriate value for each use case.
[0216] For example, the predetermined time point may be indicated together with SL-PRS transmission from the UE-X to the UE-Y. This makes it possible to flexibly change the predetermined time point.

[0217] For example, a time point at which a predetermined time has elapsed from the reception timing of the SL-PRS may be set as the predetermined time point. For example, the predetermined time point may be measured with the reception timing of the SL-PRS as a starting point. The reception timing may be specified by, for example, a slot including the SL-PRS, may be specified by the last symbol of the SL-PRS, or may be specified by the last symbol of the slot including the SL-PRS.
[0218] For example, a timer for completing the operation by the predetermined time point may be defined in a higher layer (for example, the MAC layer) and used.
[0219] For example, the UE-Y may perform the operation related to the determination of the transmission resource so as to complete the operation by the predetermined time point. For example, when the resource is autonomously selected, the end of the resource selection window may be set to the predetermined time point or a timing before the predetermined time point. For example, when the resource is scheduled from the base station **10**, the resource request and the transmission time limit for the information transmission may be indicated to the base station **10** via a scheduling request (SR) or a buffer status report (BSR).
[0220] For example, when the information transmission is not completed by the predetermined time point, the UE-Y may stop the operation related to the transmission.
[0221] For example, the series of operations may be performed as a SL-CSI (Channel State Information) report. For example, in the SL-CSI report, the UE-Y may receive indication regarding which one of a channel quality indicator (CQI)/rank indicator (RI) or information related to SL positioning is requested.
[0222] By the above-described operation 1), it is possible to complete the information transmission and reception for the position information measurement by a necessary timing.
[0223] FIG. **21** is a diagram illustrating an example (2) of the transmission/reception timing according to the embodiment of the present invention. As illustrated in FIG. **21**, when the SL-PRS request is transmitted from the UE-X to the UE-Y, and the SL-PRS is transmitted from the VE-Y to the UE-X, the UE-Y may perform the SL-PRS transmission by a predetermined time point.
[0224] For example, the predetermined time point may be determined based on an RRC parameter (for example, sl-LatencyBound-Pos). The RRC parameter may be given by configuration or pre-configuration, or may be given by PC5-RRC configuration. The RRC parameter may be given for each predetermined condition. The predetermined condition may be, for example, a requirement related to positioning, an SL-PRS setting, or a priority. Which of the predetermined conditions given to the RRC parameter is used may be explicitly or implicitly indicated from the UE-X to the UE-Y. Thus, the delay limit can be set to an appropriate value for each use case.
[0225] For example, the predetermined time point may be indicated from the UE-X to the UE-Y together with the SL-PRS request transmission. This makes it possible to flexibly change the predetermined time point.
[0226] For example, a time point at which a predetermined time has elapsed from the reception timing of the SL-PRS request as a starting point may be set as the predetermined time point. For example, the predetermined time point may be measured with the reception timing of the SL-PRS request as a starting point. The reception timing may be specified by, for example, a slot including the SL-PRS request or may be specified by the last symbol of the slot including the SL-PRS request.
[0227] For example, a timer for completing the operation by the predetermined time point may be defined in a higher layer (for example, the MAC layer) and used.
[0228] For example, the UE-Y may perform the operation related to the determination of the transmission resource so as to complete the operation by the predetermined time point. For example, when the resource is autonomously selected, the end of the resource selection window may be set to the predetermined time point or a timing before the predetermined time point. For example, when the resource is scheduled from the base station **10**, the resource request and the

transmission time limit for the information transmission may be indicated to the base station **10** via a scheduling request (SR) or a buffer status report (BSR).

[0229] For example, when the SL-PRS transmission is not completed by the predetermined time point, the UE-Y may stop the operation related to the transmission.

[0230] For example, the series of operations may be performed as SL-CSI reporting. For example, in the SL-CSI report, the UE-Y may receive indication regarding which one of the CQI/RI or the information related to the SL positioning is requested.

[0231] By the operation 2), the information transmission and reception for the position information measurement can be completed by the necessary timing.

[0232] Operation 3) The RRC parameter (for example, sl-LatencyBound-Pos-Report) in the operation 1) and the RRC parameter (for example, sl-LatencyBound-Pos) in the operation 2) may be the same parameter or may be separate parameters.

[0233] When the RRC parameter (for example, sl-LatencyBound-Pos-Report) in the operation 1) and the RRC parameter (for example, sl-LatencyBound-Pos) in the operation 2) are separate parameters and when both the operation 1) and the operation 2) are performed, the operation 1) and the operation 2) may be performed based on the respective RRC parameters.

[0234] When the RRC parameter (for example, sl-LatencyBound-Pos-Report) and the RRC parameter (for example, sl-LatencyBound-Pos) are separate parameters, and when both the operation 1) and the operation 2) are performed, the operation 1) or the operation 2) may be performed based on any one of the RRC parameters. For example, a shared timer management may be performed in the operation 1) and the operation 2). For example, individual timer management may be performed in the operation 1) and the operation 2).

[0235] In the above-described operation 3), by setting the RRC parameters to be the same parameter, the UE operations can be simplified. By setting the RRC parameters to be separate parameters, the respective optimal parameters can be used.

[0236] The above-described embodiment may be applied to D2D of NR or may be applied to D2D of another RAT. In addition, the above-described embodiment may be applied to FR2 or may be applied to other frequency bands.

[0237] The above-described embodiment is not limited to the V2X terminal, and may be applied to a terminal that performs D2D communication.

[0238] The operation according to the above-described embodiment may be executed only in a specific resource pool. For example, the operation may be executed only in a resource pool available to the terminal **20** of 3GPP release 17 or 3GPP release 18 or later.

[0239] According to the above-described embodiment, the terminal **20** can acquire the position information of the terminal **20** itself by transmitting and receiving signals for positioning at the timing by the delay limit using sidelink signals.

[0240] That is, the position information of the device itself can be acquired by the device-to-device direct communication.

(Device Configuration)

[0241] Next, functional configuration examples of the base station **10** and the terminal **20** that execute the processing and operation described above will be described. The base station **10** and the terminal **20** include a function of implementing the above-described embodiment. However, each of the base station **10** and the terminal **20** may have only a part of functions in the embodiment.

<Base Station **10**>

[0242] FIG. **22** is a diagram illustrating an example of a functional configuration of the base station **10**. As illustrated in FIG. **22**, the base station **10** includes a transmission unit **110**, a reception unit **120**, a setting unit **130**, and a control unit **140**. The functional configuration illustrated in FIG. **22** 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 units may be freely selected.

[0243] The transmission unit **110** has a function of generating a signal to be transmitted to the terminal **20** side and wirelessly transmitting the signal. The reception 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 transmission unit **110** has a function of transmitting NR-PSS, NR-SSS, NR-PBCH, a DL/UL control signal, a DL reference signal, and the like to the terminal **20**.

[0244] 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. A content of the setting information is, for example, information related to setting of the D2D communication.

[0245] As described in the embodiment, the control unit **140** performs processing related to setting for the terminal **20** to perform the D2D communication. Furthermore, the control unit **140** transmits scheduling of the D2D communication and the DL communication to the terminal **20** via the transmission unit **110**. Furthermore, the control unit **140** receives information regarding HARQ responses of the D2D communication and the DL communication from the terminal **20** via the reception unit **120**. The functional unit related to signal transmission in the control unit **140** may be included in the transmission unit **110**, and the functional unit related to signal reception in the control unit **140** may be included in the reception unit **120**.

<Terminal **20**>

[0246] FIG. **23** is a diagram illustrating an example of a functional configuration of the terminal **20**. As illustrated in FIG. **23**, the terminal **20** includes a transmission unit **210**, a reception unit **220**, a setting unit **230**, and a control unit **240**. The functional configuration illustrated in FIG. **23** 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 units may be freely selected.

[0247] The above-described LTE-SL transmission/reception mechanism (module) and the above-described NR-SL transmission/reception mechanism (module) may separately include the transmission unit **210**, the reception unit **220**, the setting unit **230**, and the control unit **240**.

[0248] The transmission unit **210** generates a transmission signal from transmission data and wirelessly transmits the transmission signal. The reception unit **220** wirelessly receives various signals and acquires a signal of an upper layer from the received signals of a physical layer. Furthermore, the reception unit **220** has a function of receiving NR-PSS, NR-SSS, NR-PBCH, a DL/UL/SL control signal, a reference signal, and the like transmitted from the base station **10**. Furthermore, for example, the transmission unit **210** transmits a physical sidelink control channel (PSCCH), a physical sidelink shared channel (PSSCH), a physical sidelink discovery channel (PSDCH), a physical sidelink broadcast channel (PSBCH), or the like to the other terminal **20** as the D2D communication, and the reception unit **220** receives PSCCH, PSSCH, PSDCH, PSBCH, or the like from the other terminal **20**.

[0249] The setting unit **230** stores various types of setting information received from the base station **10** or the terminal **20** by the reception unit **220** in a storage device, and reads the setting information from the storage device as necessary. The setting unit **230** also stores setting information set in advance. A content of the setting information is, for example, information related to settings of the D2D communication.

[0250] As described in the embodiment, the control unit **240** controls the D2D communication for establishing an RRC connection with another terminal **20**. Furthermore, the control unit **240** performs processing related to a power saving operation. Furthermore, the control unit **240** performs processing related to HARQ of the D2D communication and the DL communication. Furthermore, the control unit **240** transmits, to the base station **10**, information regarding HARQ responses of the D2D communication and the DL communication scheduled from the base station

10 to another terminal **20**. Furthermore, the control unit **240** may schedule the D2D communication to another terminal **20**. Furthermore, the control unit **240** may autonomously select a resource to be used for the D2D communication from a resource selection window based on a result of sensing, or may execute reevaluation or pre-emption. Furthermore, the control unit **240** performs processing related to power saving in transmission and reception of the D2D communication. Furthermore, the control unit **240** performs processing related to device-to-device cooperation in the D2D communication. The functional unit related to signal transmission in the control unit **240** may be included in the transmission unit **210**, and the functional unit related to signal reception in the control unit **240** may be included in the reception unit **220**.

(Hardware Configuration)

[0251] The block diagrams used for the description of the above-described embodiment (FIGS. **22** and **23**) illustrate blocks of functional units. The functional blocks (configuration units) are realized by any combination of at least one of hardware and software. A method of 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 to each other and using the plurality of devices. The functional block may be implemented by combining software with the one device or the plurality of devices.

[0252] The functions include, but are not limited to, deciding, determining, judging, calculating, computing, processing, deriving, investigating, searching, confirming, receiving, transmitting, outputting, accessing, resolving, selecting, choosing, establishing, comparing, assuming, expecting, considering, broadcasting, notifying, communicating, forwarding, configuring, reconfiguring, allocating and mapping, assigning, and the like. For example, a functional block (configuration unit) that causes transmission to function is referred to as a transmission unit (transmitting unit) or a transmitter. In any case, as described above, the implementation method is not particularly limited.

[0253] For example, the base station **10**, the terminal **20**, and the like in the embodiment of the present disclosure may function as a computer that performs processing of a wireless communication method of the present disclosure. FIG. **24** is a diagram illustrating an example of hardware configurations of the base station **10** and the terminal **20** according to the embodiment of the present disclosure. The base station **10** and the terminal **20** 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.

[0254] In the following description, the term “device” can be replaced with a circuit, a device, a unit, or the like. The hardware configurations of the base station **10** and the terminal **20** may be configured to include one or more devices illustrated in the drawing, or may be configured without including a part of devices.

[0255] Each function in the base station **10** and the terminal **20** is implemented by the processor **1001** performing calculation by loading predetermined software (program) on hardware such as the processor **1001** and the storage device **1002**, controlling communication by the communication device **1004**, and controlling at least one of reading and writing of data in the storage device **1002** and the auxiliary storage device **1003**.

[0256] 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 arithmetic 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**.

[0257] In addition, the processor **1001** reads a program (a 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 types of processing according to the program, the software module, the data, 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. **22** 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. **23** may be implemented by a control program stored in the storage device **1002** and operated by the processor **1001**. Although it has been described that the above-described various types of processing are executed by one processor **1001**, the various types of processing 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.

[0258] The storage device **1002** is a computer-readable recording medium, and may be configured with, 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 (a main storage device), or the like. The storage device **1002** can store a program (a 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.

[0259] The auxiliary storage device **1003** is a computer-readable recording medium, and may be configured with, for example, at least one of an optical disk such as a compact disc ROM (CD-ROM), a hard disk drive, a flexible disk, a magneto-optical disk (for example, a compact disc, a digital versatile disc, or a Blu-ray (registered trademark) disc), 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 including at least one of the storage device **1002** and the auxiliary storage device **1003**, a server, or another appropriate medium.

[0260] The communication device **1004** is hardware (a 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 be configured with 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 transmission/reception unit, a transmission/reception path interface, and the like may be implemented by the communication device **1004**. The transmission/reception unit may be implemented such that the transmission unit and the reception unit are physically or logically separated from each other.

[0261] 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 an output to the outside. Note that the input device **1005** and the output device **1006** may be formed to be integrated with each other (for example, a touch panel).

[0262] In addition, the 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 different buses between the devices.

[0263] Furthermore, the base station **10** and the terminal **20** 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), or 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.

[0264] FIG. **25** illustrates a configuration example of a vehicle **2001**. As illustrated in FIG. **25**, 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**.

[0265] The drive unit **2002** includes, 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 a user.

[0266] 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).

[0267] Examples of signals from the various sensors **2021** to **2029** include a current signal from the current sensor **2021** that senses the current of the motor, a rotation speed signal of the front wheel and the rear wheel acquired by the rotation speed sensor **2022**, an air pressure signal of the front wheel and the rear wheel acquired by the air pressure sensor **2023**, a vehicle speed signal acquired by the vehicle speed sensor **2024**, an acceleration signal acquired by the acceleration sensor **2025**, a depression amount signal of an accelerator pedal acquired by the accelerator pedal sensor **2029**, a depression amount signal of a brake pedal acquired by the brake pedal sensor **2026**, an operation signal of a shift lever acquired by the shift lever sensor **2027**, and a detection signal for detecting an obstacle, a vehicle, a pedestrian, and the like acquired by the object detection sensor **2028**.

[0268] The information service unit **2012** is configured with various devices for providing various types of information such as driving information, traffic information, and entertainment information, such as a car navigation system, an audio system, a speaker, a television, and a radio, and one or more ECUs that control the devices. The information service unit **2012** provides various types of multi-media information and multi-media services to an 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 an output to the outside.

[0269] A driving assistance system unit **2030** is configured with various devices for providing functions of 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 that control 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 automatic driving function.

[0270] The communication module **2013** may communicate with the microprocessor **2031** and components of the vehicle **2001** via a communication port. For example, the communication module **2013** transmits and receives, via the communication port **2033**, 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 sensors **2021** to **2029** provided in the vehicle **2001**.

[0271] The communication module **2013** is a communication device capable of being controlled by the microprocessor **2031** of the electronic control unit **2010** and capable of communicating with an external device. For example, various types of information are transmitted and received to and from the external device via wireless communication. The communication module **2013** may be provided on the inside or the outside of the electronic control unit **2010**. The external device may be, for example, a base station, a mobile station, or the like.
[0272] The communication module **2013** may transmit at least one of signals from the various sensors **2021** to **2028** described above input to the electronic control unit **2010**, information obtained based on the signals, and information based on input from the outside (user) obtained via the information service unit **2012** to an 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 an input unit that receives an input. For example, the PUSCH transmitted by the communication module **2013** may include information based on the input.
[0273] 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 referred to as an output unit that outputs information (for example, outputs information to a device such as a display or a speaker based on the PDSCH (or data/information decoded from the PDSCH) received by the communication module **2013**). The communication module **2013** also stores various types of information received from the external device in the memory **2032** available by the microprocessor **2031**. Based on the information stored in the memory **2032**, 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**.
SUMMARY OF EMBODIMENTS
[0274] As described above, according to the embodiment of the present invention, a terminal is provided. The terminal includes: [0275] a receiving unit configured to receive a signal related to positioning in device-to-device direct communication from another terminal; [0276] a transmitting unit configured to transmit a signal based on the signal related to positioning in device-to-device direct communication to the other terminal; and [0277] a control unit configured to perform control to transmit the signal based on the signal related to positioning in the device-to-device direct communication to the other terminal by a certain time point.
[0278] With the above configuration, the terminal **20** can acquire the position information of the terminal **20** by transmitting and receiving signals for positioning at the timing by the delay limit using sidelink signals. That is, the position information of the terminal **20** itself can be acquired by the device-to-device direct communication.
[0279] The signal related to positioning in the device-to-device direct communication may be a reference signal for positioning or a signal requesting transmission of the reference signal for positioning. With this configuration, the terminal **20** can acquire the position information of the terminal **20** itself by transmitting and receiving signals for positioning at a timing by the delay limit using the sidelink signals.
[0280] The control unit may determine the certain time point based on a radio resource control (RRC) parameter given for each specific condition. With this configuration, the terminal **20** can acquire the position information of the terminal **20** itself by transmitting and receiving signals for positioning at a timing by the delay limit using the sidelink signals.
[0281] The control unit may assume a time point indicated together with the signal related to positioning in the device-to-device direct communication as the certain time point. With this configuration, the terminal **20** can acquire the position information of the terminal **20** itself by transmitting and receiving signals for positioning at a timing by the delay limit using the sidelink

signals.

[0282] The control unit may set a time point at which the signal related to positioning in the device-to-device direct communication is received as a starting point for measuring the certain time point. With this configuration, the terminal **20** can acquire the position information of the terminal **20** itself by transmitting and receiving signals for positioning at a timing by the delay limit using the sidelink signals.

[0283] According to the embodiment of the present invention, a positioning method is provided. The positioning method includes: [0284] a reception procedure of receiving a signal related to positioning in device-to-device direct communication from another terminal; and [0285] a transmission procedure of transmitting a signal based on the signal related to positioning in the device-to-device direct communication to the other terminal; and [0286] a control procedure of performing control to transmit the signal based on the signal related to positioning in the device-to-device direct communication to the other terminal by a certain time point.

[0287] With the above configuration, the terminal **20** can acquire the position information of the terminal **20** itself by transmitting and receiving signals for positioning at the timing by the delay limit using sidelink signals. That is, the position information of the terminal **20** itself can be acquired by the device-to-device direct communication.

Supplement to Embodiment

[0288] Although the embodiments of the present invention have been described above, the disclosed invention is not limited to such embodiments, and those skilled in the art will understand various modifications, revisions, alternatives, substitutions, and the like. Although the description has been 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 items described in two or more items may be used in combination as necessary, or items described in one item may be applied to items 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 operations of the 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** have been described using a functional block diagram, but such a device may be implemented by hardware, software, or a combination thereof. Software operated by a processor included in the base station **10** according to the embodiments of the present invention, and software operated by a 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.

[0289] Furthermore, the indication of information is not limited to the aspects/embodiments described in the present disclosure, and may be performed using other methods. For example, the indication 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, the RRC signaling may be referred to as an RRC message, and may be referred to as, for example, an RRC connection setup message, an RRC connection reconfiguration message, or the like.

[0290] Each aspect/embodiment described in the present disclosure may be applied to at least one of a system utilizing 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), xth 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), and other appropriate systems, and a next generation system which is extended, modified, generated, and stipulated based thereon. Further, 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).

[0291] 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 method described in the present disclosure, elements of various steps are presented using an example order, and are not limited to the presented particular order.

[0292] 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. In a network including one or more network nodes including the base station **10**, it is obvious that 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 the present invention is not limited thereto) other than the base station **10**. Although a description has been given as to a case in which there is one other network node other than the base station **10**, the other network node may be a combination of a plurality of other network nodes (for example, MME and S-GW).

[0293] 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.

[0294] The input/output information and the like may be stored in a specific location (for example, in a 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.

[0295] The determination 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).

[0296] Software, whether referred to as software, firmware, middleware, microcode, hardware description language, or other names, should be construed broadly to mean an instruction, an instruction set, a code, a code segment, a program code, a program, a subprogram, a software module, an application, a software application, a software package, a routine, a subroutine, an object, an executable file, an execution thread, a procedure, a function, and the like.

[0297] In addition, software, instructions, information, and the like may be transmitted and received via a transmission medium. For example, when software is transmitted from a website, a server, or other remote sources 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 and wireless technologies is included within the definition of the transmission medium.

[0298] Information, signals, and the like described in the present disclosure may be represented using any one of a variety of different techniques. For example, data, an instruction, a command, information, a signal, a bit, a symbol, a chip, and the like which may be mentioned throughout the above description may be represented by a voltage, a current, an electromagnetic wave, a magnetic field or a particle, an optical field or a photon, or any combination thereof.

[0299] 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 the channel and the symbol may be a signal (signaling). The 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.

[0300] The terms “system” and “network” used in the present disclosure are used interchangeably.

[0301] In addition, information, parameters, 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.

[0302] The names used for parameters described above are not limitative names in any way. Furthermore, mathematical formulas 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 names, various names assigned to the various channels and information elements are not limitative names in any way.

[0303] 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. The base station may also be referred to as a macro cell, a small cell, a femto cell, a pico cell, or the like.

[0304] The base station may accommodate one or more (for example, three) cells. When the 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 of the whole of a coverage area of at least one of the base station and the base station subsystem that performs communication service in the coverage.

[0305] In the present disclosure, the transmission of information from the base station to the terminal may be replaced with the indication from the base station to the terminal to perform control and operation based on the information.

[0306] In the present disclosure, terms such as “mobile station (MS)”, “user terminal”, “user equipment (UE)”, and “terminal” can be used interchangeably.

[0307] 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.

[0308] At least one of the base station and the 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 the base station and the mobile station may be a device mounted on a mobile object, the mobile object itself, or the like. The mobile object is a movable object, and the moving speed is any given speed. The mobile object may be stopped. Examples of the mobile object include, but are not limited to, vehicles, transportation vehicles, automobiles, motorcycles, bicycles, connected cars, excavators, bulldozers, wheel loaders, dump trucks, forklifts, trains, buses, rear cars, rickshaws, ships and other watercraft, airplanes, rockets, artificial satellites, drones, multicopters, quadcopters, balloons, and objects mounted thereon. The mobile object may be a moving object that autonomously travels based on an operation command. The mobile object may be a vehicle (for example, a car, an airplane, or the like), a mobile object which is movable without human intervention (for example, a drone, a self-driving vehicle, or the like), or a robot (manned type or unmanned type). Note that at least one of the base station and the mobile station includes a device which does not necessarily move during communication operation. For example, at least one of the base station and the mobile station may be an Internet of Things (IoT) device such as a sensor.

[0309] In addition, the base station in the present disclosure may be replaced with the user terminal. For example, each aspect/embodiment of the present disclosure may be applied to a configuration in which communication between the base station and the user terminal is replaced with communication between a plurality of terminals **20** (for example, may be referred to as device-to-device (D2D), vehicle-to-everything (V2X), or the like). Here, the terminal **20** may have a function of the base station **10** described above. In addition, words such as “upstream” and “downstream” may be replaced with words corresponding to device-to-device communication (for example, “side”). For example, an uplink channel, a downlink channel, and the like may be replaced with a side channel.

[0310] Similarly, the user terminal in the present disclosure may be replaced with the base station. Here, the base station may have a function of the user terminal described above.

[0311] The terms “deciding” and “determining” used in the present disclosure may encompass a wide variety of actions. The terms “deciding” and “determining” may include considering, as “deciding” and “determining”, what has been, for example, judged, calculated, computed, processed, derived, investigated, searched (looking up, search, inquiry) (for example, searched in a table, a database, or another data structure), and ascertained. Furthermore, “deciding” and “determining” may include considering, as “deciding” and “determining”, what has been received (for example, receiving information), transmitted (for example, transmitting information), inputting, outputting, and accessed (for example, accessing data in a memory). In addition, “deciding” and “determining” may include considering, as “deciding” and “determining”, what has been resolved, selected, chosen, established, compared, and the like. That is, “deciding” and “determining” may include considering some operations as being “decided” or “determined”. Further, “deciding (determining)” may be replaced with “assuming”, “expecting”, “considering”, or the like.

[0312] The terms “connected”, “coupled”, or any variation thereof mean any direct or indirect connection or coupling between two or more elements, and one or more intermediate elements may exist between two elements which are “connected” or “coupled” to each other. The coupling or connection between the elements may be physical, logical, or a combination thereof. For example, “connection” may be replaced with “access”. As used in the 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 electric connections, and as some non-limiting and non-inclusive examples, using electromagnetic energy having wavelengths in a radio frequency domain, a microwave region, and a light (both visible and invisible) region, and the like.

[0313] The reference signal may be abbreviated as RS, or may be referred to as a pilot according to an applied standard.

[0314] As used in the disclosure, the phrase “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”.

[0315] Any reference to elements using designations such as “first”, “second”, and the like as used in the present disclosure 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 employed or that the first element must in any way precede the second element.

[0316] The “means” in the configuration of each device described above may be replaced with a “unit”, a “circuit”, a “device”, or the like.

[0317] When 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.

[0318] A radio frame may be configured with one or more frames in a time domain. Each of one or more frames in the time domain may be referred to as a sub-frame. The sub-frame may be further configured with one or more slots in the time domain. The sub-frame may be a fixed time length (for example, 1 ms) which is independent of numerology.
[0319] The numerology may be a communication parameter applied to at least one of transmission and reception of a signal or a channel. The numerology may indicate at least one of, for example, a sub-carrier spacing (SCS), a bandwidth, a symbol length, a cyclic prefix length, a transmission time interval (TTI), the number of symbols per TTI, a radio frame configuration, a particular filtering operation performed by a transceiver in the frequency domain, a particular windowing operation performed by the transceiver in the time domain, and the like.
[0320] The slot may be configured with one or a plurality of symbols (an orthogonal frequency division multiplexing (OFDM) symbol, a single carrier frequency division multiple access (SC-FDMA) symbol, and the like) in the time domain. The slot may be a time unit based on the numerology.
[0321] The slot may include a plurality of mini-slots. Each mini-slot may be configured with one or more symbols in the time domain. Further, the mini-slot may be referred to as a sub-slot. The mini-slot may be configured with a smaller number of symbols than the slot. PDSCH (or PUSCH) transmitted in a time unit larger than the mini-slot may be referred to as a PDSCH (or PUSCH) mapping type A. PDSCH (or PUSCH) transmitted using the mini-slot may be referred to as a PDSCH (or PUSCH) mapping type B.
[0322] Each of the radio frame, the sub-frame, the slot, the mini-slot, and the symbol represents a time unit when a signal is transmitted. Different names respectively corresponding to the radio frame, the sub-frame, the slot, the mini-slot, and the symbol may be used.
[0323] For example, one sub-frame may be referred to as a transmission time interval (TTI), a plurality of consecutive sub-frames 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 the sub-frame and the TTI may be a sub-frame (1 ms) in existing LTE, a period of time shorter than 1 ms (for example, 1 to 13 symbols), or a period of time longer than 1 ms. Note that the unit representing the TTI may be referred to as the slot, the mini-slot, or the like instead of the sub-frame.
[0324] Here, the TTI refers to, for example, a minimum time unit of scheduling in wireless communication. For example, in the LTE system, the 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 ITIs. Note that the definition of the TTI is not limited thereto.
[0325] The TTI may be a transmission time unit such as a channel coded data packet (a transport block), a code block, or a code word, or may be a processing unit such as scheduling or link adaptation. Note that, when a TTI is given, a time interval (for example, the number of symbols) in which the transport block, the code block, the code word, or the like is actually mapped may be shorter than the TTI.
[0326] Note that, when one slot or one mini-slot is referred to as the 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 the scheduling may be controlled.
[0327] A TTI with a time length of 1 ms may be referred to as a general TTI (TTI in LTE Rel. 8 to 12), a normal TTI, a long TTI, a general sub-frame, a normal sub-frame, a long sub-frame, a slot, or the like. A TTI shorter than the general TTI may be referred to as a shortened TTI, a short TTI, a partial TTI (or fractional TTI), a shortened sub-frame, a short sub-frame, a mini-slot, a sub-slot, a slot, or the like.
[0328] Note that the long TTI (for example, the general TTI, the sub-frame, or the like) may be replaced with a TTI having a time length exceeding 1 ms, and the short TTI (for example, the

shortened TTI or the like) may be replaced with a TTI having a TTI length less than the TTI length of the long TTI and a length of 1 ms or more.
[0329] The 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 sub-carriers in the frequency domain. The number of sub-carriers included in the RB may be the same regardless of the numerology, and for example, may be 12. The number of sub-carriers included in the RB may be determined based on the numerology.
[0330] In addition, the time domain of the RB may include one or more symbols, and may be a length of one slot, one mini-slot, one sub-frame, or one TTI. Each of one TTI, one sub-frame, and the like may be configured with one or more resource blocks.
[0331] 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.
[0332] Furthermore, the resource block may include one or a plurality of resource elements (REs). For example, one RE may be a radio resource area of one sub-carrier and one symbol.
[0333] A bandwidth part (BWP) (which may also be referred to as a partial bandwidth or the like) may represent a subset of contiguous common resource blocks (common RBs) for a numerology in a carrier. Here, the common RB may be specified by an index of the RB based on the common reference point of the carrier. The PRB may be defined by a certain BWP and numbered within the BWP.
[0334] The BWP may include a BWP for UL (UL BWP) and a BWP for DL (DL BWP). One or a plurality of BWPs may be set in one carrier for the terminal **20**.
[0335] 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 a “cell”, a “carrier”, and the like in the present disclosure may be replaced with “BWP”.
[0336] The above-described structures such as the radio frame, the sub-frame, the slot, the mini-slot, and the symbol are merely examples. For example, the number of sub-frames included in the radio frame, the number of slots per subframe or radio frame, the number of mini-slots included in the slot, the number of symbols and RBs included in the slot or the mini-slot, the number of sub-carriers included in the RB, the number of symbols in the TTI, a symbol length, a cyclic prefix (CP) length, and the like can be variously changed.
[0337] 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 in which a noun following the articles is a plural form.
[0338] 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” and “coupled” may be interpreted in the same manner as “different”.
[0339] Each aspect/embodiment described in the present disclosure may be used alone, used in combination, or used by being switched with execution. Furthermore, indication of predetermined information (for example, indication of “being X”) is not limited to being performed explicitly, and may be performed implicitly (for example, the predetermined information is not indicated).
[0340] Although the present disclosure has been 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, description of the present disclosure is given for the purpose of illustration and does not have any restrictive meaning to the present disclosure.
REFERENCE SIGNS LIST
[0341] **10** base station [0342] **110** transmission unit [0343] **120** reception unit [0344] **130** setting unit [0345] **140** control unit [0346] **20** terminal [0347] **210** transmission unit [0348] **220** reception unit [0349] **230** setting unit [0350] **240** control unit [0351] **1001** processor [0352] **1002** storage

device [0353] **1003** auxiliary storage device [0354] **1004** communication device [0355] **1005** input device [0356] **1006** output device [0357] **2001** vehicle [0358] **2002** drive unit [0359] **2003** steering unit [0360] **2004** accelerator pedal [0361] **2005** brake pedal [0362] **2006** shift lever [0363] **2007** front wheel [0364] **2008** rear wheel [0365] **2009** axle [0366] **2010** electronic control unit [0367] **2012** information service unit [0368] **2013** communication module [0369] **2021** current sensor [0370] **2022** rotation speed sensor [0371] **2023** air pressure sensor [0372] **2024** vehicle speed sensor [0373] **2025** acceleration sensor [0374] **2026** brake pedal sensor [0375] **2027** shift lever sensor [0376] **2028** object detection sensor [0377] **2029** accelerator pedal sensor [0378] **2030** driving assistance system unit [0379] **2031** microprocessor [0380] **2032** memory (ROM, RAM) [0381] **2033** communication port (IO port)

Claims

1.-**6**. (canceled)
7. A terminal comprising: a reception unit configured to receive, from another terminal, information indicating a delay limit of a positioning reference signal in a device-to-device communication (D2D communication); and a transmitter configured to transmit the positioning reference signal before a timing based on the delay limit.
8. The terminal according to claim 7, wherein the delay limit is associated with a priority of the positioning reference signal.
9. The terminal according to claim 7, further comprising: a control unit configured to select a transmission resource for transmitting the positioning reference signal, based on the delay limit.
10. The terminal according to claim 7, wherein the transmitter transmits information related to the delay limit to a network.
11. The terminal according to claim 10, wherein the transmitter transmits an SR (scheduling request) associated with the delay limit to the network.
12. A positioning method executed by a terminal, the positioning method comprising: receiving, from another terminal, information including a delay limit of a positioning reference signal in a device-to-device communication (D2D communication); and transmitting, to the another terminal, the positioning reference signal before a timing based on the delay limit.