METHOD AND APPARATUS FOR POSITIONING BASED ON VALIDITY INFORMATION AND REPORTING THE RESULT IN RRC_INACTIVE IN MOBILE WIRELESS COMMUNICATION SYSTEM

Abstract

A method and apparatus for positioning in a mobile communication system are provided. Method for positioning includes receiving from a base station a first type1 assistance data, receiving from the base station a type2 assistance data, the type2 assistance data includes a validity information and a second type1 assistance data, determining based on the validity information and a New Radio (NR) cell global identifier of serving cell whether the second type1 assistance data is valid, receiving from the base station a RRCRelease, transmitting in RRC_INACTIVE state a ProvideLocationInformation. At least a part of the ProvideLocationInformation is transmitted in a first Medium Access Control (MAC) Protocol Data Unit (PDU) and the first MAC PDU includes a ResumeRequest.

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Family ID:	**85330127**
Appl. No.:	**19/193973**
Filed:	**April 30, 2025**

Foreign Application Priority Data

Related U.S. Application Data

parent US continuation 18650114 20240430 parent-grant-document US 12323359 child US 19193973

parent US continuation 18230178 20230804 parent-grant-document US 12003453 child US 18650114
parent WO continuation PCT/KR2022/014217 20220923 PENDING child US 18230178

Publication Classification

Int. Cl.: **H04L5/00** (20060101); **H04W76/19** (20180101); **H04W76/20** (20180101); **H04W76/30** (20180101)

U.S. Cl.:

CPC   **H04L5/0051** (20130101); **H04W76/19** (20180201); **H04W76/20** (20180201); **H04W76/30** (20180201);

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] This application is a Continuation Application of U.S. patent application Ser. No. 18/650,114, Filed on Apr. 30, 2024, pending at the time of filing of the present Patent Application, which is a Continuation Application of U.S. Pat. No. 12,003,453, which is a US Bypass Continuation Application of International Application No. PCT/KR2022/014217, filed on Sep. 23, 2022, which claims priority to and the benefit of Korean Patent Application No. 10-2021-00131349, filed on Oct. 5, 2021, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND
Technical Field
[0002] The present disclosure relates to positioning in a mobile communication system. More specifically, the present disclosure relates to performing positioning based on validity information and reporting the result in RRC_INACTIVE.
Related Art
[0003] To meet the increasing demand for wireless data traffic since the commercialization of 4th generation (4G) communication systems, the 5th generation (5G) system is being developed. For the sake of high, 5G system introduced millimeter wave (mmW) frequency bands (e. g. 60 GHz bands). In order to increase the propagation distance by mitigating propagation loss in the 5G communication system, various techniques are introduced such as beamforming, massive multiple-input multiple output (MIMO), full dimensional MIMO (FD-MIMO), array antenna, analog beamforming, and large-scale antenna. In addition, base station is divided into a central unit and plurality of distribute units for better scalability. To facilitate introduction of various services, 5G communication system targets supporting higher data rate and smaller latency.
[0004] Various attempts are being made to apply the 5G communication system to the IoT network. For example, 5G communication such as sensor network, machine to machine communication (M2M), and machine type communication (MTC) is being implemented by techniques such as beam forming, MIMO, and array antenna.
[0005] The importance of terminal positioning in new services such as the above-mentioned machine communication is increasing. Positioning can be estimated in consideration of the measurement result of the base station measuring the uplink reference signal transmitted by the terminal or the measurement result of the terminal measuring the downlink reference signal transmitted by the base station.
SUMMARY

[0006] Aspects of the present disclosure are to address positioning based on validity information in mobile communication system. Accordingly, an aspect of the present disclosure includes receiving from a base station a first type 1 assistance data, receiving from the base station a type2 assistance data, the type2 assistance data includes a validity information and a second type1 assistance data, determining based on the validity information and a New Radio (NR) cell global identifier of serving cell whether the second type1 assistance data is valid, receiving from the base station a RRCRelease, transmitting in RRC_INACTIVE state a ProvideLocationInformation. At least a part of the ProvideLocationInformation is transmitted in a first Medium Access Control (MAC) Protocol Data Unit (PDU) and the first MAC PDU includes a ResumeRequest.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0007] FIG. **1**A is a diagram illustrating the architecture of an 5G system and a NG-RAN.
[0008] FIG. **1**B is a diagram illustrating a wireless protocol architecture in an 5G system.
[0009] FIG. **1**C is a diagram illustrating the architecture of positioning system.
[0010] FIG. **1**D is a diagram illustrating the protocol architecture of positioning system.
[0011] FIG. **2**A is a diagram illustrating positioning method according to the first embodiment of the present invention.
[0012] FIG. **2**B is a diagram illustrating the mapping between positioning assistance data and positioning system information block.
[0013] FIG. **2**C is a diagram illustrating a structure of immediate downlink positioning reference signal assistance data according to the first embodiment of the present invention.
[0014] FIG. **2**D is a diagram illustrating a structure of conditional downlink positioning reference signal assistance data according to the first embodiment of the present invention.
[0015] FIG. **2**E is a diagram illustrating system information acquisition procedure according to the first embodiment of the present invention.
[0016] FIG. **2**F is a diagram illustrating system information request procedure according to the first embodiment of the present invention.
[0017] FIG. **2**G is a diagram illustrating structures of an uplink MAC PDU including positioning measurement result in RRC_INACTIVE.
[0018] FIG. **2**H is a diagram illustrating structures of a first buffer status report MAC CE and a second buffer status MAC CE.
[0019] FIG. **3**A is a flow diagram illustrating an operation of a terminal and a base station and an LMF.
[0020] FIG. **3**B is a flow diagram illustrating terminal capability reporting procedure.
[0021] FIG. **3**C is a flow diagram illustrating assistance data delivery procedure.
[0022] FIG. **3**D is a flow diagram illustrating uplink positioning procedure of terminal in RRC_INACTIVE.
[0023] FIG. **3**E is a flow diagram illustrating downlink positioning procedure of terminal in RRC_INACTIVE.
[0024] FIG. **4** is a diagram illustrating operation of terminal according to the first embodiment of the present invention.
[0025] FIG. **5**A is a block diagram illustrating the internal structure of a UE to which the disclosure is applied.
[0026] FIG. **5**B is a block diagram illustrating the configuration of a base station according to the disclosure.
DETAILED DESCRIPTION
[0027] The following description with reference to the accompanying drawings is provided to

assist in a comprehensive understanding of various embodiments of the present disclosure as defined by the claims and their equivalents. It includes various specific details to assist in that understanding but these are to be regarded as merely exemplary. Accordingly, those of ordinary skill in the art will recognize that various changes and modifications of the various embodiments described herein can be made without departing from the scope and spirit of the present disclosure. In addition, descriptions of well-known functions and constructions may be omitted for clarity and conciseness.

[0028] The terms used, in the following description, for indicating access nodes, network entities, messages, interfaces between network entities, and diverse identity information is provided for convenience of explanation. Accordingly, the terms used in the following description are not limited to specific meanings but may be replaced by other terms equivalent in technical meanings.

[0029] In the following descriptions, the terms and definitions given in the 3GPP standards are used for convenience of explanation. However, the present disclosure is not limited by use of these terms and definitions and other arbitrary terms and definitions may be employed instead.

[0030] Table 1 lists the acronyms used throughout the present disclosure.

TABLE-US-00001 TABLE 1

Acronym	Full name	Acronym	Full name
5GC	5G Core Network	RACH	Random Access Channel
ACK	Acknowledgement	RAN	Radio Access Network
AM	Acknowledged Mode	RA-RNTI	Random Access RNTI
AMF	Access and Mobility Management Function	RAT	Radio Access Technology
ARQ	Automatic Repeat Request	RB	Radio Bearer
AS	Access Stratum	RLC	Radio Link Control
ASN.1	Abstract Syntax Notation One	RNA	RAN-based Notification Area
BSR	Buffer Status Report	RNAU	RAN-based Notification Area Update
BWP	Bandwidth Part	RNTI	Radio Network Temporary Identifier
CA	Carrier Aggregation	RRC	Radio Resource Control
CAG	Closed Access Group	RRM	Radio Resource Management
CG	Cell Group	RSRP	Reference Signal Received Power
C-RNTI	Cell RNTI	RSRQ	Reference Signal Received Quality
CSI	Channel State Information	RSSI	Received Signal Strength Indicator
DCI	Downlink Control Information	SCell	Secondary Cell
DRB	(user) Data Radio Bearer	SCS	Subcarrier Spacing
DRX	Discontinuous Reception	SDAP	Service Data Adaptation Protocol
HARQ	Hybrid Automatic Repeat Request	SDU	Service Data Unit
IE	Information element	SFN	System Frame Number
LCG	Logical Channel Group	S-GW	Serving Gateway
MAC	Medium Access Control	SI	System Information
MIB	Master Information Block	SIB	System Information Block
NAS	Non-Access Stratum	SpCell	Special Cell
NG-RAN	NG Radio Access Network	SRB	Signalling Radio Bearer
NR	NR Radio Access	SRS	Sounding Reference Signal
PBR	Prioritised Bit Rate	SSB	SS/PBCH block
PCell	Primary Cell	SSS	Secondary Synchronisation Signal
PCI	Physical Cell Identifier	SUL	Supplementary Uplink
PDCCH	Physical Downlink Control Channel	TM	Transparent Mode
PDCP	Packet Data Convergence Protocol	UCI	Uplink Control Information
PDSCH	Physical Downlink Shared Channel	UE	User Equipment
PDU	Protocol Data Unit	UM	Unacknowledged Mode
PHR	Power Headroom Report	CRP	Cell Reselection Priority
PLMN	Public Land Mobile Network	LPP	LTE positioning protocol
PRACH	Physical Random Access Channel	posSIB	positioning SIB
PRB	Physical Resource Block	posSI	positioning System Information
PSS	Primary Synchronisation Signal	TRP	Transmission-Reception Point
PUCCH	Physical Uplink Control Channel	DL-TDOA	Downlink Time Difference Of Arrival
PUSCH	Physical Uplink Shared Channel		

[0031] Table 2 lists the terminologies and their definition used throughout the present disclosure.

TABLE-US-00002 TABLE 2

Terminology	Definition
allowedCG-List	List of configured grants for the corresponding logical channel. This restriction applies only when the UL grant is a configured grant. If present, UL MAC SDUs from this logical channel can only be mapped to the indicated configured grant configuration. If the size of the sequence is zero, then UL MAC SDUs from this logical channel cannot be mapped to any configured grant configurations. If the field is not present, UL MAC SDUs from this logical channel can be mapped to any configured grant configurations.
allowedSCS-List	List of allowed sub-carrier spacings for the corresponding logical channel. If present, UL MAC SDUs from this logical channel can only be mapped to the indicated

numerology. Otherwise, UL MAC SDUs from this logical channel can be mapped to any configured numerology. allowedServingCells List of allowed serving cells for the corresponding logical channel. If present, UL MAC SDUs from this logical channel can only be mapped to the serving cells indicated in this list. Otherwise, UL MAC SDUs from this logical channel can be mapped to any configured serving cell of this cell group. Carrier frequency center frequency of the cell. Cell combination of downlink and optionally uplink resources. The linking between the carrier frequency of the downlink resources and the carrier frequency of the uplink resources is indicated in the system information transmitted on the downlink resources. Cell Group in dual connectivity, a group of serving cells associated with either the MeNB or the SeNB. Cell reselection A process to find a better suitable cell than the current serving cell based on the system information received in the current serving cell Cell selection A process to find a suitable cell either blindly or based on the stored information Dedicated signalling Signalling sent on DCCH logical channel between the network and a single UE. discardTimer Timer to control the discard of a PDCP SDU. Starting when the SDU arrives. Upon expiry, the SDU is discarded. F The Format field in MAC subheader indicates the size of the Length field. Field The individual contents of an information element are referred to as fields. Frequency layer set of cells with the same carrier frequency. Global cell identity An identity to uniquely identifying an NR cell. It is consisted of cellIdentity and plmn-Identity of the first PLMN-Identity in plmn- IdentityList in SIB1. gNB node providing NR user plane and control plane protocol terminations towards the UE, and connected via the NG interface to the 5GC. Handover procedure that changes the serving cell of a UE in RRC_CONNECTED. Information element A structural element containing single or multiple fields is referred as information element. L The Length field in MAC subheader indicates the length of the corresponding MAC SDU or of the corresponding MAC CE LCID 6 bit logical channel identity in MAC subheader to denote which logical channel traffic or which MAC CE is included in the MAC subPDU MAC-I Message Authentication Code - Integrity. 16 bit or 32 bit bit string calculated by NR Integrity Algorithm based on the security key and various fresh inputs Logical channel a logical path between a RLC entity and a MAC entity. There are multiple logical channel types depending on what type of information is transferred e.g. CCCH (Common Control Channel), DCCH (Dedicate Control Channel), DTCH (Dedicate Traffic Channel), PCCH (Paging Control Channel) LogicalChannelConfig The IE LogicalChannelConfig is used to configure the logical channel parameters. It includes priority, prioritisedBitRate, allowedServingCells, allowedSCS-List, maxPUSCH-Duration, logicalChannelGroup, allowedCG-List etc logicalChannelGroup ID of the logical channel group, as specified in TS 38.321, which the logical channel belongs to MAC CE Control Element generated by a MAC entity. Multiple types of MAC CEs are defined, each of which is indicated by corresponding LCID. A MAC CE and a corresponding MAC sub- header comprises MAC subPDU Master Cell Group in MR-DC, a group of serving cells associated with the Master Node, comprising of the SpCell (PCell) and optionally one or more SCells. maxPUSCH- Restriction on PUSCH-duration for the corresponding logical Duration channel. If present, UL MAC SDUs from this logical channel can only be transmitted using uplink grants that result in a PUSCH duration shorter than or equal to the duration indicated by this field. Otherwise, UL MAC SDUs from this logical channel can be transmitted using an uplink grant resulting in any PUSCH duration. NR NR radio access PCell SpCell of a master cell group. PDCP entity The process triggered upon upper layer request. It includes the reestablishment initialization of state variables, reset of header compression and manipulating of stored PDCP SDUs and PDCP PDUs. The details can be found in 5.1.2 of 38.323 PDCP suspend The process triggered upon upper layer request. When triggered, transmitting PDCP entity set TX_NEXT to the initial value and discard all stored PDCP PDUs. The receiving entity stop and reset t-Reordering, deliver all stored PDCP SDUs to the upper layer and set RX_NEXT and RX_DELIV to the initial value PDCP-config The IE PDCP-Config is used to set the configurable PDCP parameters for signalling and data radio bearers. For a data radio bearer, discardTimer, pdcp-SN-Size, header compression parameters, t-

Reordering and whether integrity protection is enabled are configured. For a signaling radio bearer, t-Reordering can be configured PLMN ID Check the process that checks whether a PLMN ID is the RPLMN identity or an EPLMN identity of the UE. Primary Cell The MCG cell, operating on the primary frequency, in which the UE either performs the initial connection establishment procedure or initiates the connection re-establishment procedure. Primary SCG Cell For dual connectivity operation, the SCG cell in which the UE performs random access when performing the Reconfiguration with Sync procedure. priority Logical channel priority, as specified in TS 38.321. an integer between 0 and 7. 0 means the highest priority and 7 means the lowest priority PUCCH SCell a Secondary Cell configured with PUCCH. Radio Bearer Logical path between a PDCP entity and upper layer (i.e. SDAP entity or RRC) RLC bearer RLC and MAC logical channel configuration of a radio bearer in one cell group. RLC bearer The lower layer part of the radio bearer configuration comprising configuration the RLC and logical channel configurations. RX_DELIV This state variable indicates the COUNT value of the first PDCP SDU not delivered to the upper layers, but still waited for. RX_NEXT This state variable indicates the COUNT value of the next PDCP SDU expected to be received. RX_REORD This state variable indicates the COUNT value following the COUNT value associated with the PDCP Data PDU which triggered t-Reordering. Serving Cell For a UE in RRC_CONNECTED not configured with CA/DC there is only one serving cell comprising of the primary cell. For a UE in RRC_CONNECTED configured with CA/DC the term 'serving cells' is used to denote the set of cells comprising of the Special Cell(s) and all secondary cells. SpCell primary cell of a master or secondary cell group. Special Cell For Dual Connectivity operation the term Special Cell refers to the PCell of the MCG or the PSCell of the SCG, otherwise the term Special Cell refers to the PCell. SRB Signalling Radio Bearers" (SRBs) are defined as Radio Bearers (RBs) that are used only for the transmission of RRC and NAS messages. SRB0 SRB0 is for RRC messages using the CCCH logical channel SRB1 SRB1 is for RRC messages (which may include a piggybacked NAS message) as well as for NAS messages prior to the establishment of SRB2, all using DCCH logical channel; SRB2 SRB2 is for NAS messages and for RRC messages which include logged measurement information, all using DCCH logical channel. SRB2 has a lower priority than SRB1 and may be configured by the network after AS security activation; SRB3 SRB3 is for specific RRC messages when UE is in (NG)EN-DC or NR-DC, all using DCCH logical channel SRB4 SRB4 is for RRC messages which include application layer measurement reporting information, all using DCCH logical channel. Suitable cell A cell on which a UE may camp. Following criteria apply The cell is part of either the selected PLMN or the registered PLMN or PLMN of the Equivalent PLMN list The cell is not barred The cell is part of at least one TA that is not part of the list of "Forbidden Tracking Areas for Roaming" (TS 22.011 [18]), which belongs to a PLMN that fulfils the first bullet above. The cell selection criterion S is fulfilled (i.e. RSRP and RSRQ are better than specific values

[0032] In the present invention, "trigger" or "triggered" and "initiate" or "initiated" may be used in the same meaning.

[0033] In the present invention, "radio bearers allowed for the second resume procedure", "radio bearers for which the second resume procedure is set", and "radio bearers for which the second resume procedure is enabled" may all have the same meaning.

[0034] FIG. **1**A is a diagram illustrating the architecture of an 5G system and a NG-RAN to which the disclosure may be applied.

[0035] 5G system consists of NG-RAN 1A-01 and 5GC 1A-02. An NG-RAN node is either: [0036] a gNB, providing NR user plane and control plane protocol terminations towards the UE; or [0037] an ng-eNB, providing E-UTRA user plane and control plane protocol terminations towards the UE.

[0038] The gNBs 1A-05 or 1A-06 and ng-eNBs 1A-03 or 1A-04 are interconnected with each other by means of the Xn interface. The gNBs and ng-eNBs are also connected by means of the NG interfaces to the 5GC, more specifically to the AMF Access and Mobility Management Function) and to the UPF (User Plane Function). AMF 1A-07 and UPF 1A-08 may be realized as a physical

node or as separate physical nodes.

[0039] A gNB 1A-05 or 1A-06 or an ng-eNBs 1A-03 or 1A-04 hosts the functions listed below.

[0040] Functions for Radio Resource Management such as Radio Bearer Control, Radio Admission Control, Connection Mobility Control, Dynamic allocation of resources to UEs in uplink, downlink and sidelink (scheduling); and

[0041] IP and Ethernet header compression, uplink data decompression and encryption of user data stream; and

[0042] Selection of an AMF at UE attachment when no routing to an MME can be determined from the information provided by the UE; and

[0043] Routing of User Plane data towards UPF; and

[0044] Scheduling and transmission of paging messages; and

[0045] Scheduling and transmission of broadcast information (originated from the AMF or O&M); and

[0046] Measurement and measurement reporting configuration for mobility and scheduling; and

[0047] Session Management; and

[0048] QOS Flow management and mapping to data radio bearers; and

[0049] Support of UEs in RRC_INACTIVE state; and

[0050] Radio access network sharing; and

[0051] Tight interworking between NR and E-UTRA; and

[0052] Support of Network Slicing.

[0053] The AMF 1A-07 hosts the functions such as NAS signaling, NAS signaling security, AS security control, SMF selection, Authentication, Mobility management and positioning management.

[0054] The UPF 1A-08 hosts the functions such as packet routing and forwarding, transport level packet marking in the uplink, QoS handling and the downlink, mobility anchoring for mobility etc.

[0055] FIG. **1**B is a diagram illustrating a wireless protocol architecture in an 5G system to which the disclosure may be applied.

[0056] User plane protocol stack consists of SDAP 1B-01 or 1B-02, PDCP 1B-03 or 1B-04, RLC 1B-05 or 1B-06, MAC 1B-07 or 1B-08 and PHY 1B-09 or 1B-10. Control plane protocol stack consists of NAS 1B-11 or 1B-15, RRC 1B-13 or 1B-14, PDCP, RLC, MAC and PHY.

[0057] Each protocol sublayer performs functions related to the operations listed in the table 3. TABLE-US-00003 TABLE 3 Sub- layer Functions NAS authentication, mobility management, security control etc RRC System Information, Paging, Establishment, maintenance and release of an RRC connection, Security functions, Establishment, configuration, maintenance and release of Signalling Radio Bearers (SRBs) and Data Radio Bearers (DRBs), Mobility, QoS management, Detection of and recovery from radio link failure, NAS message transfer etc. SDAP Mapping between a QoS flow and a data radio bearer, Marking QoS flow ID (QFI) in both DL and UL packets. PDCP Transfer of data, Header compression and decompression, Ciphering and deciphering, Integrity protection and integrity verification, Duplication, Reordering and in-order delivery, Out-of-order delivery etc. RLC Transfer of upper layer PDUs, Error Correction through ARQ, Segmentation and re-segmentation of RLC SDUs, Reassembly of SDU, RLC re-establishment etc. MAC Mapping between logical channels and transport channels, Multiplexing/demultiplexing of MAC SDUs belonging to one or different logical channels into/from transport blocks (TB) delivered to/from the physical layer on transport channels, Scheduling information reporting, Priority handling between UEs, Priority handling between logical channels of one UE etc. PHY Channel coding, Physical-layer hybrid-ARQ processing, Rate matching, Scrambling, Modulation, Layer mapping, Downlink Control Information, Uplink Control Information etc.

[0058] FIG. **1**C is a diagram illustrating a structure of a positioning system according to an embodiment of the present disclosure.

[0059] The terminal 1C-03 is connected to the LMF 1C-33 through the gNB 1C-13 and the AMF 1C-23. Hereinafter, gNB is also referred to as a base station, AMF as an access mobility function, and LMF as a location management function.

[0060] The base station provides the TRP function. AMF stores the capability of the terminal related to location confirmation and relays the signaling between the location management function and the terminal. AMF may be connected to several base stations. One AMF can be connected to several LMFs. The AMF may initially select the LMF for any terminal. The AMF may select another LMF when the terminal moves to a new cell.

[0061] The LMF manages the support of different location services for target UEs, including positioning of UEs and delivery of assistance data to UEs.

[0062] The LMF may interact with a target UE in order to deliver assistance data if requested for a particular location service, or to obtain a location estimate if that was requested.

[0063] For positioning of a target UE, the LMF decides on the position methods to be used

[0064] The positioning methods may yield a location estimate for UE-based position methods and/or positioning measurements for UE-assisted and network-based position methods. The LMF may combine all the received results and determine a single location estimate for the target UE (hybrid positioning). Additional information like accuracy of the location estimate and velocity may also be determined.

[0065] FIG. **1**D is a diagram illustrating a protocol hierarchical structure for signaling between a location management function and a terminal according to an embodiment of the present disclosure.

[0066] The terminal and LMF exchange signaling through LPP 1D-03. LPP defines various control messages related to positioning. The LPP control message is included in the NAS 1D-13 message and delivered to the AMF, and the AMF delivers the LPP control message included in the NAS message to the LMF.

[0067] LPP is a protocol applied to both LTE and NR. Hereinafter, LPP is also called positioning protocol.

[0068] FIG. **2**A shows the types of positioning method.

[0069] The positioning methods are GNSS positioning 2A-01, OTDOA positioning 2A-05, Barometric pressure sensor positioning 2A-03, DL-AoD positioning 2A-07, DL-TDOA positioning 2A-09, UL-TDOA positioning 2A-11, etc.

[0070] GNSS positioning and barometric pressure sensor positioning are positioning methods independent of radio access technology, OTDOA positioning is a positioning method using an LTE downlink signal, and DL-AoD positioning and DL-TDOA positioning are positioning methods using a specific NR downlink signal. The specific NR downlink signal is a positioning reference signal (PRS). UL-TDOA positioning is a positioning method using a specific NR uplink signal. The specific NR uplink signal is a sounding reference signal (SRS).

[0071] FIG. **2**B is a diagram illustrating positioning assistance data.

[0072] Assistance data may be transmitted to the positioning device so that each positioning can be performed more quickly and accurately. The assistance data may be provided through system information or transmitted through an LPP message. The positioning device may be a terminal or a base station.

[0073] Assistance data is transmitted while being included in assistanceDataElement (assitanceDataElement). One assitanceDataElement contains specific information related to a specific positioning method. For example, GNSS-ReferenceTime assitanceDataElement includes reference time information of GNSS and is transmitted through the positioning SIB called posSibType1-1 or delivered to the terminal through the LPP control message called ProvideAssistanceData. When provided through the positioning SIB, assitanceDataElement is mapped to a specific positioning SIB type. GNSS-related assitanceDataElements 2B-01 to 2B-03 are mapped to positioning SIB type 1 and positioning SIB type 2. OTDOA-related

assitanceDataElement 2B-05 is mapped to positioning SIB type 3, barometric pressure sensor positioning-related assistanceDataElement 2B-07 is mapped to positioning SIB type 4, and DL-AoD and DL-TDOA-related assistanceDataElement 2B-11 are mapped with positioning SIB type 6. Most of the assistanceDataElements are immediately applicable upon receipt. However, specific information, such as PRS-related assistance data, can be divided into those that are immediately applicable and those that are applicable when a predetermined condition is met that are transmitted through the SIB. For example, NR-DL-PRS-AssistanceData 2B-13 includes assistance data that is applied immediately, and NR-DL-PRS-ConditionalAssistanceData 2B-15 includes assistance data that is applied when a predetermined condition is satisfied or is selectively applied.

[0074] Assistance data immediately applicable is called type 1 assistance data, and assistance data applicable when predetermined conditions are met is called type 2 assistance data.

[0075] FIG. **2**C is a diagram illustrating the structure of NR-DL-PRS-AssistanceData.

[0076] Definitions of each type of IEs used in FIG. **2**C follow specification 37.355, unless otherwise defined.

[0077] NR-DL-PRS-AssistanceData provides information on PRS as assistance data for DL-TDOA or DL-AOD. NR-DL-PRS-AssistanceData is provided to the terminal through positioning SIB type 6-1 or through ProvideAssistanceData.

[0078] One NR-DL-PRS-AssistanceData 2C-01 is composed of one nr-DL-PRS-ReferenceInfo 2C-03 and one nr-DL-PRS-AssistanceDataList 2C-05.

[0079] The nr-DL-PRS-ReferenceInfo 2C-03 provides information on the identifier and frequency of the TRP that provides a reference for nr-DL-PRS-SFNO-Offset or dl-PRS-ResourceSlotOffset, etc.

[0080] The nr-DL-PRS-AssistanceDataList2C-05 is composed of a plurality of NR-DL-PRS-AssistanceDataPerFreq2C-07. One NR-DL-PRS-AssistanceDataPerFreq 2C-07 provides information on PRS provided at a specific frequency, and is composed of nr-DL-PRS-PositioningFrequencyLayer 2C-09 and nr-DL-PRS-AssistanceDataPerFreq 2C-11. NR-DL-PRS-AssistanceDataPerFreq2C-07 and nr-DL-PRS-AssistanceDataPerFreq 2C-11 are different IEs.

[0081] The nr-DL-PRS-AssistanceDataPerFreq 2C-11 is composed of a plurality of NR-DL-PRS-AssistanceDataPerTRP 2C-13. The nr-DL-PRS-PositioningFrequencyLayer 2C-09 is common information applied to a plurality of NR-DL-PRS-AssistanceDataPerTRP 2C-13. This is composed of information such as the subcarrier interval, the bandwidth of the PRS resource, the PRB from which the PRS resource starts. One NR-DL-PRS-AssistanceDataPerTRP 2C-13 provides information on PRS provided by a specific TRP. TRP may be a cell.

[0082] NR-DL-PRS-AssistanceDataPerTRP 2C-13 consists of information commonly applied to multiple nr-DL-PRS-ResourceSet 2C-17 and multiple nr-DL-PRS-ResourceSet 2C-17. The. Information commonly applied to the plurality of nr-DL-PRS-ResourceSets 2C-17 includes dl-PRS-ID, a cell identifier corresponding to the TRP and the time offset of the SFN #0 slot #0 for the given TRP with respect to SFN #0 slot #0 of the assistance data reference.

[0083] One nr-DL-PRS-ResourceSet 2C-17 consists of one dl-PRS-ResourceList 2C-19, and dl-PRS-ResourceList 2C-19 consists of a plurality of dl-PRS-Resources.

[0084] One dl-PRS-Resource has an identifier, code sequence information applied to the corresponding PRS, and the starting slot of the DL-PRS Resource with respect to the corresponding DL-PRS-Resource Set Slot Offset and QCL information (beam information) of the corresponding PRS.

[0085] The PRS-ResourceSet is composed of a plurality of PRSs using the same frequency resource, and is a set of PRS resources grouped for beam sweeping.

[0086] Consequently, one nr-DL-PRS-AssistanceDataList 2C-05 includes assistance data for a plurality of frequencies. The assistance data for each frequency includes assistance data for a plurality of TRPs. The assistance data for each TRP may provide information on a plurality of DL-PRS-ResourceSets. One DL-PRS-ResourceSet is composed of a plurality of DL-PRS-Resources.

The terminal may perform positioning measurement by measuring the plurality of DL-PRS-Resources indicated in the nr-DL-PRS-AssistanceDataList 2C-05.

[0087] NR-DL-PRS-AssistanceData is assistance data that is applied immediately. DL-PRS included in NR-DL-PRS-AssistanceData are continuously transmitted from the time point when the terminal receives NR-DL-PRS-AssistanceData until the terminal stops measuring positioning using DL-PRS, and the terminal immediately use the immediately applied assistance data when positioning measurement using the assistance data is necessary.

[0088] FIG. **2**D is a diagram illustrating the structure of PRS-ConditionalAssistanceData.

[0089] The PRS-ConditionalAssistanceDataSet (hereinafter, conditional assistance data set) 2D-01 is composed of a PRS-ConditionalAssistanceDataList 2D-03 including a plurality of PRS-ConditioanlAssistanceData 2D-05 (hereinafter, conditional assistance data). Each conditional assistance data 2D-05 includes PRS-AssistanceData 2D-13 (hereinafter, assistance data) that is currently being transmitted or that can be started when a terminal requests it.

[0090] The conditional assistance data set includes type 2 assistance data and is provided to the terminal through positioning SIB type 6-4 or through ProvideAssistanceData. Positioning SIB type 6-1 includes only one type 1 assistance data 2C-01, and positioning SIB type 6-4 includes one or more type 2 assistance data 2D-13.

[0091] conditional assistance data 2D-05 is composed of PRS-ConditionalAssistanceDataId 2D-07 (hereinafter assistance data id), PRS-ConditionalAssistanceDataStatus 2D-09 (hereinafter assistance data status), PRS-ConditionalAssistanceDataValidity 2D-11 (assistance data validity), ReportConfig (hereinafter, Report Configuration), and PRS-AssistanceData 2D-13 (hereinafter, assistance data).

[0092] The assistance data id 2D-07 is an identifier of the related conditional assistance data 2D-05 or the related assistance data 2D-13 and is an integer between 0 and 15.

[0093] The assistance data status 2D-09 is 1-bit information indicating whether the related assistance data 2D-13 is being transmitted (or provided). The fact that the assistance data 2D-13 is being transmitted means that the PRSs specified in the assistance data 2D-13 are currently being transmitted. If the assistance data status related to the assistance data exists (or the assistance data status is set to the first value), the terminal determines that the PRSs specified in the assistance data are currently being transmitted and performs the necessary operation. If the assistance data status related to the assistance data does not exist (or if the assistance data status is set to the second value), the terminal determines that the PRSs specified in the assistance data are not currently being transmitted. The terminal if necessary, requests the LMF to start transmission of the PRS

[0094] The assistance data validity 2D-11 indicates under what conditions the relevant conditional assistance data 2D-05 or the relevant assistance data 2D-13 are valid. Alternatively the assistance data validity indicates which conditions to be fulfilled for UE to initiate measurement on the relevant PRS and to report measurement results. The assistance data validity 2D-11 may include an NR CGI (Cell Global Idnetifier) List or time interval information. The time interval information is composed of the first time point and the second time point. In the terminal, if the NR CGI of the current cell belongs to the NR CGI List, and the current time expressed in UTC (Universal Coordinate Time) belongs to the time interval information expressed in the first time point and the second time point, the related conditional assistance data 2D-05 or related assistance data 2D-13 is considered valid. If the assistance data status 2D-09 of the conditional assistance data 2D-05 determined to be valid is set to 'available', 'transmit' or 'broadcast', the terminal performs positioning measurement for the related PRS and report measurement results to the LMF. If the assistance data status 2D-09 of the conditional assistance data 2D-05 determined to be valid is set to 'unavailable', 'not transmitted', or 'non-broadcast', the terminal requests LMF to activate the conditional assistance data 2D-05. Activation of the conditional assistance data means that the PRSs specified in the conditional assistance data are transmitted.

[0095] The conditional assistance data set 2D-01 may be provided through a positioning SIB or

may be provided through an LPP control message. The assistance data status 2D-09 is included only in the conditional assistance data set 2D-01 provided through the positioning SIB, and the assistance data validity is included only in the conditional assistance data set provided through the LPP control message. Alternatively, assistance data status is used only for type 2 assistance data provided through positioning SIB, and assistance data validity is used only for type 2 assistance data provided through assistanceDataProvide.

[0096] ReportConfig 2D-12 (hereinafter Report Configuration) is parameters related to positioning measurement result reporting and consists of maxDL-PRS-RSTD-MeasurementsPerTRPPair and timingReportingGranularityFactor. maxDL-PRS-RSTD-MeasurementsPerTRPPair indicates the maximum number of. DL-PRS RSTD measurements for downlink PRS RSTD (Reference Signal Time Difference). timingReportingGranularityFactor indicates recommended reporting granularity for the DL RSTD measurements.

[0097] The terminal reports the measurement result according to the above ReportConfig when the validity condition of the conditional assistance data is met.

[0098] The assistance data 2D-13 of the conditional assistance data 2D-05 is an IE having the same structure as the PRS-AssistanceData 2C-01.

[0099] The conditional assistance data is classified into conditional assistance data**1** received through the positioning SIB and conditional assistance data**2** received through the LPP control message. The assistance data status IE is essentially present in conditional assistance data**1**, but the assistance data status IE does not exist in conditional assistance data**2**. In conditional assistance data**2**, assistance data validity exists, but in conditional assistance data**1**, data validity condition does not exist.

[0100] The purpose of conditional assistance data**1** is to inform the terminal of PRSs in which transmission can be activated in the corresponding cell. The terminal may determine the PRSs required for its own positioning measurement among the PRSs indicated in conditional assistance data**1**, and may request the LMF to activate the corresponding conditional assistance data.

[0101] The purpose of conditional assistance data**2** is to inform the terminal of PRSs to be measured when a predetermined condition is met. The terminal may measure the PRSs that satisfy the condition among the PRSs specified in conditional assistance data**2** and report the results to the LMF.

[0102] FIG. **2**E is a diagram illustrating a system information acquisition process.

[0103] System Information Block (hereinafter referred to as SIB) includes general SIB and positioning SIB. Types of general SIB include SIB**1**, SIB**2**, SIB**3**, SIB**4**, SIB**5**, SIB**6**, SIB**7**, SIB**8**, and SIB**9**. SIB**1** includes information related to scheduling of other system information and radio resource configuration information commonly applied to all terminals. SIB**2** includes cell reselection information. SIB**3** includes information about neighboring cells for intra-frequency cell resection. SIB**4** includes information for inter-frequency cell resection. SIB**5** includes E-UTRA frequency information and the like for inter-RAT cell reselection. SIB**6** includes ETWS (Earthquake Tsunami Warning System) main notification. SIB**7** includes the ETWS sub-notification. SIB**8** contains CMAS notifications. SIB**9** includes information related to GPS time and Coordinated Universal Time (UTC).

[0104] The assistance data mapped with the type of positioning SIB is as shown in FIG. **2**B

[0105] One or a plurality of SIBs having the same transmission period are included in one system information (System Information, SI) and transmitted. scheduling information of SI related to general SIB is indicated in SI scheduling Information. The scheduling information of the SI related to the positioning SIB is indicated in the positioning SI scheduling Information. SI scheduling Information and positioning SI scheduling Information are included in SIB**1**.

[0106] The SI scheduling Information includes one or more scheduling information and one SI window length. The scheduling information consists of SI broadcast status, SI periodicity, and SIB mapping information. SI broadcast status indicates whether the corresponding SI message is being

broadcast. SI periodicity is the period of the corresponding SI message. The SI window length is the length of the SI scheduling window. The SIB mapping information consists of one or a plurality of SIB type information. The SIB type information includes type information indicating one of sibType2, sibType3, sibType4, sibType5, sibType6, sibType7, sibType8, sibType9, sibType10, sibType11, sibType12, sibType13, and sibType14, and a value tag indicating one of integers between 0 and 31.

[0107] The positioning SI scheduling Information is composed of one or more positioning scheduling information and the like. The positioning scheduling information consists of positioning SI broadcast status, positioning SI periodicity, and positioning SIB mapping information. The positioning SI broadcast status indicates whether the corresponding positioning SI message is being broadcast. The positioning SI periodicity is the period of the positioning SI message. The positioning SIB mapping information consists of one or a plurality of positioning SIB type information. positioning SIB type information consist of a type information indicating one of posSibType1-1, posSibType1-2, posSibType1-3, posSibType1-4, posSibType1-5, posSibType1-6, posSibType1-7, posSibType1-8, posSibType2-1, posSibType2-2, posSibType2-3, posSibType2-4, posSibType2-5, posSibType2-6, posSibType2-7, posSibType2-8, posSibType2-9, posSibType2-10, posSibType2-11, posSibType2-12, posSibType2-13, posSibType2-14, posSibType2-15, posSibType2, posSibType2-17, posSibType2-18, posSibType2-19, posSibType2-20, posSibType2-21, posSibType2-22, posSibType2-23, posSibType3-1, posSibType4-1, posSibType5-1, posSibType6-1, posSibType6-2, posSibType6-2, posSibType6-3 and posSibType6-4.

[0108] In step **2E**-**11**, the terminal **2E**-**01** receives SIB**1** from the base station **2E**-**03**.

[0109] SI scheduling Information of SIB**1** is set as in **2E**-**13**. The positioning SI scheduling Information of SIB **1** is set as in **2E**-**15**.

[0110] SI with SI broadcast status set to being broadcast and positioning SI with positioning SI broadcast status set to being broadcast are transmitted according to the order included in SI scheduling Information and positioning SI scheduling Information.

[0111] For example, it is transmitted in the order of the first SI, the second SI, and the first positioning SI.

[0112] SI and positioning SI are transmitted within the SI scheduling window and the positioning SI scheduling window. The length of the SI scheduling window and the length of the positioning SI scheduling window are determined by the SI window length of SI scheduling Information.

[0113] In step **2E**-**17**, the terminal receives the first SI in the SI scheduling window for the first SI. The first SI contains only SIB**2** as shown in **2E**-**13**. As shown in **2E**-**19**, the first SI includes one IE called sib-TypeAndInfo, and sib-TypeAndInfo includes SIB**2**.

[0114] In step **2E**-**21**, the terminal receives the second SI in the SI scheduling window for the second SI. The second SI denotes SIB**3** and SIB**4** as shown in **2E**-**13**. As shown in **2E**-**23**, the second SI includes two sib-TypeAndInfo IEs, the first sib-TypeAndInfo includes SIB**3**, and the second sib-TypeAndInfo includes SIB**4**.

[0115] In step **2E**-**25**, the terminal receives the first positioning SI in the positioning SI scheduling window for the first positioning SI. The first positioning SI includes positioning SIB **6-1** and positioning SIB **6-2** as shown in **2E**-**15**. As shown in **2E**-**27**, the first positioning SI includes two posSIB-TypeAndInfo IEs, the first posSIB-TypeAndInfo includes positioning SIB**6-1**, and the second posSIB-TypeAndInfo includes positioning SIB**6-2**.

[0116] As shown in **2E**-**29**, one positioning SIB is composed of value tag**2**, expiration time, and assistanceDataElement. value tag**2** indicates one of integers between 0 and 63 and indicates whether broadcast assistance data has been changed. value tag**2** is set by LMF. The expiration time indicates the time point at which the contents of the broadcast assistance data expire in UTC. assistanceDataElement is a field containing actual assistance data.

[0117] General SIB indicates one of the integers between 0 and 31, and the change is indicated by the value tag set by the base station. The positioning SIB indicates one of the integers between 0

and 63 and value tag**2** set by the LMF. indicates whether the change has been made or not. Value tag is included in SIB**1** and broadcast, and value tag**2** is included in positioning SI and broadcast.

[0118] As shown in **2E-15**, the second positioning scheduling information is not broadcast. The terminal performs a system information request procedure to receive non-broadcast positioning scheduling information.

[0119] The terminal should always store valid system information. The terminal maintains the validity of the system information by reacquiring the system information when a predetermined event occurs.

[0120] When the short message included in the DCI addressed to the P-RNTI indicates systemInfoModification, the terminal receives SIB**1**, determines the first type SIBs in which the value tag is changed, and receive the first type SIBs in which the value tag is changed and store it. The terminal receives and stores positioning SIs including the second type SIB again without considering the value tag. First type SIB is a general SIB, and second type SIB is a positioning SIB.

[0121] When 3 hours have elapsed since the terminal successfully received the first type SIB, the terminal discards the first type SIB and initiates a procedure for acquiring the SI including the first type SIB.

[0122] When the terminal successfully receives the second type SIB, it stores the second type SIB. Then, in a systemInfoModification period starting just before the expiration time of the second type SIB, terminal starts a procedure for acquiring the SI including the second type.

[0123] The systemInfoModification period is a time interval that occurs sequentially. During one systemInfoModification period, system information cannot be changed. When it is necessary to change the system information, the base station transmits new system information from the time point at which the next systemInfoModification period starts.

[0124] FIG. **2**F is a diagram illustrating a system information request procedure.

[0125] The terminal can request system information that is not broadcast by using the RRC control message. The RRC_IDLE terminal or RRC_INACTIVE terminal transmits positioning system information request**1**, and the terminal in RRC_CONNECTED state transmits positioning system information request**2**.

[0126] In step **2F-11**, the RRC_IDLE terminal or RRC_INACTIVE terminal transmits positioning system information request**1**, which is an RRC control message for requesting positioning system information, to the base station. The positioning system information request**1** includes the requested positioning SI list. The requested positioning SI list is a list of SI messages requested by the terminal to be provided to the base station. The requested SI list is a 32-bit bitmap. Each bit of the requested positioning SI list corresponds to each entry according to the order of the entries included in the positioning SI scheduling Information. For example, the first bit corresponds to the first positioning SI of the positioning SI scheduling information.

[0127] In step **2F-13**, the RRC_CONNECTED terminal transmits positioning system information request**2**, which is an RRC control message for requesting positioning system information, to the base station. The positioning system information request**2** includes the requested positioning SIB list. The requested positioning SIB list is a list of positioning SIBs requested by the terminal to be provided to the base station, and includes a plurality of positioning SIB type information. The positioning SIB type information indicates the type of positioning SIB requested by the terminal.

[0128] In step **2F-15**, the terminal that has transmitted the positioning system information request**1** or positioning system information request**2** receives SIB**1** from the base station. The terminal checks whether the requested positioning SI or SI including the positioning SIB is broadcast.

[0129] In step **2F-17**, the terminal receives the positioning SI requested by the terminal or the positioning SI including the positioning SIB requested by the terminal.

[0130] Positioning system information request**1** is transmitted via SRB**0** and CCCH. The positioning system information request**2** is transmitted via SRB**1** and DCCH. Since the size of the control message transmitted through the CCCH is limited, positioning system information request**1**

reduces the size of transmitted information by indicating the requested SI type information in a bitmap format instead of directly indicating it. On the other hand, since a relatively large message can be transmitted through the DCCH, the positioning system information request **2** directly indicates the requested positioning SIB.

[0131] FIG. **2**G is a diagram illustrating the structure of an uplink MAC PDU including an inactive positioning measurement result.

[0132] The uplink MAC PDU including the inactive positioning measurement result consists of three MAC subPDUs. The MAC SDU (the first SDU) **2G-15** including the ResumeRequest message belonging to SRB**0** is located at the front of the MAC PDU **2G-11**, and the MAC SDU (the second SDU) including the LPP segment message belonging to SRB**2** (the second SDU) **2G-19** is located next. The first BSR **2G-27** is located at the rearmost part. That is, the first MAC subPDU including SRB**0** data, the second MAC subPDU including SRB**2** data, and the third MAC subPDU including the first BSR are included in the order. The MAC sub-header of the first MAC subPDU and the third MAC subPDU consists of two reserved bits and an LCID field. The MAC sub-header of the second MAC subPDU consists of one reserved bit, an F field, an LCID field, and an L field. This is so that the base station receiving the MAC PDU processes the ResumeRequest first, so that the MAC PDU is recognized as a MAC PDU related to the small data transfer procedure as quickly as possible. The remaining part **2G-15** excluding the MAC sub-header in the first MAC subPDU and the remaining part **2G-27** excluding the MAC sub-header in the third MAC subPDU are plain text that is not ciphered. In the second MAC subPDU, the remaining part **2G-19** except for the MAC sub-header includes data ciphered with a predetermined security key. The MAC sub-header is not ciphered. The reason for locating the MAC subPDUs as described above is that the first MAC subPDU and the second MAC subPDU include data processed by RRC, and the third MAC subPDU includes data processed by MAC, so it is to facilitate the processing operation of the terminal by locating the unciphered data first and locating the ciphered data later.

[0133] FIG. **2**H is a diagram illustrating the structure of a buffer status report MAC CE.

[0134] The first BSR MAC CE consists of one logical channel group identifier field **2H-01** and one first buffer size field **2H-03**. The logical channel group identifier field **2H-01** has a 3-bit size and indicates one of the logical channel group identifiers between 0 and 7. The first buffer size field **2H-03** has a size of 5 bits and indicates one of the first buffer size indexes from 0 to 31. The first buffer size index 0 means that there is no data available for transmission in logical channels belonging to the corresponding logical channel group. The first buffer size index 31 means that the amount of data for transmission of the logical channels belonging to the corresponding logical channel group is greater than the 30th first buffer size. The first buffer size index 1 means that the amount of data for transmission of logical channels belonging to the corresponding logical channel group is greater than 0 and less than or equal to the first buffer size. The first buffer size index n ($2<=n<=30$) indicates that the amount of data for transmission of the logical channels belonging to the corresponding logical channel group is greater than the n−1st buffer size and less than or equal to the nth first buffer size. The 30 first buffer sizes are defined in the standard.

[0135] The second BSR MAC CE consists of 8 LCGi bits **2H-11** and a plurality of the second buffer size fields **2H-13**. The LCGi bit indicates whether the second buffer size field for logical channel group i exists. For example, it indicates whether the second buffer size field for LCG**1** logical channel group 1 exists. If this field is 1, the second buffer size field for the corresponding LCG exists. The second buffer size field has an 8-bit size and indicates one of the second buffer size indexes between 0 and 255. The second buffer size index 0 means that there is no data available for transmission in logical channels belonging to the corresponding logical channel group. The second buffer size index 254 means that the amount of data for transmission of the logical channels belonging to the corresponding logical channel group is greater than the size of the 253-th second buffer size. The second buffer size index 1 means that the amount of data for transmission of the logical channels belonging to the corresponding logical channel group is greater

than 0 and less than or equal to the first second buffer size. The second buffer size index n (2<=n<=253) indicates that the amount of data for transmission of the logical channels belonging to the corresponding logical channel group is greater than the (n−1).sup.th buffer size and less than or equal to the n.sup.th buffer size. The second buffer size index 255 is not used. The 252 second buffer sizes are defined in the specification.

[0136] The first BSR MAC CE is referred to as a BSR to which the first format is applied or the first format BSR. The second BSR MAC CE is referred to as a BSR to which the second format is applied or the second format BSR.

[0137] Logical channel group is configured when logical channel is configured. A logical channel and a logical channel group are configured with an RRC control message.

[0138] In general, a buffer size index reflecting the amount of data available for transmission of the RLC layer and the amount of data available for transmission of the PDCP layer is set in buffer size field.

[0139] FIG. **3**A is a diagram illustrating the overall operation of a terminal, a base station, and an LMF.

[0140] In step **3**A-**11**, the terminal selects a NR cell and camps on it. The terminal may select an NR cell in which downlink reference signal received power and downlink reference signal received quality exceed a predetermined threshold. The terminal does not consider neighboring cell information included in the System Information Block in cell selection. In step **3**A-**13**, the terminal receives system information from the base station in the selected NR cell. The terminal receives the MIB first, and receives SIB**1** based on the information of the MIB. The terminal receives the remaining system information by referring to the scheduling information of SIB**1**.

[0141] In steps **3**A-**15**, the terminal establishes an RRC connection with the base station. The terminal and the base station exchange RRCRequest messages, RRCSetup messages, and RRCSetupComplete messages through the random access process. When the terminal receives the RRCSetup message from the base station, the RRC connection is established. A terminal that has established an RRC connection may perform a positioning preparation procedure and a positioning execution procedure with a base station or LMF.

[0142] The positioning preparation procedure consists of a UE capability reporting phase **3**A-**17** and an assistance data delivery phase **3**A-**19**. The positioning execution procedure **3**A-**21**, **3**A-**23** consists of a terminal and a base station performing positioning measurement using an uplink signal and a downlink signal and reporting it to the LMF. The UE capability reporting phase is performed only in the RRC connected state, but the assistance data delivery phase and the positioning execution procedure may be performed not only in the RRC connected state but also in the RRC inactive state.

[0143] When the terminal receives assistance data and report configuration from the base station or the LMF, it measures for positioning based on the assistance data, and reports the measurement result to the LMF based on the report configuration. The terminal may receive the first type assistance data in assistanceDataProvide and may receive Report Configuration in positioningDataRequest. Upon receiving the positioningDataRequest, the terminal performs positioning measurement based on the assistance data of the first type assistance data of assistanceDataProvide and reports the measurement result to the LMF based on the Report Configuration of positioningDataRequest. The terminal can receive the second type assistance data including Report Configuration and assistance data validity in one assistanceDataProvide. When the validity of the assistance data is satisfied, the terminal performs the measurement for positioning based on the second type assistance data of the assistanceDataProvide and reports the measurement result to the LMF based on the Report Configuration of the same assistanceDataProvide.

[0144] FIG. **3**B is a diagram illustrating a terminal capability reporting procedure.

[0145] In step **3**B-**11**, the first base station **3**A-**03** instructs capability reporting by transmitting a

UECapabilityEnquiry RRC message to the terminal **3A**-**01**.

[0146] In step reports the capability by sending a UECapabilityInformation RRC message to the first base station. UECapabilityInformation includes the first capability information and the third capability information. The base station may determine the positioning measurement configuration for the terminal by referring to the first capability information and the third capability information.

[0147] In step **3B**-**15**, the first base station delivers the first capability information and the third capability information to the AMF **3A**-**04**, and in step **3B**-**17**, the AMF stores the first capability information and the third capability information for future use.

[0148] In step **3B**-**21**, the first LMF **3A**-**05** instructs capability reporting by sending an LMF message called requestCapabilities to the terminal. The message includes information indicating for which positioning method the terminal should report capability.

[0149] In step **3B**-**23**, the terminal reports the capability by sending the LMF message provideCapabilities to the first LMF. provideCapabilities includes the second capability information and the third capability information. The first LMF refers to the second capability information and the third capability information to instruct positioning measurement for the terminal and provides assistance data required by the terminal.

[0150] In step **3B**-**25**, the first LMF transfers the second capability information and the third capability information to the AMF, and in step **3B**-**27**, the AMF stores the second capability information and the third capability information for future use.

[0151] At future, the terminal establishes an RRC connection at the second base station **3A**-**07**. When the location service for the terminal is started, the AMF provides the first capability information and the third capability information to the second base station in step **3B**-**31**, instead of the base station and the LMF directly acquiring the relevant capability information to the terminal, and in step **3B**-**33**, the AMF provides the stored second capability information and the third capability information to the second LMF.

[0152] The first capability information is capability information that the terminal reports to the base station through the RRC control message. It is capability information that LMF does not require only base station requires. The following IEs are applicable. The first capability information is information necessary for the base station to establish positioning measurement and is information about capability closely related to the radio interface.

[0153] The first capability information**1**: it indicates whether the UE supports parallel transmission of SRS and PUCCH/PUSCH

[0154] The first capability information**2**: Information indicating whether the terminal supports SRS for positioning in the connected state (indicating support of SRS for positioning in RRC_CONNECTED) it is defined for each band of the band combination (or defined within the band combination) It is reported as part of the band combination specific capability information. The terminal reports band specific capability information for each band it supports. The terminal reports band combination specific capability information that is valid only for the band combination within the band combination for each band combination supported by the terminal. Whether the connection state positioning SRS is supported is indicated for each band in the band combination. For example, if the terminal supports band A, band B, and band combination [A, B], the terminal reports to the base station band A specific capability information applied to band A and band B specific capability information applied to band B and band A capability information in the band combination [A,B] and band B capability information in the band combination [A,B]. Terminal reports as band capability information of the band combination whether positioning SRS is supported in connected mode

[0155] The first capability information**3**: it indicates the maximum number of configured pathloss reference RSs for PUSCH/PUCCH/SRS for pathloss reference RS update.

[0156] The first capability information**4**: it indicates measurement gap pattern(s) optionally supported by the UE for PRS measurement.

[0157] The first capability information**5**: it indicates support of small data transfer via SRB**2**.

[0158] The second capability information is capability information that the terminal reports to the LMF through the LPP control message. It is the capability information that LMF needs and base station does not need. The following IEs are applicable. The second capability information is information required for the LMF to establish positioning measurement and positioning report. It is information on capability closely related to the positioning function.

[0159] The second capability information**1**: It indicate several positioning modes using a bit map. positioning mode information indicates a mode supported by the UE among UE-assisted and LMF-based mode, LMF-based mode, LMF-assisted and UE based mode, UE based mode and UE standalone mode.

[0160] The second capability information**2**: It indicates the target device's LPP message segmentation capabilities. If bit**0** is 1, it indicates that the target device can receive the segmented LPP message. If bit**1** is 1, it indicates that the target device can transmit a segmented LPP message.

[0161] The second capability information**3**: It indicates whether the target device can perform positioning measurement using PRS for a predetermined positioning method in an inactive state. The predetermined positioning method may be, for example, DL-AoD or DL-TDOA. That is, it indicates whether the terminal can measure PRS in the inactive state.

[0162] The second capability information**4**: It indicates whether the target device can report the positioning measurement result in the inactive state.

[0163] The third capability information is capability information that the terminal reports to the LMF through the LPP control message and to the base station through the RRC control message. It is the capability information required by both the LMF and the base station, and the following IEs are applicable.

[0164] The third capability information**1**: It indicates support of SRS for positioning in RRC_INACTIVE. It is defined per band and reported as part of band specific capability information.

[0165] The third capability information**2**: It is outer loop power control related information. It indicates whether the UE supports OLPC for SRS for positioning.

[0166] The third capability information**3**: It indicates whether the UE supports spatial relations for SRS for positioning.

[0167] The first capability information**2** (indicating whether positioning SRS is supported in CONNECTED state) is reported to base station per band combination (or per feature set). The third capability information**1** (indicating whether positioning SRS is supported in INACTIVE state) is reported per band to base station and to LMF. The definition of FeatureSet can be referred to 3GPP specification 38.331 and 38.306.

[0168] Capability information on positioning SRS in INACTIVE state is reported both to base station and to LMF. Capability information on PRS in INACTIVE state is reported to LMF only.

[0169] FIG. **3**C is illustrating assistance data delivery phase.

[0170] The assistance data is classified into immediate assistance data (first type assistance data) and conditional assistance data (second type assistance data). The base station may provide assistance data using the positioning SIB. The LMF sets the contents of the assistance data included in the positioning SIB. The LMF can provide assistance data to the terminal using the LPP control message. The terminal may acquire assistance data through system information in the idle state as in steps **3**A-**13** or may acquire assistance data through system information after RRC connection state transition **3**A-**15**. When the location service is started, the terminal may initiate a procedure for obtaining assistance data. The location service may be started regardless of the RRC state of the terminal.

[0171] In step **3**C-**11**, the terminal receives SIB**1** from the base station. The terminal stores SI scheduling Information and positioning SI scheduling Information.

[0172] The terminal transitions to the connected state through steps **3**A-**15** and **3**A-**17** and performs

the terminal capability reporting step. If the location service is started, the terminal performs steps **3**A-**19** to obtain assistance data.

[0173] In step **3**C-**13**, the terminal receives the SI including the positioning SIB from the base station and determines whether required assistance data is provided in the corresponding cell. Required assistance data means assistance data for a positioning method supported by a terminal or assistance data for a positioning method to be used in a disclosed location service. The terminal determines, through the positioning SI scheduling information of SIB**1**, the required assistance data directly or indirectly provided from the corresponding cell and the required assistance data not provided from the corresponding cell. The assistance data currently being transmitted from the corresponding cell, that is, the assistance data of the positioning SIB in which the positioning SI broadcast status is set to being broadcast, is assistance data directly provided from the corresponding cell. Assistance data that is not currently transmitted from the corresponding cell but may be transmitted in the future, that is, the assistance data of the positioning SIB in which the positioning SI broadcast status is set to non-broadcast, is assistance data that is indirectly provided from the corresponding cell. The terminal receives the positioning SI including the positioning SIB provided directly in step **3**C-**13** as follows. [0174] 1: Determining the time interval in which the positioning SI/positioning SIB can be transmitted based on the SI window length in the SI scheduling information and positioning SIB mapping information and the order of the SI scheduling information in the positioning SI scheduling information obtained from SIB**1**. [0175] 2: Monitoring SI-RNTI in the time interval [0176] 3: Receive a MAC PDU scheduled through SI-RNTI in the time interval [0177] 4: Acquire positioning SI included in the MAC PDU

[0178] In order to obtain the necessary positioning SIB provided indirectly, the terminal generates a positioning system information request**2** requesting the positioning SIB to the base station.

[0179] In step **3**C-**15**, the terminal sends positioning system information request**2** to the base station. The terminal sets the requested positioning SIB list as follows. [0180] 1: Identifying the positioning SI mapped with the required positioning SIB [0181] 2: Identifying the positioning SI in which the positioning SI broadcast status is non-broadcast among the positioning SIs [0182] 3: Determining the positioning SIB mapped to the positioning SI [0183] 4: Including the positioning SIB type information in the requested positioning SIB list

[0184] That is, the terminal includes, in the requested positioning SIB list, a positioning SIB mapped to a positioning SI in which the positioning SI broadcast status is set to non-broadcast among the required positioning SIBs.

[0185] In step **3**C-**17**, the terminal receives the requested indirect positioning SIB/positioning SI from the base station. The indirect positioning SIB includes immediate assistance data**1**. The immediate assistance data**1** may be, for example, GNSS-related assistance data included in positioning SIB**1**-*x* or positioning SIB**2**-*x*. Alternatively, immediate assistance data**1** may be NR-DL-PRS-AssistanceData included in positioning SIB **6**-**1**.

[0186] In step **3**C-**21**, the terminal receives the indirect positioning SIB/positioning SI requested from the base station. The indirect positioning SIB includes conditional assistance data**1**. The conditional assistance data**1** may be, for example, a conditional assistance data set included in positioning SIB **6**-**4**.

[0187] The base station includes the immediate assistance data and the conditional assistance data in different positioning SIBs and maps the positioning SIB corresponding to the immediate assistance data and the positioning SIB corresponding to the conditional assistance data to the different positioning SIs. Through this, terminals requiring only immediate assistance data and terminals requiring only conditional assistance data can receive only required. In addition, assistance data can be provided more flexibly, for example, immediate assistance data is transmitted directly to positioning SIB/direct positioning SI and conditional assistance data is transmitted to indirect positioning SIB/indirect positioning SI.

[0188] In step **3**C-**23**, the terminal transmits an LPP message called requestAssistanceData

requesting assistance data to the base station. The LPP message is delivered to the LMF through the base station. requestAssistanceData is transmitted to the base station through SRB**2**/DCCH.

[0189] RequestAssistanceData contains the fields below. [0190] 1: PCI of PCell. The LMF identifies the cell in which the terminal is located by referring to the PCI of the PCell and determines the assistance data valid for the cell and the adjacent area. [0191] 2: Type of required assistance information. It indicates the type of assistance data requested by the terminal. This field indicates the relevant positioning method. For example, if this field indicates GNSS, the LMF determines that the terminal requests to provide GNSS-related assistance data. [0192] 3: Identifier of conditional assistance data**1** requiring activation. It is an identifier of conditional assistance data**1** for which a terminal is desired to be activated among conditional assistance data**1** obtained through positioning SIB or the like. The terminal indicates the assistance data id **2D-07** of the desired conditional assistance data **2D-05** among the plurality of conditional assistance data **2D-05** included in the conditional assistance data set **2D-01**. [0193] 4: Information indicating that the required (or requested) assistance data is conditional assistance data. The terminal includes this field if the conditional assistance data **1** received from the base station does not include the conditional assistance data for the positioning method it wants.

[0194] In step **3**C-**25**, the LMF transmits an LPP message called ProvideAssistanceData that provides assistance data to the terminal. ProvideAssistanceData contains the fields below. [0195] 1: immediate assistance data. Among the immediate assistance data requested by the terminal, this is the immediate assistance data that the LMF can provide. [0196] 2: Activated conditional assistance data id. The activated conditional assistance data is indicated among the conditional assistance data**1** for which the terminal has requested activation. It is indicated by the assistance data id. [0197] 3: conditional assistance data**2**. Among the conditional assistance data requested by the terminal, this is the conditional assistance data that the LMF can provide. When a predetermined condition is met, the terminal performs positioning measurement by applying conditional assistance data**2** and reports the positioning measurement result to the LMF. [0198] 4: inactive positioning. Information indicating whether the terminal should perform positioning-related operations in the inactive state. It may be at least one of the following three pieces of information. [0199] 4-1: positioning measurement continuation indicator: 1-bit information indicating whether to continue the currently performed positioning measurement operation after transitioning to the inactive state. [0200] 4-2: conditional assistance data based positioning measurement: 1-bit information instructing to perform positioning measurement by applying available conditional assistance data when transitioning to an inactive state. The available conditional assistance data may be a plurality of conditional assistance data included in conditional assistance data**1** and a plurality of conditional assistance data included in conditional assistance data**2**. [0201] 4-3: inactive positioning measurement method list: A list of positioning measurement methods to be performed by the terminal when transitioning to inactive state. It may be composed of a bitmap in which each bit is mapped with a predetermined positioning measurement method.

[0202] The terminal may perform positioning measurement by measuring PRSs indicated in immediate assistance data and PRSs indicated in activated conditional assistance data**1**.

[0203] The terminal reports the PCI to the LMF in requestAssistanceData. The LMF may provide conditional assistance data validity information composed of multiple NR CGIs to the terminal in ProvideAssistanceData. Alternatively, the LMF may provide conditional assistance data validity information composed of a plurality of CellIdentity to the terminal in ProvideAssistanceData. Alternatively, the LMF may provide conditional assistance data validity information composed of a plurality of cell identities and a plurality of base station identifier (gNB identifier) length information to the terminal in ProvideAssistanceData.

[0204] LMF considers PCI and determines which cell's assistance data to provide to the terminal. The terminal determines in which cell the assistance data is valid by considering the cell identifier provided by the LMF.

[0205] The NR CGI consists of MCC (Mobile Country Code) and MNC (Mobile Network Code), which are information indicating the PLMN, and Cell Identity, which is information indicating the cell. Cell Identity has a size of 36 bits, and the leftmost n bits are the base station indicator (gNB identifier). The n has a variable size between 22 and 32 and may be known to the terminal as separate information called base station identifier length information. PCI is an integer between 0 and 1007. PCI is an indicator that specifies a cell within a relatively narrow area, NR CGI is an indicator that specifies a cell globally, and Cell Identity is an indicator that specifies a cell within one PLMN.

[0206] FIG. **3**D is a diagram illustrating an uplink positioning process of an inactive terminal.

[0207] In the uplink positioning process, the terminal in the RRC connected state receives the SRS configuration from the base station and transmits the SRS, the base station measures the SRS and reports the measurement result to the LMF, and the LMF calculates the terminal's position based on the measurement result. Although the SRS measurement can be performed by several base stations, only one base station is illustrated in FIG. **3**D for convenience.

[0208] In step **3D-01**, the terminal receives an RRCReconfiguration message including SRS configuration from the base station. The SRS configuration may be provided for each UL BWP, and the SRS configuration consists of one or more SRS-PosResourceSet (hereinafter, SRS positioning resource set). One SRS positioning resource set consists of one or more SRS-PosResource (hereinafter, SRS positioning resource).

[0209] The SRS positioning resource is defined by srs-PosResourceId (SRS positioning resource identifier), startPosition, nrofSymbols, freqDomainShift, freqHopping, periodicity AndOffset-sp, spatialRelationInfoPos, and the like.

[0210] StartPosition and nrofSymbols indicate the start position of a symbol in which SRS is transmitted and the number of symbols in which SRS is transmitted in the positioning SRS slot.

[0211] FreqDomainShift and freqHopping define the frequency resource through which the SRS is transmitted in relation to the frequency domain of the corresponding BWP.

[0212] PeriodicityAndOffset-sp indicates the periodicity and the slot at which the positioning SRS slot starts. The positioning SRS slot means a slot in which a positioning SRS resource is configured or a slot in which a positioning SRS is transmitted.

[0213] SpatialRelationInfoPos defines a spatial domain transmission filter to be applied to positioning SRS transmission and may be set to a downlink reference signal index of a serving cell, an SSB index of a neighboring cell, and the like.

[0214] SRS positioning resource set consists of SRS positioning resource set identifier, SRS positioning resource identifier list, ResourceType, alpha, p**0**, pathlossReferenceRS-Pos.

[0215] SRS positioning resource identifier list is the list of SRS positioning resource identifiers composing the SRS positioning resource set.

[0216] ResourceType indicates one of "periodic" and "semi-persistent" and "aperiodic". In the present disclosure, a semi-persistent SRS positioning resource set will be described as an example. For SRS positioning resource set of which ResourceType is indicated as semi-persistent, SRS transmission of SRS positioning resource set starts only after a specific control message instructs transmission.

[0217] Alpha, p**0** and pathlossReferenceRS-Pos are parameters for transmission power control of positioning SRS. alpha and p**0** are power offsets that are added when determining positioning SRS transmission power, and pathlossReferenceRS-Pos provides path loss when determining positioning SRS transmission power. is the reference signal.

[0218] In step **3D-03**, the terminal receives a Positioning SRS Activation/Deactivation MAC CE instructing to start transmission of a specific SRS positioning resource set from the base station.

[0219] The Positioning SRS Activation/Deactivation MAC CE consists of an A/D field, a Cell ID field, a BWP ID field, a SUL field, and a Positioning SRS Resource Set ID.

[0220] The A/D field indicates whether to activate or deactivate the indicated SRS positioning

resource set.

[0221] The Cell ID field indicates the identifier of the serving cell to which the SRS positioning resource set to be activated/deactivated belongs.

[0222] The BWP ID field indicates the identifier of the BWP to which the SRS positioning resource set to be activated/deactivated belongs.

[0223] The SUL field indicates whether the MAC CE is applied to a NUL carrier configuration or a SUL carrier configuration. Or it indicates whether the activated or deactivated SRS positioning resource set is an SRS positioning resource set of SUL or an SRS positioning resource set of NUL.

[0224] The Positioning SRS Resource Set ID field is an identifier of the SRS positioning resource set to be activated or deactivated.

[0225] NUL is normal uplink and SUL is supplementary uplink. One serving cell may have only NUL or may have NUL and SUL. The SUL is configured in the low frequency band comparing to the NUL to increase the uplink coverage of the cell.

[0226] In step **3D-05**, the terminal transmits a positioning SRS in the activated SRS positioning resource set. The terminal transmits the positioning SRS from SRS positioning resources belonging to the SRS positioning resource set by applying the transmission power control parameter of the SRS resource set. The SRS positioning resources are periodically generated according to periodicity AndOffset-sp.

[0227] In step **3D-07**, the terminal receives the RRCRelease message from the base station.

[0228] The base station may change the state of the terminal to RRC_INACTIVE or RRC_IDLE in consideration of the terminal's traffic condition, cell load condition, and RRM condition of the terminal. If the uplink positioning has not yet been completed, the base station instructs the terminal to transition to the RRC_INACTIVE state while continuing to transmit the positioning SRS. The base station transmits an RRCRelease message including inactive SRS IE, stop condition IE, and SuspendConfig **1**E to the terminal.

[0229] The terminal stores the SRS configuration in the Inactive Access Stratum Context.

[0230] The terminal receiving the message performs cell selection. At this time, the terminal preferentially selects the first cell if it is possible to select the first cell. If the reference signal received quality of the first cell is higher than a predetermined threshold, the terminal preferentially selects the first cell and camps on it. The first cell is one of a serving cell in which the terminal receives the RRCRelease message, a PCell at the time point when the terminal receives the RRCRelease message, or a serving cell in which the SRS positioning resource set is activated. Alternatively, the first cell may be a cell belonging to the first cell list. The first cell list includes a plurality of cell information, and each cell information includes PCI and an Absolute Radio Frequency Channel Number (ARFCN). The first cell list may be included in the RRCRelease message and transmitted to the terminal. ARFCN is defined in specification 38.101, and each AFRCN corresponds to a specific frequency.

[0231] In step **3D-09**, the terminal determines whether to continue to perform positioning SRS transmission, if so, which SRS positioning resource set to transmit. The terminal determines whether to transmit the positioning SRS in consideration of the inactive SRS IE and whether the newly reselected cell is the first cell. The inactive SRS IE includes one of an inactive SRS transmission continuation indicator, the first SRS resource set IE and the second SRS resource set IE. The inactive SRS IE may also include an SRS transmission stop condition IE. The inactive SRS IE may also include an SRS transmission condition IE.

[0232] The inactive SRS transmission continuation indicator is an indicator supporting that the SRS positioning resource set of NUL continues to transmit and the SRS positioning resource set of SUL stops transmission among the currently active SRS positioning resource sets. The terminal performs the above operation if the indicator is included.

[0233] The first SRS resource set IE consists of an identifier of an SRS positioning resource set, a cell identifier, a BWP identifier, and the like. After the terminal transitions to the inactive state, it

transmits the positioning SRS by activating the SRS positioning resource set specified by the cell identifier, the BWP identifier, and the SRS positioning resource set identifier. The SRS positioning resource set to be activated is limited to the SRS positioning resource set in the BWP of the NUL. In other words, when the NUL BWP and the SUL

[0234] BWP having the same BWP identifier exist, the SRS positioning resource set identifier is an identifier indicating the SRS positioning resource set in the NUL BWP. The identifier of the SRS positioning resource set indicates a specific SRS positioning resource set of a specific BWP of the NUL of a specific serving cell, and the SRS positioning resource set corresponding to the SRS positioning resource set identifier is defined in the SRS configuration provided for the specific BWP. Alternatively, the first SRS resource set IE may include an identifier of an SRS positioning resource set, a cell identifier, a BWP identifier, and a SUL indicator. If the SUL indicator is not included in the first SRS resource set IE, the inactive state terminal transmits a positioning SRS in the NUL, and when the SUL indicator is included in the first SRS resource set IE, the inactive state terminal transmits a positioning SRS in the SUL.

[0235] The second SRS resource set IE consists of an SRS positioning resource set IE, a cell identifier, a BWP identifier, and the like. After transitioning to the inactive state, the terminal transmits the positioning SRS in the SRS positioning resource specified by the SRS positioning resource set IE in the frequency domain indicated by the cell identifier and the BWP identifier. At this time, if there are two BWPs corresponding to the BWP identifier, a BWP of NUL is selected. Alternatively, the second SRS resource set IE may include an SRS positioning resource set IE, a cell identifier, a BWP identifier, a SUL indicator, and the like. If the SUL indicator is not included in the second SRS resource set IE, the inactive state terminal transmits a positioning SRS in the NUL, and when the SUL indicator is included in the second SRS resource set IE, the inactive state terminal transmits a positioning SRS in the SUL.

[0236] The SRS transmission stop condition IE defines a condition for stopping the transmission of the positioning SRS, which the terminal was transmitting in the inactive state. The SRS transmission stop condition may be the number of positioning SRS transmissions, a time point to stop positioning SRS transmission, and the like.

[0237] The SRS transmission condition IE defines the conditions that must be satisfied in order for the terminal to transmit the positioning SRS in the inactive state. The SRS transmission condition may be defined as the first time point and the second time point. The terminal starts transmitting positioning SRS at the first time point in the inactive state and stops transmitting positioning SRS at the second time point. The first time point and the second time point may be indicated by the SEN and subframe number of the first cell. The first time point and the second time point can be expressed in absolute times such as UTC.

[0238] If the newly selected cell is the first cell and the inactive SRS IE exists, the terminal transmits the positioning SRS as described above even in the inactive state.

[0239] If the newly selected cell is not the first cell, the terminal removes the SRS configuration from the inactive AS context and does not transmit the positioning SRS in the inactive state.

[0240] In step **3**D-**11**, the terminal periodically transmits the positioning SRS in the inactive state. The terminal continues to transmit the previously activated SRS positioning resource set. Or the terminal deactivates the previously activated SRS positioning resource set, activates the SRS positioning resource set indicated in the first SRS resource set IE and transmits the SRS positioning resource set. Or the terminal deactivates the previously activated SRS positioning resource set, activates the SRS positioning resource set indicated in the second SRS resource set IE and transmits the SRS positioning resource set

[0241] The base station collects location-related measurement information by receiving the positioning SRS transmitted by the terminal in the inactive state.

[0242] In step **3**D-**13**, the base station transmits a MEASUREMENT RESPONSE message including the SRS measurement result to the LMF. The LMF calculates the position of the terminal

using the measurement result. When positioning of the terminal is completed, the LMF notifies the base station that positioning is complete.

[0243] In step **3D-15**, the base station receives the message POSITIONING DEACTIVATION from the LMF and recognizes that the uplink positioning has been completed.

[0244] In step **3D-17**, the base station transmits a downlink control message to stop transmitting the positioning SRS of the terminal. The downlink control message may be, for example, a paging message. The base station may include the terminal's I-RNTI (inactive wireless network temporary identifier) and positioning SRS transmission stop information in the paging message. The I-RNTI is assigned in the RRCRelease message. The RRCRelease message allocates two I-RNTIs: a full I-RNTI and a short I-RNTI. The terminal determines whether an I-RNTI matching its full I-RNTI is included in the paging.

[0245] Upon receiving the paging message including its I-RNTI, the terminal determines whether information related to SRS transmission stop, for example, positioning SRS transmission stop information, is included in the paging message. The terminal performs one of the following actions according to its judgment. [0246] 1: If the paging message including its I-RNTI does not contain information related to SRS stop and inactive SRS transmission is being performed, the terminal stops SRS transmission and initiates the RRC connection resumption procedure. [0247] 2: If the paging message including its I-RNTI does not include information related to SRS stop and inactive SRS transmission is not being performed, the terminal initiates the RRC connection resumption procedure. [0248] 3: If information related to SRS stop is included in the paging message including its I-RNTI and inactive SRS transmission is being performed, the terminal stops SRS transmission and does not initiate the RRC connection resumption procedure. [0249] 4: If the paging message including its I-RNTI includes information related to SRS stop and inactive SRS transmission is not being performed, the terminal ignores the paging message and does not initiate the RRC connection resumption procedure.

[0250] The terminal performs random access to perform a resumption procedure and transmits a predetermined uplink RRC control message.

[0251] In step **3D-19**, the terminal stops inactive SRS transmission or initiates a resumption procedure with reference to the information included in the paging message.

[0252] A terminal in inactive state stops transmitting positioning SRS in the following cases.

[0253] 1: The cell selected after receiving the RRCRelease message is not the first cell. [0254] 2: Reselect another cell from the first cell. [0255] 3: SRS transmission stop condition is satisfied. [0256] 4: The resumption procedure is started. [0257] 5: Receives a paging message indicating to stop inactive SRS transmission.

[0258] One paging message includes a plurality of pagingRecords, and each pagingRecord among the plurality of pagingRecords includes one terminalidentifier field and one second information field. Among the plurality of pagingRecords, in each pagingRecord, the terminalidentifier field is mandatory present and the second information field is optionally present. The terminalidentifier field is set to full I-RNTI and the second information field is enumerated with a single value indicating an SRS stop.

[0259] Optionally present IE being enumerated with a single value means that the single value is applied if the IE is present and the single value is not applied if the IE is not present.

[0260] FIG. **3E** is a diagram illustrating a downlink positioning process of an inactive terminal.

[0261] A terminal that has obtained immediate assistance data, conditional assistance data**1**, and conditional assistance data**2** through steps **3C-13** to **3C-25** performs an operation related to downlink positioning by using the assistance data.

[0262] An operation related to downlink positioning is, for example, measuring the reception time difference of PRSs transmitted from a plurality of TRPs and reporting the result to the LMF, or measuring the received power of PRSs transmitted from a plurality of TRPs and reporting to the LMF, etc.,

[0263] In step **3E-01**, the terminal generates an RRC control message called UEAssistanceInformation to report to the base station that downlink positioning should be performed even in the RRC_INACTIVE state and transmits it to the base station. The control message may include an inactive positioning**2** IE indicating the type of positioning method that the terminal can perform in an inactive state. the control message can include a informatino requesting to configure small data transfer via SRB**2**. The control message may include time pattern information of PRS for positioning. The terminal performs steps **3E-03** if the inactive positioning IE is included in the ProvideAssistanceData received in steps **3C-25**.

[0264] In step **3E-03**, the base station sends an RRCRelease message to the terminal.

[0265] The base station may change the state of the terminal to RRC_INACTIVE or RRC_IDLE in consideration of the terminal's traffic condition, cell load condition, and RRM condition of the terminal. If the base station determines that the terminal needs to measure positioning in the inactive state, the base station may provide information related to downlink positioning measurement while instructing the terminal to transition to the RRC_INACTIVE state.

[0266] Information related to downlink positioning measurement may include, for example, offset information for moving the paging monitoring period of the terminal so that the paging monitoring time interval of the terminal does not overlap with the PRS measurement period.

[0267] The base station can configure small data transfer through SRB**2** to the terminal. The small data transfer configuration may consist of a list of data bearers for which small data transfer is configured, and 1-bit information indicating whether small data transfer can be configured to SRB**2**. When small data transfer is applied to SRB**2**, the terminal can transmit the data of SRB**2** to the base station through the small data transfer procedure. The small data transfer procedure is a procedure in which the RRC_INACTIVE terminal transmits small data through the RRC connection resumption procedure without transitioning to RRC_CONNECTED.

[0268] Upon receiving the RRCRelease message including information related to downlink positioning measurement, the terminal performs cell selection. At this time, if the reference signal received power of the second cell is greater than or equal to a predetermined threshold, the terminal preferentially selects the second cell to camp on. The second cell may be a serving cell receiving the RRCRelease message or a PCell at a time point receiving the RRCRelease message.

[0269] In step **3E-05**, the terminal selecting the new cell monitors whether the assistance data validity is met. If the newly selected cell is the second cell, the terminal considers both conditional assistance data**1** and conditional assistance data**2**. The terminal considers only conditional assistance data**2** if the newly selected cell is not the second cell.

[0270] The terminal monitors if at least one assistance data validity is fulfilled among the assistance data validity of which data status is broadcast included in either conditional assistance data**1** or conditional assistance data**2**

[0271] In step **3E-06**, if it is determined that the assistance data of the conditional assistance data for which the assistance data validity is satisfied is determined to be valid, the terminal starts measuring the downlink PRSs specified in the assistance data. The terminal measures the arrival time difference of PRSs transmitted by a plurality of TRPs. When the PRS measurement is completed, the terminal generates an LPP ProvideLocatinoInformation message including the measurement result. The terminal initiates a small data transfer procedure to transmit the LPP message. If necessary, the ProvideLocatinoInformation message can be segmented into a plurality of segments and transmitted. The ProvideLocatinoInformation message includes information on arrival time difference of PRSs transmitted by a plurality of TRPs, one assistance data identifier and a plurality of downlink positioning reference signal identifiers (DL-PRS id). The downlink positioning reference signal identifier is an identifier of the measured PRSs, and the assistance data identifier is an identifier of assistance data providing the configuration of the measured PRSs. If the PRS measurement is made based on the first type assistance data, the ProvideLocatinoInformation message includes a plurality of measurement results and a plurality of downlink positioning

reference signal identifiers. If the RRS measurement is made based on the second type assistance data, the ProvideLocatinoInformation message includes a plurality of measurement results and a plurality of downlink positioning reference signal identifiers and one assistance data id.

[0272] In step **3E-07**, the terminal transmits a ResumeRequest, an LPP segment message, and a MAC PDU including a Buffer Status Report (BSR) to the base station. The LPP segment message includes the first segment of the LPP ProvideLocatinoInformation message. The BSR includes information on the size of the remaining segments of the LPP ProvideLocatinoInformation message. The ResumeRequest belongs to SRB**0** and the LPP segment message belongs to SRB**2**. The ResumeRequest of SRB**0** is not ciphered, the LPP segment message of SRB**2** is ciphered, and the BSR is not ciphered. The ciphering is performed with a new security key calculated through the value of NCC received by the terminal in the RRCRelease message and the security key stored by the terminal. In principle, all RRC messages are ciphered, but the RRC message of SRB**0** is not ciphered because it is a message that the base station must process without prior information. Since BSR is information processed by the MAC layer of the base station, it is not ciphered. As a result, the MAC PDU transmitted to report the positioning measurement result in the inactive state includes three MAC subPDUs, the first MAC subPDU and the third MAC subPDU include an unciphered payload, and the second MAC subPDU includes a ciphered payload. The terminal reports the amount of data available for transmission through the BSR. The RRC_CONNECTED terminal determines the BSR format in consideration of the number of logical channel groups in which data available for transmission exists. That is, the RRC_CONNECTED terminal uses the first BSR if the number of logical channel groups in which data available for transmission is one and uses the second BSR if it is more than one. The RRC_INACTIVE terminal determines the BSR format without considering the number of logical channel groups in which data available for transmission exists. That is, the RRC_INACTIVE terminal uses the first BSR even if the number of logical channel groups in which data available for transmission exists is more than one. The RRC_INACTIVE terminal sets the identifier of a logical channel group with the highest priority among logical channel groups in which data available for transmission exists in the logical channel group identifier field **2H-01**, and sets in the first buffer size field **2H-03** the first buffer size index corresponding to the amount of data available for transmission across all the logical channels.

[0273] The RRC_INACTIVE terminal uses the logical channel group identifier predefined in the specification instead of the logical channel group identifier configured in the RRC_CONNECTED state. In the RRC_INACTIVE state, the terminal uses the preconfigured configuration instead of the terminal specific configuration because the base station does not know the terminal's buffer status reporting configuration.

[0274] The RRC_CONNECTED terminal determines the buffer size index to be set in buffer size field of the BSR by considering only the data of the PDCP layer and the data of the RLC layer. If RRC_INACTIVE terminal operates in the same manner, remaining LPP segments stored in LPP layer is not considered. To overcome this problem, the RRC_INACTIVE terminal determines the buffer size index to be set in buffer size field by considering the amount of data of PDCP layer and data of RLC layer and data of LPP layer (or upper layers of PDCP layer or upper layers of RRC layer). That is, a buffer size index corresponding to the sum of all the data amounts is selected.

[0275] In step **3E-09**, the base station transmits a locationInformation segment to the LMF.

[0276] In step **3E-11**, the terminal transmits the MAC PDU including the LPP segment message and information indicating no more data for transmission. The LPP segment message includes the last segment of the LPP ProvideLocatinoInformation message. Information indicating no more data for transmission may be the first BSR in which buffer size index 0 is set.

[0277] In step **3E-13**, the base station transmits a locationInformation segment to the LMF. After receiving the last segment, the LMF assembles the segments to make a location information message and determines the location of the terminal by referring to the positioning measurement result of the location information message.

[0278] In steps **3**E-**15**, the terminal monitors whether the assistance data validity is met.

[0279] In step **3**E-**16**, when it is determined that the assistance data of the conditional assistance data for which the assistance data validity is satisfied is determined to be valid, the terminal starts measuring the downlink PRSs specified in the assistance data.

[0280] In step **3**E-**17**, the terminal transmits the MAC PDU including ResumeRequest, LPP segment message and BSR (Buffer Status Report) to the base station.

[0281] In step **3**E-**19**, the base station transmits a locationInformation segment to the LMF.

[0282] In step **3**E-**21**, the terminal transmits the MAC PDU including the LPP segment message and information indicating no more data for transmission.

[0283] In step **3**E-**23**, the base station transmits an LPP segment message to the LMF. After receiving the last segment, the LMF assembles the segments to generate a location information message and determines the location of the terminal by referring to the positioning measurement result of the locationInformation message.

[0284] If the terminal transitions to RRC_IDLE or RRC_CONNECTED or the assistance data validity is not met, the terminal stops measuring the downlink PRS for location measurement and reporting the measurement result.

[0285] FIG. **4** is a diagram illustrating an operation of a terminal.

[0286] In step **4**A-**01**, the UE receives a first location protocol message including first information for a location method in an inactive state from the location management function.

[0287] In step **4**A-**03**, the UE receives radio resource control release including configuration information for small data transmission through the signaling radio bearer **2**. In step **4**A-**05**, the UE enters an inactive state.

[0288] In step **4**A-**07**, if the first information is included in the assistance data providing message, the UE performs the positioning method in an inactive state.

[0289] In step **4**A-**09**, the terminal transmits to the base station a MAC PDU including a first MAC subPDU for signaling radio bearer **0** resource control message and a second MAC subPDU for signaling radio bearer **2** resource control message and a third MAC subPDU for buffer status report.

[0290] The signaling radio bearer **0** resource control message is a resume request and the SRB**2** resource control message includes a segmentation of the location protocol message for the location measurement result.

[0291] The first MAC subPDU, the second MAC subPDU, and the third MAC subPDU are sequentially located in the MAC subPDU.

[0292] The first MAC subPDU does not contain the ciphered part, the second MAC subPDU contains ciphered part, and the third MAC subPDU does not contain the ciphered part. In other words, MAC subPDUs including ciphered parts are located between MAC subPDUs that do not contain ciphered parts.

[0293] The MAC sub header of the first MAC subPDU is composed of two reserved bits and one logical channel identifier field, and the MAC sub header of the second MAC subPDU includes one reserved bit, one format field, and one logical channel identifier field. It consists of a logical channel identifier field and one length field, and the MAC subheader of the third MAC subPDU consists of two reserved bits and one logical channel identifier field.

[0294] The positioning method is a downlink arrival time difference based on positioning reference signal measurement.

[0295] The first positioning protocol message may include help information for a positioning reference signal.

[0296] The first positioning protocol message may include report configuration.

[0297] FIG. **5**A is a block diagram illustrating the internal structure of a UE to which the disclosure is applied.

[0298] Referring to the diagram, the UE includes a controller **5**A-**01**, a storage unit **5**A-**02**, a

transceiver **5A-03**, a main processor **5A-04** and I/O unit **5A-05**.

[0299] The controller **5A-01** controls the overall operations of the UE in terms of mobile communication. For example, the controller **5A-01** receives/transmits signals through the transceiver **5A-03**. In addition, the controller **5A-01** records and reads data in the storage unit **5A-02**. To this end, the controller **5A-01** includes at least one processor. For example, the controller **5A-01** may include a communication processor CP that performs control for communication and an application processor AP that controls the upper layer, such as an application program. The controller controls storage unit and transceiver such that UE operations illustrated in FIG. **2**A and FIG. **2**B and FIG. **3**A are performed.

[0300] The storage unit **5A-02** stores data for operation of the UE, such as a basic program, an application program, and configuration information. The storage unit **5A-02** provides stored data at a request of the controller **5A-01**.

[0301] The transceiver **5A-03** consists of a RF processor, a baseband processor and plurality of antennas. The RF processor performs functions for transmitting/receiving signals through a wireless channel, such as signal band conversion, amplification, and the like. Specifically, the RF processor up-converts a baseband signal provided from the baseband processor into an RF band signal, transmits the same through an antenna, and down-converts an RF band signal received through the antenna into a baseband signal. The RF processor may include a transmission filter, a reception filter, an amplifier, a mi10r, an oscillator, a digital-to-analog converter (DAC), an analog-to-digital converter (ADC), and the like. The RF processor may perform MIMO and may receive multiple layers when performing the MIMO operation. The baseband processor performs a function of conversion between a baseband signal and a bit string according to the physical layer specification of the system. For example, during data transmission, the baseband processor encodes and modulates a transmission bit string, thereby generating complex symbols. In addition, during data reception, the baseband processor demodulates and decodes a baseband signal provided from the RF processor, thereby restoring a reception bit string.

[0302] The main processor **5A-04** controls the overall operations other than mobile operation. The main processor **5A-04** process user input received from I/O unit **5A-05**, stores data in the storage unit **5A-02**, controls the controller **5A-01** for required mobile communication operations and forward user data to I/O unit **5A-05**.

[0303] I/O unit **5A-05** consists of equipment for inputting user data and for outputting user data such as a microphone and a screen. I/O unit **5A-05** performs inputting and outputting user data based on the main processor's instruction.

[0304] FIG. **5**B is a block diagram illustrating the configuration of a base station according to the disclosure.

[0305] As illustrated in the diagram, the base station includes a controller **5B-01**, a storage unit **5B-02**, a transceiver **5B-03** and a backhaul interface unit **5B-04**.

[0306] The controller **5B-01** controls the overall operations of the main base station. For example, the controller **5B-01** receives/transmits signals through the transceiver **5B-03**, or through the backhaul interface unit **5B-04**. In addition, the controller **5B-01** records and reads data in the storage unit **5B-02**. To this end, the controller **5B-01** may include at least one processor. The controller controls transceiver, storage unit and backhaul interface such that base station operation illustrated in FIG. **2**A and FIG. **2**B are performed.

[0307] The storage unit **5B-02** stores data for operation of the main base station, such as a basic program, an application program, and configuration information. Particularly, the storage unit **5B-02** may store information regarding a bearer allocated to an accessed UE, a measurement result reported from the accessed UE, and the like. In addition, the storage unit **5B-02** may store information serving as a criterion to deter mine whether to provide the UE with multi-connection or to discontinue the same. In addition, the storage unit **5B-02** provides stored data at a request of the controller **5B-01**.

[0308] The transceiver **5B-03** consists of a RF processor, a baseband processor and plurality of antennas. The RF processor performs functions for transmitting/receiving signals through a wireless channel, such as signal band conversion, amplification, and the like. Specifically, the RF processor up-converts a baseband signal provided from the baseband processor into an RF band signal, transmits the same through an antenna, and down-converts an RF band signal received through the antenna into a baseband signal. The RF processor may include a transmission filter, a reception filter, an amplifier, a mi10r, an oscillator, a DAC, an ADC, and the like. The RF processor may perform a down link MIMO operation by transmitting at least one layer. The baseband processor performs a function of conversion between a baseband signal and a bit string according to the physical layer specification of the first radio access technology. For example, during data transmission, the baseband processor encodes and modulates a transmission bit string, thereby generating complex symbols. In addition, during data reception, the baseband processor demodulates and decodes a baseband signal provided from the RF processor, thereby restoring a reception bit string.

[0309] The backhaul interface unit **5B-04** provides an interface for communicating with other nodes inside the network. The backhaul interface unit **5B-04** converts a bit string transmitted from the base station to another node, for example, another base station or a core network, into a physical signal, and converts a physical signal received from the other node into a bit string.

Claims

1. A method by a terminal, the method comprising: receiving by the terminal in RRC_CONNECTED at least one instance of validity information and a set of Positioning Reference Signal (PRS) parameters, wherein: the at least one instance of validity information comprises at least one base station identifier; size of the base station identifier is variable; and size of the at least one instance of validity information is constant; determining by the terminal, based on the at least one instance of validity information, that the set of PRS parameters is valid; performing by the terminal measurement on PRS; and transmitting by the terminal in RRC_INCATIVE a Positioning Protocol message that comprises: a single instance of identifier information; and one or more PRS resource identifiers.

2. The method of claim 1, wherein the set of PRS parameters comprises: the single instance of identifier information; and one or more sets of PRS resource parameters.

3. The method of claim 2, wherein each of the one or more sets of PRS resource parameters comprises: a PRS resource identifier; a parameter for code sequence; and a parameter for starting slot.

4. The method of claim 1, wherein: a first part of the Positioning Protocol message is transmitted in a Medium Access Control (MAC) Protocol Data Unit (PDU); the MAC PDU comprises a Signaling Radio Bearer **0** (SRB**0**) message and a SRB**2** message; and the SRB**2** message comprises the first part of the Positioning Protocol message.

5. The method of claim 4, wherein a subsequent part of the Positioning Protocol message is transmitted in a second MAC PDU.

6. The method of claim 5, wherein the second MAC PDU is transmitted after the MAC PDU that comprises the first part of the Positioning Protocol message is transmitted.

7. The method of claim 4, wherein the SRB**0** message is a message requesting connection resume.

8. A terminal in a wireless communication system, the terminal comprising: a transceiver configured to transmit and receive a signal; and a controller configured to control the transceiver to: receive in RRC_CONNECTED at least one instance of validity information and a set of Positioning Reference Signal (PRS) parameters, wherein: the at least one instance of validity information comprises at least one base station identifier; size of the base station identifier is variable; and size of the at least one instance of validity information is constant, determine, based

on the at least one instance of validity information, that the set of PRS parameters is valid, perform measurement on PRS, and transmit in RRC_INCATIVE a Positioning Protocol message that comprises: a single instance of identifier information; and one or more PRS resource identifiers.