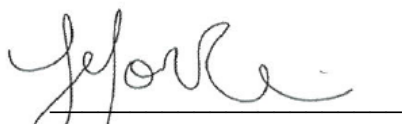


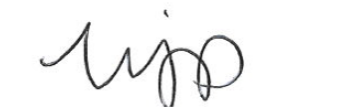
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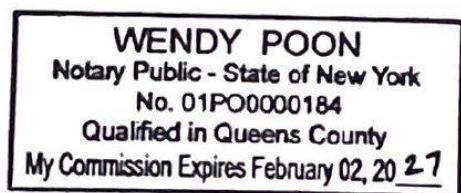


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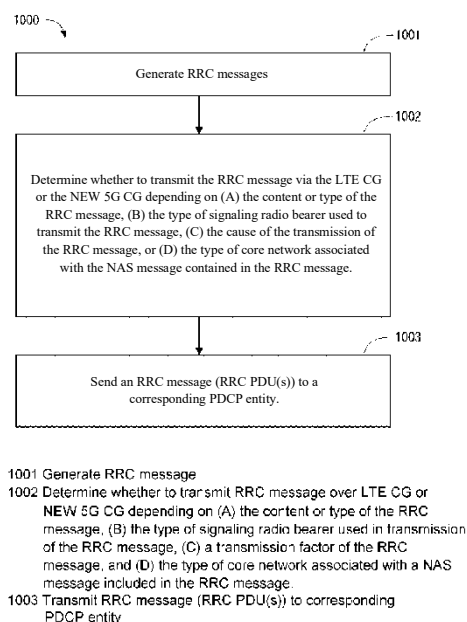


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- [Go to the next page]

(54) Title: RADIO STATION SYSTEM, RADIO TERMINAL, AND METHOD FOR THESE

(54) Name of invention: Radio station system, radio terminal, and method thereof



(57) Abstract: If a prescribed condition is satisfied, in a second cell (23, 24), this radio terminal (2) transmits to a radio terminal (1) or receives from a radio terminal (1) control plane (CP) messages which include NAS messages, RRC messages or both. The second cell (23, 24) uses a Radio Access Technology (RAT) different from that of a first cell, and is added to the first cell and used subordinately. The prescribed condition relates to at least one of (a) the content or type of a CP message, (b) the type of signaling radio bearer used in transmission of the CP message, (c) a transmission factor of the CP message, and (d) the type of core network associated with a NAS message. By this means, it is possible to contribute to the effective transmission of CP messages in a radio architecture that supports interworking of two different RATs.

(57) Summary: A radio station (2) transmits or receives a CP message including a NAS message or an RRC message, or both, to or from a radio terminal (1) in a second cell (23, 24) when a predetermined condition is met. The second cell (23, 24) uses a different RAT than the first cell and is used in addition to and subordinate to the first cell. The predetermined condition relates to at least one of: (a) the content or type of the CP message; (b) the type of signaling radio bearer used to transmit the CP message; (c) the cause of the transmission of the CP message; and (d) the type of core network associated with the NAS message. This can contribute, for example, to efficient transmission of control plane (CP) messages in radio architectures that provide interworking of two different Radio Access Technologies (RATs).

WO 2017/119247 A1

Attached public documents:

- International Investigation Report (Article 21(3) of the Convention)

Specification

Name of invention: Radio station system, radio terminal, and method thereof

Technical field

[0001] The present disclosure relates to communications between radio stations and radio terminals utilizing multiple Radio Access Technologies (RATs).

Background Art

[0002] The 3rd Generation Partnership Project (3GPP) plans to begin standardization work on 5G for deployment after 2020 as 3GPP Release 14 in 2016. 5G is expected to be realized through a combination of the continued enhancement/evolution of LTE and LTE-Advanced, and revolutionary developments resulting from the introduction of a new 5G air interface (new Radio Access Technology (RAT)). The new RAT (New 5G RAT) will support higher frequency bands than those targeted by the continued development of LTE/LTE-Advanced (e.g., 6 GHz or less), such as centimeter wave bands above 10 GHz and millimeter wave bands above 30 GHz.

[0003] Higher frequency bands can provide higher rate communications. However, the coverage of the higher frequency bands is more localized due to their frequency characteristics. Thus, higher frequency bands are used to improve capacity and data rates in specific areas, while broad coverage is provided by existing lower frequency bands. In other words, to ensure the stability of New 5G RAT communications in high frequency bands, tight integration or close interworking between low and high frequency bands, i.e., LTE/LTE-Advanced and New 5G RAT, is required. A radio terminal that supports 5G (5G User Equipment (UE)) connects to both lower and higher frequency bands (i.e., LTE/LTE-Advanced cells and New 5G cells) using Carrier Aggregation (CA) or Dual Connectivity (DC) or improved technologies.

[0004] Non-Patent Literature 1 discloses a user plane and control plane architecture for use with both the LTE air interface (LTE RAT) and the new 5G air interface (New 5G RAT). In some implementations, a common Radio Resource Control (RRC) layer and a common Packet Data Convergence Protocol (PDCP) layer (sublayer) are used. The common PDCP layer is connected to the LTE lower layers and the New 5G lower layers, and provides the upper layers with the transfer services of user plane data and control plane data via these LTE lower layers and New 5G lower layers. The LTE lower layers include the Radio Link Control (RLC) layer, the Medium Access Control (MAC) layer, and the physical layer for the LTE-RAT. Similarly, the New 5G lower layers include an RLC layer, a MAC layer and a physical layer for the New 5G RAT.

[0005] Non-Patent Literature 1 further describes the simultaneous transmission of the same control plane message in both the LTE cell and the New 5G cell (Control Plane Diversity), assuming that a common PDCP layer and a common RRC layer are placed in the LTE base station, and the switching of the path of the control plane connection between the LTE cell and the New 5G cell (Fast Control Plane Switching). By using a common PDCP and a common RRC layer, a UE only needs to connect to one control point (ie, a common RRC layer) via any of multiple air interfaces.

[0006] In addition, the term "LTE" as used in this specification, unless otherwise specified, includes the evolution of LTE and LTE-Advanced for 5G that enables close interworking with the New 5G RAT. Such development of LTE and LTE-Advanced is also called LTE-Advanced Pro, LTE+, or enhanced LTE (eLTE). Moreover, the terms "5G" and "New 5G" in this specification are used for convenience to refer to the air interface (RAT) newly introduced for the fifth generation mobile communication system (5G) and the associated nodes, cells, protocol layers, etc. The formal names of the newly introduced air interface (RAT) and associated nodes, cells and protocol layers will be determined in the future as standardization work progresses. For example, the LTE RAT may be called the Primary RAT (P-RAT, pRAT) or Master RAT, and the New 5G RAT may be called the Secondary RAT (S-RAT, sRAT).

Prior Art Literature

Patent literature

[0007] Non-Patent Literature 1: Da Silva, I.; Mildh, G.; Rune, J.; Wallentin, P.; Vikberg, J.; Schliwa-Bertling, P.; Rui Fan, "Tight Integration of New 5G Air Interface and LTE to Fulfill 5G Requirements," in Vehicular Technology Conference (VTC Spring), 2015 IEEE 81st, pp.1-5,

11-14 May 2015

Outline of the Invention

Problem to be solved by the invention

[0008] The inventors conducted research into 5G radio architecture that provides close interworking between LTE RAT and New 5G RAT and found several challenges. For example, Non-Patent Literature 1 does not take into consideration a control plane specific to New 5G cells. In some implementations, new 5G cell-specific control plane (CP) messages (e.g., temporary UE ID allocation, lower layer configuration, signaling for quality of service control, measurement reporting) may be required. In some implementations, 5G cell-specific signaling connections (e.g., RRC connections, Signaling Radio Bearers (SRBs)) may also be required. It may be efficient for the transfer of New 5G cell-specific control plane (CP) messages and 5G cell-specific signaling connections to be sent via the New 5G cell instead of the LTE cell. For example, one of the key requirements for 5G is low latency, and 5G UEs can be expected to communicate with New 5G cells with lower latency than with LTE cells.

[0009] Therefore, one of the objectives that the embodiments disclosed in this specification aim to achieve is to provide an apparatus, a method, and a program that contribute to effectively transmitting control plane messages via cells of a subordinately used RAT in a radio architecture that provides interworking of two different RATs. It should be noted that this objective is just one of the objectives that the embodiments disclosed herein seek to accomplish. Other objects or problems and novel features will become apparent from the description of this specification or the accompanying drawings.

Means for solving the problems

[0010] In a first aspect, a radio station system includes one or more radio stations. The one or more radio stations are configured to simultaneously provide one radio terminal with one or more first cells conforming to a first radio access technology and one or more second cells conforming to a second radio access technology that is used in addition to and subordinate to the one or more first cells. The one or more radio stations are configured to transmit or receive a control plane message to or from the radio terminal in the one or more second cells when a predetermined condition is met. The control plane messages include non-access stratum (NAS) messages or radio resource control (RRC) messages or both. The predetermined condition relates to at least one of: (a) the content or type of the control plane message, (b) the type of signaling radio bearer used to transmit the control plane message, (c) the cause of the transmission of the control plane message, and (d) the type of core network associated with the NAS message.

[0011] In a second aspect, a method in a radio station system including one or more radio stations includes:

- (a) simultaneously providing one or more first cells according to a first radio access technology and one or more second cells according to a second radio access technology used in addition to and subordinate to the one or more first cells to a radio terminal; and
- (b) transmitting or receiving a control plane message to or from the radio terminal in the one or more second cells when a predetermined condition is met. The control plane messages include non-access stratum (NAS) messages or radio resource control (RRC) messages or both. The predetermined condition relates to at least one of (a) the content or type of the control plane message, (b) the type of signaling radio bearer used to transmit the control plane message, (c) the cause of the transmission of the control plane message, and (d) the type of core network associated with the NAS message.

[0012] In a third aspect, a radio terminal includes a memory and at least one processor coupled to the memory. The at least one processor is configured to communicate with a radio station system including one or more radio stations simultaneously in one or more first cells conforming to a first radio access technology and in one or more second cells conforming to a second radio access technology used in addition to and subordinate to the one or more first cells. The at least one processor is configured to transmit or receive a control plane message to or from the radio station system in the one or more second cells when a predetermined condition is met. The control plane messages include non-access stratum (NAS) messages or radio resource control (RRC) messages or both. The predetermined condition relates to at least one of (a) the content or type of the control plane message, (b) the type of signaling radio bearer used to

transmit the control plane message, (c) the cause of the transmission of the control plane message, and (d) the type of core network associated with the NAS message.

[0013] In a fourth aspect, the method in a radio terminal comprises:

(a) communicating with a radio station system including one or more radio stations simultaneously in one or more first cells according to a first radio access technology and in one or more second cells according to a second radio access technology used in addition to and subordinate to the one or more first cells;

(b) transmitting or receiving a control plane message to or from the radio station system in the one or more second cells when a predetermined condition is met.

The control plane messages include non-access stratum (NAS) messages or radio resource control (RRC) messages or both. The predetermined condition relates to at least one of (a) the content or type of the control plane message, (b) the type of signaling radio bearer used to transmit the control plane message, (c) the cause of the transmission of the control plane message, and (d) the type of core network associated with the NAS message.

[0014] In a fifth aspect, a program comprises a set of instructions (software code) which, when loaded into a computer, causes the computer to carry out a method according to the second or fourth aspect above.

Effect of the Invention

[0015] According to the above-mentioned aspects, it is possible to provide an apparatus, a method, and a program that contribute to effectively transmitting control plane messages through cells of a RAT that is used subordinately in a radio architecture that provides interworking of two different RATs.

Brief Description of the Drawings

[0016] [FIG. 1] is a diagram illustrating an example of the configuration of a radio communication network according to some embodiments.

[FIG. 2] is a diagram illustrating an example of a configuration of a radio communication network according to some embodiments.

[Fig. 3] is a diagram illustrating another example of a radio communication network according to some embodiments.

[FIG. 4] is a diagram illustrating an example of a radio protocol stack according to some embodiments.

[FIG. 5] is a diagram illustrating an example of a radio protocol stack according to some embodiments.

[FIG. 6] is a diagram illustrating an example of a layer 2 structure according to some embodiments.

[FIG. 7] is a sequence diagram showing an example of the operation of a radio terminal and a base station according to the first embodiment.

[FIG. 8] is a sequence diagram showing an example of the operation of a radio terminal and a base station according to the first embodiment.

[FIG. 9] is a sequence diagram showing an example of the operation of a radio terminal and a base station according to the first embodiment.

[FIG. 10] is a flowchart showing an example of an operation of an RRC layer according to the first embodiment.

[FIG. 11] is a table showing an example of keys used to generate temporary keys for encryption/decryption of each radio bearer in the second embodiment.

[FIG. 12] is a block diagram showing an example configuration of a radio terminal according to some embodiments.

[FIG. 13] is a block diagram illustrating an example configuration of a base station according to some embodiments.

Examples of Embodiment of the Invention

[0017] Hereinafter, the specific embodiments will be described in detail with reference to the drawings.

In each drawing, identical or corresponding elements are given the same reference numerals, and duplicate descriptions are omitted where necessary for clarity of explanation.

[0018] The multiple embodiments described below can be implemented independently or in any suitable combination. These multiple embodiments have novel features that are different from

each other. Therefore, these multiple embodiments contribute to solving mutually different objectives or problems, and contribute to mutually achieving different effects.

[0019] The following embodiments are described primarily with a focus on a 5G radio architecture that provides close interworking between the LTE RAT and the New 5G RAT. However, these embodiments are not limited to the 5G radio architecture and may be applied to other radio architectures that provide close interworking of two different RATs.

[0020] <First embodiment>

FIG. 1 shows a configuration example of a radio communication network according to some embodiments including this embodiment. In the example of FIG. 1, the radio communication network includes a radio terminal (UE) 1 and an integrated base station (integrated eNB) 2. UE1 is a 5G UE and connects to both one or more LTE cells (e.g., cells 21 and 22) and one or more New 5G cells (e.g., cells 23 and 24) using CA or DC or improved technologies. Hereinafter, one or more LTE cells and one or more New 5G cells used by 5G UE 1 are referred to as a LTE cell group (CG) and a New 5G CG, respectively. Each cell in the LTE CG and the New 5G CG is a cell that is configured and activated for the 5G UE 1 by the integrated eNB2. In some implementations, the frequency bands (e.g., F1 and F2) of the LTE CG (e.g., cells 21 and 22) are lower frequency bands (e.g., lower than 6 GHz) and the frequency bands (e.g., F3 and F4) of the New 5G CG (e.g., cells 23 and 24) are higher frequency bands (e.g., higher than 6 GHz).

[0021] The Integrated eNB 2 supports 5G and provides multiple cells using multiple component carriers (CCs) with different frequencies and RATs. In the example of FIG. 1, integrated eNB 2 provides LTE cells 21 and 22 and New 5G cells 23 and 24. The Integrated eNB2 communicates with the 5G UE 1 via both the LTE CG (e.g., cells 21 and 22) and the New 5G CG (e.g., cells 23 and 24) using CA or DC or improved techniques. Furthermore, the integrated eNB2 is connected to a core network, namely an integrated Evolved Packet Core (integrated EPC) 41. The Integrated EPC41 provides LTE core network functions and new core network functions for 5G. In some implementations, the integrated eNB2 may be connected to a 5G specific core network (5G specific EPC 42).

[0022] As shown in FIG. 2, a remote radio unit 3 may be used to provide at least one of multiple cells of the integrated eNB 2 (e.g., New 5G cells 23 and 24). In the configuration of FIG. 2, the integrated eNB 2 performs digital signal processing on uplink and downlink signals, and the radio unit 3 performs analog signal processing of the physical layer. For example, an optical fiber is connected between the integrated eNB2 and the radio unit 3, and digital baseband signals are transferred over the optical fiber using the Common Public Radio Interface (CPRI) standard. The configuration in Figure 2 is called Cloud Radio Access Network (C-RAN). The radio unit 3 is called a Remote Radio Head (RRH) or a Remote Radio Equipment (RRE). In addition, the integrated eNB 2, which is responsible for baseband digital signal processing, is called a Baseband Unit (BBU). Furthermore, in addition to CPRI, information (or signals containing information) of Layer 1, 2, or 3 may be transferred using a standardized fronthaul (interface) defined in advance (e.g., in 3GPP or the Small Cell Forum). For example, a configuration in which a fronthaul connection is used between L1 and L2 or between sub-layers within L2 is also called L2 C-RAN. In this case, the integrated eNB 2 in FIG. 2 is also called a Digital Unit (DU), and the RRH 3 is also called a Radio Unit (RU).

[0023] In the configuration example shown in FIG. 1 and FIG. 2, the LTE radio protocol and the New 5G radio protocol are implemented in one node (i.e., integrated eNB2). The configuration examples shown in FIGS. 1 and 2 are therefore referred to as co-located deployments or co-located RAN. In the case of an L2 C-RAN configuration, part of the New 5G radio protocol may be located in the RU. On the other hand, in other configuration examples, a non-co-located deployment or a non-co-located RAN may be adopted. In a non-co-located deployment, the LTE radio protocol and the New 5G radio protocol are provided by two different nodes (eNBs). These two nodes may, for example, be located at two different geographically separated sites.

[0024] FIG. 3 illustrates an example of a non-co-located arrangement of a radio communication network according to some embodiments, including this embodiment. In the example of FIG. 3, the radio communication network includes a 5G UE 1, an LTE+ eNB 5, and a 5G specific eNB 6. The LTE+ eNB 5 provides the LTE CG (e.g., cells 21 and 22), and the 5G specific eNB 6 provides the New 5G CG (e.g., cells 23 and 24). The LTE+ eNB 5 is connected to the 5G specific

eNB 6 via a communication line such as an optical fiber link or a point-to-point wireless link, and communicates with the 5G specific eNB 6 over an inter-base station interface 301 (e.g., an enhanced X2 interface). The LTE+ eNB5 and the 5G specific eNB6 interwork with each other to enable the 5G UE 1 to connect to both the LTE CG and the 5G CG using CA or DC or improved technologies.

[0025] FIG. 4 shows an example of a radio protocol stack supported by 5G UE 1 and integrated eNB 2. The radio protocol stack 400 shown in FIG. 4 includes an integrated RRC layer 401 and an integrated PDCP layer (sub-layer) 402. The integrated RRC layer 401 and the integrated PDCP layer 402 may also be referred to as a common RRC layer and a common PDCP layer, respectively. The radio protocol stack 400 further includes LTE lower layers and New 5G lower layers. The LTE lower layers include an LTE RLC layer 403, an LTE MAC layer 404, and an LTE PHY layer 405. The New 5G lower layers include a New RLC layer 406, a New MAC layer 407, and a New PHY layer 408. In the case of Integrated eNB 2, some of the functions of the LTE PHY layer 405 (e.g., analog signal processing) may be provided by the RRH for LTE. Similarly, some of the functions of the New PHY layer 408 (e.g., analog signal processing) may be provided by the RRH for New 5G. In addition, in the case of the above-mentioned L2 C-RAN configuration, some of the functions of the New PHY layer, New MAC layer, or New RLC layer (and lower functions) may be provided by the New 5G RU.

[0026] The integrated RRC layer 401 is responsible for control plane functions in the LTE RAT and the New 5G RAT. The main services and functions of the integrated RRC layer 401 include:

- Transmission of system information for non-access stratum (NAS) and access stratum (AS),
- Paging,
- Establishment, maintenance and release of RRC connections,
- Security features, including key management,
- Radio bearer setup, maintenance and release,
- Lower layer protocol (i.e., PDCP, RLC, MAC, PHY) configuration,
- QoS management,
- UE measurement report and its configuration, and
- Transfer of NAS messages between the UE and the core network.

[0027] The integrated RRC layer 401 communicates with the integrated PDCP layer 402 for radio bearer management, control of encryption/decryption of user plane (data radio bearer) data, control of encryption/decryption of control plane (signaling radio bearer) data (RRC PDUs), and control of integrity protection of control plane (signaling radio bearer) data (RRC PDUs). Furthermore, the integrated RRC layer 401 controls the LTE RLC layer 403, the LTE MAC layer 404, and the LTE PHY layer 405, as well as the New RLC layer 406, the New MAC layer 407, and the New PHY layer 408.

[0028] The integrated PDCP layer 402 provides transport services for data radio bearers and signaling radio bearers to the higher layers. The integrated PDCP layer 402 receives services from the LTE RLC layer 403 and the New RLC layer 406. That is, the integrated PDCP layer 402 receives a transfer service of PDCP PDUs via the LTE RAT from the LTE RLC layer 403, and receives a transfer service of PDCP PDUs via the New 5G RAT from the New RLC layer 406.

[0029] It should be noted that the radio protocol stack 400 using the integrated PDCP layer 402 shown in FIG. 4 can be applied not only to co-located deployments (FIGS. 1 and 2) but also to non-co-located deployments (FIG. 3). That is, as shown in FIG. 5, in a non-co-located deployment, an LTE+ eNB 5 is deployed at a site 501 and provides an integrated RRC layer 401, an integrated PDCP layer 402, an LTE RLC layer 403, an LTE MAC layer 404, and an LTE PHY layer 405. On the other hand, 5G specific eNB 6 is located in another site 502 and provides a New RLC layer 406, a New MAC layer 407, and a New PHY layer 408.

[0030] In some implementations, a 5G specific eNB6 used in a non-co-located deployment may have a New RRC layer 511 and a New PDCP layer 512. Moreover, the 5G specific eNB6 may have a control interface or connection (e.g., S1-MME interface, S1-U interface) with a core network (e.g., Integrated EPC41 or 5G specific EPC42) for the 5G UE 1. In some implementations, the New RRC layer 511 may configure the lower layers 406-408 of the New 5G CG (e.g., New 5G cells 23 and 24) and transmit system information (i.e., Master Information Block (MIB) or System Information Blocks (SIBs) or both) via the New 5G CG. The New RRC layer 511 may

set up a signaling radio bearer with the 5G UE 1, set up the lower layers 406 to 408 of the New 5G CG (e.g., New 5G cells 23 and 24) and the New PDCP layer 512, and transmit and receive RRC messages to and from the 5G UE 1 via the New 5G CG. The New RRC layer 511 may transfer NAS messages between the core network (e.g., Integrated EPC 41 or 5G specific EPC 42) and 5G UE 1. The New PDCP layer 512 provides the New RRC layer 511 with RRC message forwarding services via the New 5G lower layers 406-408.

[0031] The new RRC layer 511 may be subordinate to the integrated RRC layer 401 (i.e., a subordinate relationship), or may have the same control as the integrated RRC layer 401 (i.e., have similar functions). In the former case (subordinate relationship), the 5G specific eNB6 (New RRC layer 511) may generate RRC configuration information for the New 5G cell (New 5G CG) in response to an instruction or request from the LTE+ eNB5 (integrated RRC layer 401). The 5G specific eNB6 (New RRC layer 511) may transmit the RRC setting information to the LTE+ eNB5 (integrated RRC layer 401), and the LTE+ eNB5 may transmit an RRC message (e.g., RRC Connection Reconfiguration message) including the RRC setting information to the 5G UE 1 in the LTE cell (LTE CG). Alternatively, the 5G specific eNB6 (New RRC layer 511) may send an RRC message including the RRC configuration information to the 5G UE 1 in the New 5G cell.

[0032] To communicate with the radio network shown in FIG. 5, the 5G UE 1 may support the protocol stack shown in FIG. 4 or a different protocol stack. For example, 5G UE 1 may have an RRC layer (master RRC layer, primary RRC layer) corresponding to the integrated RRC layer 401 of LTE+ eNB5 and an auxiliary RRC layer (sub RRC layer, secondary RRC layer) corresponding to the New RRC layer 511 of 5G specific eNB6. For example, the sub RRC layer may transmit or receive (generate or restore) part of the RRC configuration information controlled by the master RRC layer, or both. For example, 5G UE 1 may receive both the RRC setting information of the LTE cell (LTE CG) and the RRC setting information of the New 5G cell (New 5G CG) in the LTE cell or in the New 5G cell. Alternatively, 5G UE 1 may receive RRC setting information of the LTE cell (LTE CG) in the LTE cell and receive RRC setting information of the New 5G cell (New 5G CG) in the New 5G cell.

[0033] The radio protocol stack shown in FIG. 4 is an example, and the 5G UE 1 and the integrated eNB 2 may support other protocol stacks. For example, in FIG. 4, the integrated PDCP layer 402 integrates (links) the LTE lower layer and the New 5G lower layer. Alternatively, an integrated MAC layer may be used that operates to integrate (interact with) the LTE PHY layer 405 and the New PHY layer 408.

[0034] FIG. 6 illustrates an example of a Layer 2 structure for the uplink according to some embodiments. The Layer 2 structure for the downlink is similar to that shown in FIG. 6, except for a few differences, such as the names of the transport channels. The integrated PDCP layer 602, LTE RLC layer 603, LTE MAC layer 604, New RLC layer 606, and New MAC layer 607 shown in FIG. 6 correspond to the integrated PDCP layer 402, LTE RLC layer 403, LTE MAC layer 404, New RLC layer 406, and New MAC layer 407 shown in FIG. 4 and FIG. 5, respectively.

[0035] The integrated PDCP layer 602 includes one or more PDCP entities. Each PDCP entity carries the data of one radio bearer. Each PDCP entity is associated with either the user plane or the control plane, depending on whether it carries data from a Data Radio Bearer (DRB) or a Signaling Radio Bearer (SRB). In the example of FIG. 6, the integrated PDCP layer 602 includes three PDCP entities 6021, 6022, and 6023 corresponding to three radio bearers #1, #2, and #3, respectively. Each of the radio bearers #1, #2, and #3 may be an SRB or a DRB.

[0036] In addition, data of radio bearer #1 is transmitted from 5G UE 1 to the integrated eNB2 (or LTE+ eNB5) in LTE CG (e.g., LTE cells 21 and 22) via the LTE RAT. Therefore, in the following, radio bearer #1 may also be referred to as an LTE bearer. The radio bearer #1 is a bearer equivalent to an MCG bearer in LTE Release 12 DC.

[0037] The data of radio bearer #2 is transmitted from 5G UE 1 to integrated eNB 2 (or 5G specific eNB 6) in the New 5G CG (e.g., New 5G cells 23 and 24) via the New 5G RAT. Therefore, hereinafter, radio bearer #2 may also be referred to as New 5G Bearer. Here, when data is transmitted in a New 5G CG managed by a 5G specific eNB 6, radio bearer #2 is a bearer equivalent to the SCG bearer of LTE Release 12 DC. On the other hand, when data is transmitted

in a New 5G CG managed by integrated eNB2, radio bearer #2 may correspond to the SCG side bearer of a split bearer in the LTE Release 12 DC.

- [0038] The radio bearer #3 is a bearer equivalent to a split bearer in the LTE Release 12 DC. That is, radio bearer #3 is associated with both one logical channel of the LTE RAT and one logical channel of the New 5G RAT in order to use both LTE CG resources and New 5G CG resources. For user data, the logical channel in the LTE RAT is the Dedicated Traffic Channel (DTCH). The logical channel of the New 5G RAT is a 5G logical channel for user data equivalent to DTCH. Hereinafter, radio bearer #3 may be referred to as a split bearer or an integrated bearer.
- [0039] For uplink transmission by 5G UE 1, the PDCP entity 6021 generates PDCP PDUs from data on radio bearer #1 (LTE bearer) and sends them to the LTE RLC entity 6031. In the case of uplink reception by Integrated eNB2 (or LTE+ eNB5), the PDCP entity 6021 receives RLC SDUs (PDCP PDUs) from the LTE RLC entity 6031 and sends data for radio bearer #1 to the higher layers.
- [0040] For uplink transmission by 5G UE 1, the PDCP entity 6022 generates PDCP PDUs from data on radio bearer #2 (New 5G Bearer) and sends them to the New RLC entity 6061. In the case of uplink reception by Integrated eNB2 (or 5G specific eNB 6), the PDCP entity 6022 receives RLC SDUs (PDCP PDUs) from the New RLC entity 6061 and sends data for radio bearer #2 to the upper layers.
- [0041] For uplink transmission by 5G UE 1, the PDCP entity 6023 generates PDCP PDUs from data on radio bearer #3 (integrated bearer) and routes these PDCP PDUs to the LTE RLC entity 6032 or the New RLC entity 6062. In the case of uplink reception by Integrated eNB 2 (or LTE+ eNB 5 and 5G specific eNB 6), the PDCP entity 6023 reorders the PDCP PDUs (RLC SDUs) received from the LTE RLC entity 6032 and the New RLC entity 6062 and sends the data of radio bearer #3 to the upper layers.
- [0042] Each RLC entity of the LTE RLC layer 603 and the New RLC layer 606 is configured by the integrated RRC entity (RRC entity 401 in FIG. 4) to provide RLC Acknowledged Mode (RLC AM) data transfer or RLC Unacknowledged Mode (RLC UM) data transfer and provides a transfer service for PDCP PDUs. For uplink transmission by 5G UE 1, each RLC entity in the LTE RLC layer 603 generates RLC PDUs (i.e., data for logical channels) from PDCP PDUs (RLC SDUs) and sends them to the MAC entity 6041 in the LTE MAC layer 604. Similarly, each RLC entity in the New RLC layer 606 generates RLC PDUs (i.e., logical channel data) from PDCP PDUs (RLC SDUs) and sends them to the MAC entity 6071 in the New MAC layer 607.
- [0043] In the example of FIG. 6, one MAC entity 6041 is used for two LTE cells (LTE CG) configured in one 5G UE 1. For uplink transmission by 5G UE 1, the MAC entity 6041 multiplexes the RLC PDUs (MAC SDUs) belonging to the two logical channels from the two RLC entities 6031 and 6032 into two transport blocks per Transmission Time Interval (TTI). Here, the two transport blocks per TTI are sent to the LTE physical layer 405 on two UL transport channels (UL-SCHs) corresponding to the two LTE cells 21 and 22.
- [0044] Similarly, one MAC entity 6071 is used for two New 5G cells (New 5G CGs) configured in one 5G UE 1. For uplink transmission by 5G UE 1, the MAC entity 6071 multiplexes RLC PDUs (MAC SDUs) belonging to two logical channels from the two RLC entities 6071 and 6072 into two transport blocks per Transmission Time Interval (TTI). Here, the two transport blocks per TTI are sent to the physical layer 408 for New 5G on two UL transport channels (UL TrCHs) corresponding to the two New 5G cells 23 and 24.
- [0045] As previously described, the Layer 2 structure for the downlink is similar to that shown in FIG. 6, except for a few differences, such as the names of the transport channels. For example, in the case of downlink reception by 5G UE 1, the PDCP entity 6023 of 5G UE 1 reorders the PDCP PDUs (RLC SDUs) received from the LTE RLC entity 6032 and the New RLC entity 6062, and sends the data of radio bearer #3 (integrated bearer) to the upper layers.
- [0046] Next, the control plane (CP) message transmission operation by the 5G UE 1 and integrated eNB2 (or LTE+ eNB 5 and 5G specific eNB 6) in this embodiment will be described below. The 5G UE 1 and the base station system are configured to transmit a CP message (i.e., RRC signaling) in a New 5G cell after the configuration and activation of any New 5G cell is completed, i.e., after the 5G UE 1 becomes available to the New 5G cell. The 5G UE 1 and the base station system may switch the cell in which the CP message is transmitted from the LTE

cell to the New 5G cell. Additionally or alternatively, the 5G UE 1 and base station system may adaptively switch between an LTE cell and a New 5G cell as the cell from which the CP message is transmitted. Here, the CP message includes a NAS message or an RRC message or both. The base station system refers to an integrated eNB2, or an LTE+ eNB 5 and a 5G specific eNB 6.

[0047] More specifically, 5G UE 1 is configured to transmit a CP message to a base station system or receive a CP message from a base station system in any New 5G cell in the New 5G CG when a predetermined condition is met. Similarly, the base station system is configured to transmit a CP message to or receive a CP message from 5G UE 1 in any New 5G cell in the New 5G CG when a predetermined condition is met. The predetermined condition for determining whether the CP message is transmitted in the LTE CG or the New 5G CG relates to at least one of the following:

- (a) the content or type of the CP message;
- (b) the type of signaling radio bearer used to transmit the CP message;
- (c) the sending factors of the CP message; and
- (d) the type of core network associated with the NAS message.

[0048] Here, (a) the condition regarding the content or type of the CP message may be, for example, that the content or type of the CP message corresponds (or does not correspond) to a specific content or type. The specific content or type may be, for example, at least one of a request for terminal measurements on a New 5G cell or a report of the measurement results, a request for or a report of terminal (held) information held by the terminal, access stratum (AS) security setting information on a New 5G cell, an activation request for AS security or a response to the activation request, setting information specific to the New 5G RAT, and control information newly specified by 3GPP for a New 5G cell.

[0049] (b) The condition on the type of signalling radio bearer used for transmitting the CP message may, for example, be that the signalling radio bearer used corresponds (or does not correspond) to a particular signalling radio bearer type. The type of the particular signaling radio bearer may, for example, correspond to a pre-specified LTE SRB0, SRB1, or SRB2, or may be a new signaling radio bearer (e.g., SRBx).

[0050] (c) The condition regarding the CP message sending factor may be, for example, that the CP message sending factor corresponds to (or does not correspond to) a specific sending factor. The specific transmission factor may be, for example, at least one of a deterioration in radio quality of a New 5G cell, a failure to establish a radio link in an LTE cell or a New 5G cell, and a request or response to re-establishment of a radio link following a failure to establish the radio link.

[0051] (d) A condition regarding the type of core network associated with a NAS message may be, for example, that the core network used to transmit the NAS message corresponds (or does not correspond) to a particular core network type. The specific type of core network may be one newly introduced for the New 5G RAT, for example, or may be a unique core network that is prespecified to be used for a predetermined service or function.

[0052] In a first implementation, the 5G UE 1 may determine whether to transmit the RRC message via the New 5G CG or the LTE CG depending on whether the RRC message includes a measurement report message from the 5G UE 1 for one or more New 5G cells in the New 5G CG. That is, when the RRC message includes a measurement result report from 5G UE 1 regarding one or more New 5G cells, 5G UE 1 may transmit the RRC message in any cell within the New 5G CG. The base station system may receive the RRC message in any cell within the New 5G CG. On the other hand, 5G UE 1 may transmit an RRC message in any of the LTE cells if the RRC message includes a report of measurement results from 5G UE 1 regarding one or more LTE cells. Here, the measurement result reports to be transmitted by the New 5G CG and the measurement result reports to be transmitted by the LTE CG may be distinguished (or specified) by the measurement instruction (e.g., MeasConfig IE) or the criteria that define the trigger conditions for the measurement report event (e.g., ReportConfigEUTRA IE). For example, a measurement reporting event targeting a cell of a New 5G CG (e.g., PSCell, special cell, SCell) may be specified, and the 5G UE 1 may transmit a report of a measurement result triggered by the measurement reporting event in any cell of the New 5G CG. The cell-targeted measurement reporting event of the New 5G CG may be defined as an Inter-RAT measurement for an LTE cell.

- [0053] In a second implementation, 5G UE 1 may determine whether to transmit the RRC message via the New 5G CG or the LTE CG depending on whether the RRC message includes a request message (e.g., UE information request message) or a report message (e.g., UE information response message) for 5G UE 1's terminal (held) information regarding the New 5G RAT. That is, when an RRC message includes a report (or request) of 5G UE 1's terminal (possessed) information regarding the New 5G RAT, 5G UE 1 may transmit (or receive) the RRC message in any cell within the New 5G CG. The base station system may receive (or transmit) the RRC message in any cell within the New 5G CG. On the other hand, 5G UE 1 may transmit (or receive) an RRC message in any LTE cell if the RRC message includes a report (or request) of 5G UE 1's terminal (possessed) information regarding the LTE RAT. Furthermore, 5G UE 1 may determine whether to transmit via New 5G CG or LTE CG depending on the type of terminal (held) information requested or reported. The type of device (held) information may be, for example, at least one of the following, or a combination of them:
- Information about radio links;
 - Information about random access; and
 - Information about movement history.
- [0054] The information regarding the radio link may be, for example, information regarding deterioration of radio quality (e.g., radio link disconnection (Radio Link Failure: RLF)) in the LTE CG (e.g., PCell) or New 5G CG (e.g., PSCell, Special cell), or information regarding failure to establish a radio link (e.g., RRC Connection Establishment Failure: CEF, RRC Connection Re-establishment failure). For example, information on degradation of radio quality in the LTE CG may be requested or reported in the LTE CG (or New 5G CG). Similarly, information on degradation of radio quality in the 5G CG may be requested or reported in the New 5G CG (or LTE CG). On the other hand, information on radio link establishment failure may always be requested or reported in the LTE CG (or New 5G CG). In addition, the establishment of a radio link may include a procedure for changing the settings of radio protocols (e.g., RRC, PDCP, RLC, MAC, PHY) using RRC Connection Reconfiguration. Moreover, 5G UE 1 may separately retain information on failure to establish a radio link in LTE CG and information on failure to establish a radio link in New 5G CG.
- [0055] The information about random access (RACH) may be, for example, the number of preamble transmissions performed before random access was successful, and a flag indicating that preamble contention has been detected. For example, information regarding random access in the LTE CG may be requested or reported in the LTE CG (or New 5G CG). Similarly, information regarding random access in the New 5G CG may be requested or reported in the New 5G CG (or LTE CG). In addition, 5G UE 1 may separately hold the number of preamble transmissions in the LTE CG and the number of preamble transmissions in the New 5G CG.
- [0056] The information regarding the mobility history (mobility history report) may be, for example, information regarding the cells in which 5G UE 1 has visited (up to the time when the request to report the information was received) (visited cell information list: VisitedCellInfoList). The visited cell information list may include at least one of the identification information of the visited cell (e.g., CGI, PCI, Carrier frequency) and information on the time (seconds) spent in each cell (timeSpent). Moreover, 5G UE 1 may record the history of specific cells (e.g., PSCell, Special cell) of New 5G cells as information of visited cells specific to New 5G RAT (e.g., VisitedCellInfoList-5G, VisitedCellInfoList-SRAT). Further, the visited cell information list for the LTE RAT may be requested or reported by the LTE CG, and the visited cell information list for the New 5G RAT may be requested or reported by the 5G CG.
- [0057] In a third implementation, the base station system may determine whether to send the RRC message via the New 5G CG or the LTE CG depending on whether the RRC message includes access stratum (AS) security configuration information for one or more New 5G cells in the New 5G CG. That is, the base station system may transmit an RRC message in any cell within the New 5G CG if the RRC message includes AS security setting information for one or more New 5G cells. 5G UE 1 may receive the RRC message in any cell within the New 5G CG. On the other hand, the base station system may transmit the RRC message in any of the LTE cells if the RRC message includes AS security setting information for one or more LTE cells. In addition, security setting information may be transmitted as a NAS message (NAS PDU).

- [0058] In a fourth implementation, the base station system may determine whether to transmit the RRC message via the New 5G CG or the LTE CG depending on whether the RRC message includes an AS security activation request for one or more New 5G cells in the New 5G CG. That is, the base station system may transmit an RRC message in any cell within the New 5G CG if the RRC message includes an AS security activation request (Security Mode Command: SMC) for one or more New 5G cells. 5G UE 1 may receive the RRC message in any cell within the New 5G CG. On the other hand, the base station system may transmit an RRC message in any of the LTE cells if the RRC message includes an activation request for AS security for one or more LTE cells.
- [0059] In a fifth implementation, 5G UE 1 may determine whether to transmit an RRC message via a New 5G CG or an LTE CG depending on whether the RRC message includes a response (Security Mode Complete, Security Mode Failure) to an AS security activation request for one or more New 5G cells. That is, 5G UE 1 may transmit an RRC message in any cell within the New 5G CG if the RRC message includes a response to an AS security activation request for one or more New 5G cells. The base station system may receive the RRC message in any cell within the New 5G CG. On the other hand, 5G UE 1 may send an RRC message in any of the LTE cells if the RRC message includes a response to an AS security activation request for one or more LTE cells.
- [0060] In a sixth implementation, the base station system may determine whether to transmit the RRC message via the New 5G CG or the LTE CG depending on whether the RRC message includes configuration information specific to the New 5G RAT (e.g., SCG configuration for 5G, Secondary RAT (sRAT) configuration). That is, the base station system may transmit the RRC message in any cell within the New 5G CG if the RRC message includes configuration information specific to the New 5G RAT. 5G UE 1 may receive the RRC message in any cell within the New 5G CG. On the other hand, the base station system may transmit an RRC message in any of the LTE cells if the RRC message includes configuration information specific to the LTE RAT. Here, the configuration information specific to the New 5G RAT may be at least one of the following, or a combination of them:
- Information about the device capabilities;
 - Information about the Services; and
 - Information on the management of 5G CG.
- [0061] The information regarding terminal capabilities may be, for example, terminal capabilities related to the New 5G RAT (e.g., UE-EUTRA-CapabilityAddSRAT, UE-EUTRA-Capability-SRAT), or a terminal response to a request (or inquiry) from a base station system regarding functions supported in a New 5G cell, which may be requested (e.g., via UE Capability Enquiry message) and reported (e.g., via UE Capability Information message) in the New 5G CG. Here, to indicate that this is a request for terminal capabilities related to the New 5G RAT, for example, "sRAT" or "eutra2" may be specified and used as the RAT-Type of the UE-CapabilityRequest IE. In addition, at least a portion of the terminal capabilities related to the New 5G RAT required for connecting to a New 5G cell may be transmitted in an LTE cell.
- [0062] The information about the service may be, for example, control information necessary to realize the services provided in the New 5G CG (e.g., Radio resource configuration, Service area information, Service availability information, Service type/category information), or control information about the content of the service (e.g., Content information, Scheduling/planning information). The services referred to here may be services that can be provided in LTE as well, or services that can only be provided in 5G. The service may be, for example, any of the following: Multimedia Broadcast and Multicast Service (MBMS) (MBMS over a Single Frequency Network (MBSFN), single cell point to multipoint (SC-PTM)), Cell Broadcast Service (CBS), Proximity Services (ProSe), Vehicle-to-Everything (V2X) services, or Mobile Edge Computing (MEC).
- [0063] The information regarding the management of the New 5G CG may be, for example, information regarding changes to specific cells (e.g., PSCell, Special cell) of the New 5G CG (e.g., PSCell/Special cell reconfiguration, pSCellToAddMod-r1x). Additionally or alternatively, after configuring a specific New 5G cell (e.g., PSCell, Special cell) for 5G UE 1 (i.e., after the specific 5G cell becomes available), when configuring or releasing another New 5G cell (e.g.,

5G SCell) for 5G UE 1, the base station system may transmit radio resource configuration information (e.g., sCellToAddModListSRAT, sCellToReleaseListSRAT, RadioResourceConfigDedicatedSCellSRAT) of the other New 5G cell as information regarding the management of New 5G CG. That is, information related to the addition and release of cells in a New 5G CG and the change of a specific New 5G cell may be transmitted in any cell of the New 5G CG.

[0064] It should be noted that although the basic configuration information is specific to the New 5G RAT, it may be transmitted in an LTE cell, as long as the basic configuration information is required for 5G UE 1 to connect to (or detect) a New 5G cell. The basic setting information may be, for example, information regarding a subframe configuration (different from LTE), information regarding a TTI length, information regarding a sampling rate, or information regarding a cell type.

[0065] In a sixth implementation, the base station system may determine whether to transmit the RRC message via the New 5G CG or the LTE CG depending on whether the RRC message includes control information newly defined by 3GPP for a New 5G cell. That is, if the RRC message includes control information newly defined for a New 5G cell, the base station system may transmit the RRC message in any cell within the New 5G CG. 5G UE 1 may receive the RRC message in any cell within the New 5G CG. On the other hand, the base station system may transmit an RRC message in any LTE cell if the RRC message contains existing control information for LTE. Here, the control information for the New 5G cell may be at least one or a combination of the following:

- Information about core network selection; and
- Information about the independent operation of New 5G cells.

[0066] The information regarding core network selection may include, for example, a new type of core network associated with the introduction of the New 5G RAT (e.g., 5G specific EPC42). The information regarding the 5G Dedicated Core Network (DCN) is also acceptable. For example, the information regarding core network selection may be identification information (e.g., MME, S-GW, P-GW) of a core network node (e.g., MME ID, MMEC, GUMMEI, MMEGI, GUTI, TAI, TEID), or a request (or notification) for switching the connection of a core network node (e.g., Reroute Command, Reroute Request, Reroute indication, DCN selection information, DCN relocation information). These are needed when switching a connection from an integrated EPC 41 to a 5G specific EPC 42 (or vice versa). Additionally or alternatively, the information regarding core network selection may be assistance information for selecting a 5G specific EPC (5G DCN) 42. The auxiliary information may be, for example, device type, UE usage type, or expected/preferred core network information (expected/preferred CN information). In addition, information regarding core network selection may be transmitted as a NAS message (NAS PDU).

[0067] The information regarding the standalone operation of the New 5G cell may be, for example, configuration information (e.g., Radio resource configuration for 5G/SRAT PCell) required to use the New 5G cell as a primary cell (PCell) instead of using it as a secondary cell (SCell) for the LTE cell (PCell), or information requesting or specifying the use of the New 5G cell as a PCell (e.g., Handover to 5G/SRAT cell, Redirection to 5G/SRAT cell). In addition, this information may be transmitted via a newly defined signaling radio bearer (e.g., SRBx). Furthermore, the information required to set up the SRBx may be transmitted by either a New 5G cell or an LTE cell.

[0068] In the first to sixth implementations described above, the 5G UE 1 and the base station system determine whether to transmit the RRC message via the New 5G CG or the LTE CG depending on whether the RRC message is related to a New 5G RAT or a New 5G cell. Therefore, the 5G UE 1 and the base station system can exchange RRC messages related to the New 5G RAT or New 5G cells via any cell in the New 5G CG. This can contribute, for example, to transmitting RRC messages related to New 5G RATs or New 5G cells with low latency.

[0069] In the seventh implementation, the 5G UE 1 may determine whether to transmit a CP message (i.e., an RRC message or a NAS message) via a New 5G CG or an LTE CG depending on whether the CP message is transmitted via a specific signaling radio bearer associated with a New 5G RAT. That is, when 5G UE 1 transmits a CP message via a specific signaling radio bearer associated with a New 5G RAT, the CP message may be transmitted in any cell within the New

5G CG. The base station system may receive the CP message in any cell within the New 5G CG. In addition, the specific signaling radio bearer may be LTE SRB0, SRB1, or SRB2, or may be a new signaling radio bearer (e.g., SRBx). On the other hand, when 5G UE 1 transmits a CP message via a specific signaling radio bearer associated with the LTE RAT, the CP message may be transmitted in any LTE cell.

[0070] Similarly, in the eighth implementation, the base station system may determine whether to transmit a CP message (i.e., an RRC message or a NAS message) via a New 5G CG or an LTE CG depending on whether the CP message is transmitted via a specific signaling radio bearer associated with a New 5G RAT. That is, when the base station system transmits a CP message via a specific signaling radio bearer associated with the New 5G RAT, the base station system may transmit the CP message in any cell within the New 5G CG. 5G UE 1 may receive the CP message in any cell within the New 5G CG. On the other hand, when the base station system transmits a CP message via a specific signaling radio bearer associated with the LTE RAT, the base station system may transmit the CP message in any of the LTE cells.

[0071] In the seventh and eighth implementations described above, the 5G UE 1 and the base station system determine whether to transmit the CP message via the New 5G CG or the LTE CG depending on whether the signaling radio bearer used for transmitting the CP message is a specific bearer associated with the New 5G RAT. Therefore, 5G UE 1 and the base station system can exchange CP messages related to the New 5G RAT or New 5G cells via any cell in the New 5G CG. This can contribute, for example, to transmitting CP messages related to New 5G RATs or New 5G cells with low latency.

[0072] In a ninth implementation, the 5G UE 1 may determine whether to transmit a CP message (i.e., an RRC message or a NAS message) via the New 5G CG or the LTE CG depending on whether the cause of the transmission of the CP message is deterioration of the radio quality of any of the New 5G cells. That is, when a CP message is transmitted due to deterioration of the radio quality of any New 5G cell, 5G UE 1 may transmit the CP message in any cell within the New 5G CG. The base station system may receive the CP message in any cell within the New 5G CG. This can contribute, for example, to transmitting CP messages related to New 5G RATs or New 5G cells with low latency. On the other hand, if the cause of sending the CP message is deterioration of the radio quality of any LTE cell, 5G UE 1 may send an RRC message including the NAS message in any LTE cell.

[0073] In the tenth implementation, the 5G UE 1 may determine whether to transmit the NAS message via the New 5G CG or the LTE CG depending on whether the core network associated with the NAS message is a new type of core network (e.g., 5G specific EPC42) associated with the introduction of the New 5G RAT. That is, when the core network associated with the NAS message is a new type of core network associated with the introduction of the New 5G RAT, 5G UE 1 may transmit an RRC message including the NAS message in any cell within the New 5G CG. The base station system may receive an RRC message containing the NAS message in any cell within the New 5G CG. This will contribute, for example, to low-latency transmission of NAS messages related to new types of core networks that will come with the introduction of the New 5G RAT. On the other hand, if the core network associated with the NAS message is another core network (e.g., integrated EPC41), 5G UE 1 may send an RRC message including the NAS message in any LTE cell.

[0074] Similarly, in the 11th implementation, the base station system may determine whether to transmit the NAS message via the New 5G CG or the LTE CG depending on whether the core network associated with the NAS message is a new type of core network (e.g., 5G specific EPC42) associated with the introduction of the New 5G RAT. That is, when the core network associated with the NAS message is a new type of core network associated with the introduction of the New 5G RAT, the base station system may transmit an RRC message including the NAS message in any cell within the New 5G CG. 5G UE 1 may receive an RRC message containing the NAS message in any cell within the New 5G CG. On the other hand, when the core network associated with the NAS message is another core network (e.g., integrated EPC41), the base station system may transmit an RRC message including the NAS message in any of the LTE cells.

[0075] In the first to eleventh implementations described above, the transmission or reception of the

RRC message may be performed in a specific cell of the LTE CG or New 5G CG. For example, when an RRC message is transmitted or received in an LTE CG, a primary cell (PCell) may be used. In addition, when an RRC message is transmitted or received in the New 5G CG, a primary/secondary cell (PSCell) may be used. Note that PCell and PSCell are also collectively referred to as a special cell (SpCell).

[0076] In some implementations, the LTE+ eNB5 may send a CP message or information regarding the CP message to be transmitted in the New 5G cell to the 5G specific eNB6. Additionally or alternatively, the 5G specific eNB 6 may send to the LTE+ eNB 5 a CP message or information relating thereto that has been sent or received in the New 5G cell (i.e., sent from the 5G UE 1). Furthermore, the 5G specific eNB 6 may send or receive control plane information (CP messages (e.g., NAS messages, S1 Application Protocol (S1AP) messages)) between nodes (e.g., MME) in the core network (integrated EPC 41 or 5G specific EPC 42).

[0077] FIG. 7 illustrates an example in which an LTE+ eNB 5 sends control plane information (CP message) regarding a new 5G cell to a 5G specific eNB 6. In step 701A or 701B, the 5G specific eNB 6 receives an X2 message from the LTE+ eNB 5 that includes at least control plane information (CP message) regarding the new 5G cell. The X2 message may be a DL USER DATA message of the X2 User Plane Protocol (X2-UP) (step 701A), or may be a newly defined DL CONTROL DATA message. The X2 message may be an X2 AP Message Transfer message of the X2AP (step 701B). Alternatively, the X2 message may be a SeNB Modification Request message (e.g., MeNB to SeNB Container) defined for Dual Connectivity, or a newly defined X2 message (e.g., SeNB Configuration Request message).

[0078] Additionally or alternatively, the 5G specific eNB 6 may receive an S1AP message containing control plane information regarding the New 5G cell from the integrated EPC 41 (e.g., MME 7) or the 5G specific EPC 42 (step 702). The S1AP message may be an MME Configuration Transfer message, an MME Direct Information Transfer message, or any other S1AP message. In step 703, the 5G specific eNB 6 sends an RRC Connection Reconfiguration message to the 5G UE 1 in the New 5G cell, the RRC Connection Reconfiguration message including control plane information (CP message) regarding the New 5G cell received from the LTE+ eNB 5, the integrated EPC 41, or the 5G specific EPC 42.

[0079] FIG. 8 illustrates an example in which a 5G specific eNB 6 sends control plane information (CP message) regarding a New 5G cell to an LTE+ eNB 5. In step 801A or 801B, the 5G specific eNB 6 sends an X2 message to the LTE+ eNB 5, the X2 message including at least control plane information (CP message) regarding the new 5G cell. The X2 message may be an X2AP Message Transfer message (step 801A). Alternatively, the X2 message may be a SeNB Modification Required message defined for Dual Connectivity (Step 801B).

[0080] In response to receiving the X2 message, the LTE+ eNB 5 may initiate a SeNB Modification procedure. For example, the LTE+ eNB 5 may send a SeNB Modification Request message (including an RRC Container: SCG-ConfigInfo) to the 5G specific eNB 6 (step 802). In response to receiving the SeNB Modification Request message, the 5G specific eNB 6 may send a SeNB Modification Request Acknowledge message (including an RRC Container: SCG-Config) to the LTE+ eNB 5 (step 803). In step 803, the 5G specific eNB 6 may send control plane information regarding the 5G cell to the LTE+ eNB 5.

[0081] The 5G specific eNB 6 may receive an S1AP message containing control plane information regarding the new 5G cell from the integrated EPC 41 (e.g., MME 7) or the 5G specific EPC 42 (step 804). In addition, the 5G specific eNB 6 may perform steps 801A or 801B in response to receiving control plane information regarding the 5G cell from the integrated EPC 41 or the 5G specific EPC 42.

[0082] In step 805, the 5G specific eNB 6 sends an RRC Connection Reconfiguration message containing control plane information (CP message) regarding the New 5G cell to the 5G UE 1 in the New 5G cell.

[0083] FIG. 9 illustrates another example in which a 5G specific eNB 6 sends control plane information (CP message) regarding a New 5G cell to an LTE+ eNB 5. In step 901, the 5G specific eNB 6 receives control plane information from the 5G UE 1 in a 5G cell. In step 902, the 5G specific eNB 6 sends an X2 message to the LTE+ eNB 5 that contains at least a portion of the control plane information received from the 5G UE 1. The X2 message may be, for

example, an X2A P Message Transfer message, or a newly defined X2 message (e.g., a SeNB Configuration Update message). In addition, the 5G specific eNB 6 may generate other control information in response to receiving the control plane information from the 5G UE 1 and transmit the other control information to the LTE+ eNB 5 in step 902.

[0084] Further, the 5G specific eNB 6 may send an S1AP message containing at least a portion of the control plane information received from the 5G UE 1 to the integrated EPC 41 (e.g., MME 7) or the 5G specific EPC 42 (step 903). The S1AP message may be, for example, an eNB Configuration Transfer message, an eNB Direct Information Transfer message, or any other S1AP message. The 5G specific eNB 6 may generate other control information in response to receiving the control plane information from the 5G UE 1 and send the other control information to the integrated EPC 41 (e.g., MME 7) or the 5G specific EPC 42 in step 903.

[0085] FIG. 10 is a flowchart showing an example (process 1000) of a CP message transmission operation by a 5G UE 1 and a base station system. In step 1001, the RRC layer (i.e., the integrated RRC layer 401 or the New RRC layer 511) generates an RRC message. The RRC message may be an RRC message carrying a NAS message (e.g., a UL Information Transfer message, a DL Information Transfer message).

[0086] In step 1002, the RRC layer determines whether to transmit the RRC message via the LTE CG or the New 5G CG depending on (a) the content or type of the RRC message, (b) the type of signaling radio bearer used to transmit the RRC message, (c) the transmission cause of the RRC message, or (d) the type of core network associated with the NAS message included in the RRC message. As already described, the RRC layer may transmit the RRC message via any New 5G cell, for example, if the content or type of the RRC message relates to a New 5G RAT or a New 5G cell.

[0087] In step 1003, the RRC layer sends the RRC message to a PDCP entity corresponding to the cell for transmitting the message determined in step 1002. This allows the 5G UE 1 and the base station system to control whether the RRC message or the NAS message contained therein is transmitted via the LTE CG or the New 5G CG.

[0088] <Second embodiment>

Examples of wireless communication networks and wireless protocol stacks according to this embodiment are similar to FIGS. 1-6. In this embodiment, the selection of a key K_{eNB} for deriving temporary keys (e.g., K_{UPenc} , K_{RRCin}) used by each PDCP entity in the PDCP layer (i.e., the integrated PDCP layer 602 or the New PDCP layer 512) is described. These temporary keys are used by each PDCP entity, for example, for ciphering and deciphering User Plane (UP) traffic and RRC traffic. These temporary keys are derived by the 5G UE 1 from the key K_{eNB} . Similarly, these temporary keys are derived from the key K_{eNB} by the integrated eNB2, the LTE+ eNB5, or the 5G specific eNB6.

[0089] In some implementations, the 5G UE 1 and the integrated eNB2 (or the LTE+ eNB5 and the 5G specific eNB6) may use a first key K_{eNB} for encryption/decryption of data of a radio bearer of a certain bearer type, and may use another second key sub- K_{eNB} for encryption/decryption of data of a radio bearer of another bearer type. The second key, sub- K_{eNB} , may be derived from the first key, K_{eNB} , similar to the key S- K_{eNB} used for SCG bearers in Dual Connectivity (DC).

[0090] For example, as shown in FIG. 11, 5G UE 1 and integrated eNB2 (or LTE+ eNB 5 and 5G specific eNB 6) may use a first key K_{eNB} to encrypt/decrypt data of the LTE bearer (radio bearer #1 in FIG. 6) and the integrated bearer (radio bearer #3 in FIG. 6), and may use a second key sub- K_{eNB} to encrypt/decrypt data of the New 5G bearer (radio bearer #2 in FIG. 6).

[0091] For example, in the case of a co-located configuration (FIG. 1 and FIG. 2), 5G UE 1 and integrated eNB 2 may use a first key K_{eNB} when transmitting an RRC message on an LTE bearer, and may also use the same first key K_{eNB} when transmitting an RRC message on a New 5G bearer. In contrast, in the case of a non-co-located deployment (Figure 3), 5G UE 1 and LTE+ eNB5 may use a first key K_{eNB} when transmitting an RRC message on an LTE bearer, and 5G UE 1 and 5G specific eNB6 may use a second key sub- K_{eNB} when transmitting an RRC message on a New 5G bearer.

[0092] Next, configuration examples of the 5GUE 1, the integrated eNB 2, the LTE+ eNB 5, and the 5G specific eNB 6 according to the above-described embodiments will be described below. FIG. 12 is a block diagram illustrating an example configuration of 5G UE 1. The LTE transceiver

1201 performs analog RF signal processing for the PHY layer of the LTE RAT to communicate with the integrated eNB2 (or LTE+ eNB5). The analog RF signal processing performed by the LTE transceiver 1301 includes frequency up-conversion, frequency down-conversion, and amplification. The LTE transceiver 1201 is coupled to an antenna 1202 and a baseband processor 1205. That is, the LTE transceiver 1201 receives modulation symbol data (or OFDM symbol data) from a baseband processor 1205, generates a transmit RF signal, and provides the transmit RF signal to an antenna 1202. The LTE transceiver 1201 also generates a baseband received signal based on the received RF signal received by the antenna 1202 and supplies it to the baseband processor 1205.

[0093] The New 5G transceiver 1203 performs analog RF signal processing for the PHY layer of the New 5G RAT to communicate with the integrated eNB 2 (or 5G specific eNB 6). The New 5G transceiver 1203 is coupled to the antenna 1204 and the baseband processor 1205.

[0094] The baseband processor 1205 performs digital baseband signal processing (data plane processing) and control plane processing for wireless communication. Digital baseband signal processing includes (a) data compression/decompression, (b) data segmentation/concateration, (c) generation/decomposition of transmission formats (transmission frames), (d) transmission channel coding/decoding, (e) modulation (symbol mapping)/demodulation, and (f) generation of OFDM symbol data (baseband OFDM signal) using Inverse Fast Fourier Transform (IFFT). On the other hand, control plane processing includes communication management of Layer 1 (e.g., transmit power control), Layer 2 (e.g., radio resource management and hybrid automatic repeat request (HARQ) processing), and Layer 3 (e.g., signaling related to attachment, mobility, and packet communication).

[0095] For example, in the case of LTE and LTE-Advanced, the digital baseband signal processing by the baseband processor 1205 may include signal processing of a Packet Data Convergence Protocol (PDCP) layer, a Radio Link Control (RLC) layer, a MAC layer, and a PHY layer.

Additionally, the control plane processing by the baseband processor 1205 may include processing of the Non-Access Stratum (NAS) protocol, the RRC protocol, and the MAC CE.

[0096] The baseband processor 1205 may include a modem processor (e.g., Digital Signal Processor (DSP)) that performs digital baseband signal processing and a protocol stack processor (e.g., Central Processing Unit (CPU) or Micro Processing Unit (MPU)) that performs control plane processing. In this case, the protocol stack processor performing the control plane processing may be shared with the application processor 1206 described below.

[0097] The application processor 1206 may also be called a CPU, an MPU, a microprocessor, or a processor core. The application processor 1206 may include multiple processors (multiple processor cores). The application processor 1206 realizes various functions of the 5G UE 1 by executing a system software program (Operating System (OS)) and various application programs (e.g., communication applications that acquire metering data or sensing data) read from the memory 1208 or a memory not shown.

[0098] In some implementations, the baseband processor 1205 and the application processor 1206 may be integrated onto a single chip, as indicated by the dashed line (1207) in FIG. 12. In other words, the baseband processor 1205 and the application processor 1206 may be implemented as a single System on Chip (SoC) device 1207. SoC devices are sometimes called systems Large Scale Integration (LSI) or chipsets.

[0099] The memory 1208 may be a volatile memory or a non-volatile memory, or a combination thereof. The memory 1208 may include multiple physically separate memory devices. Volatile memory can be, for example, Static Random Access Memory (SRAM) or Dynamic RAM (DRAM), or a combination thereof. The non-volatile memory may be a Mask Read Only Memory (MROM), an Electrically Erasable Programmable ROM (EEPROM), a flash memory, or a hard disk drive, or any combination of these. For example, the memory 1208 may include an external memory device accessible from the baseband processor 1205, the application processor 1206, and the SoC 1207. The memory 1208 may include an embedded memory device integrated within the baseband processor 1205, the application processor 1206, or the SoC 1207. Additionally, the memory 1208 may include memory within a Universal Integrated Circuit Card (UICC).

[0100] The memory 1208 may store one or more software modules (computer programs) 1209

containing instructions and data for processing by the 5G UE 1 as described in the above embodiments. In some implementations, the baseband processor 1205 or the application processor 1206 may be configured to read and execute the software module 1209 from the memory 1208 to perform the processing of the 5G UE 1 described in the above embodiments.

[0101] FIG. 13 is a block diagram showing an example of the configuration of the integrated eNB2 according to the above embodiment. Referring to FIG. 13, eNB2 includes an LTE transceiver 1301, a New 5G transceiver 1303, a network interface 1305, a processor 1306, and a memory 1307. The LTE transceiver 1301 performs analog RF signal processing for the PHY layer of the LTE RAT to communicate with the 5G UE 1 via an LTE cell. The LTE transceiver 1301 may include multiple transceivers. The LTE transceiver 1301 is coupled to the antenna 1302 and the processor 1306.

[0102] The New 5G transceiver 1303 performs analog RF signal processing for the PHY layer of the New 5G RAT to communicate with the 5G UE 1 via the New 5G cell. The New 5G transceiver 1303 is coupled to the antenna 1304 and the baseband processor 1306.

[0103] The network interface 1305 is used to communicate with network nodes within the integrated EPC 41 or 5G specific EPC 42 (e.g., Mobility Management Entity (MME) and Serving Gateway (S-GW)) and other eNBs. The network interface 1305 may include, for example, a network interface card (NIC) that complies with the IEEE 802.3 series.

[0104] The processor 1306 performs digital baseband signal processing (data plane processing) and control plane processing for wireless communication. For example, in the case of LTE and LTE-Advanced, the digital baseband signal processing by the processor 1306 may include signal processing of a PDCP layer, an RLC layer, a MAC layer, and a PHY layer. Additionally, the control plane processing by the processor 1306 may include processing of the S1 protocol, the RRC protocol, and the MAC CE.

[0105] The processor 1306 may include multiple processors. For example, the processor 1306 may include a modem processor (e.g., DSP) that performs digital baseband signal processing and a protocol stack processor (e.g., CPU or MPU) that performs control plane processing.

[0106] The memory 1307 is comprised of a combination of volatile and non-volatile memory. The volatile memory is, for example, SRAM or DRAM or a combination of both. The non-volatile memory is, for example, an MROM, a PROM, a flash memory, or a hard disk drive, or a combination of these. The memory 1307 may include storage located remotely from the processor 1306. In this case, the processor 1306 may access the memory 1307 via the network interface 1305 or an I/O interface not shown.

[0107] The memory 1307 may store software modules (computer programs) 1308 including instructions and data for performing processing by the integrated eNB 2 as described in the above embodiments. In some implementations, the processor 1306 may be configured to read and execute the software modules 1308 from the memory 1307 to perform the processing of the integrated eNB 2 described in the above embodiments.

[0108] The configuration of each of the LTE+ eNB 5 and the 5G specific eNB 6 may be similar to the configuration of the integrated eNB 2 shown in FIG. 13. However, the LTE+ eNB 5 does not need to be equipped with a New 5G transceiver 1303, and the 5G specific eNB 6 does not need to be equipped with an LTE transceiver 1301.

[0109] As described with FIGS. 12 and 13, each of the processors in the 5G UE 1, integrated eNB 2, LTE+ eNB 5, and 5G specific eNB 6 according to the above-mentioned embodiments executes one or more programs including instructions for causing a computer to perform the algorithms described using the drawings. The program may be stored and provided to a computer using various types of non-transitory computer readable media. Non-transitory computer readable media include various types of tangible storage media. Examples of non-transitory computer-readable media include magnetic recording media (e.g., floppy disks, magnetic tapes, hard disk drives), magneto-optical recording media (e.g., magneto-optical disks), Compact Disc Read Only Memory (CD-ROM), CD-R, CD-R/W, and semiconductor memory (e.g., mask ROM, Programmable ROM (PROM), Erasable PROM (EPROM), flash ROM, Random Access Memory (RAM)). The program may also be provided to the computer by various types of transitory computer readable media. Examples of transitory computer-readable media include electrical signals, optical signals, and electromagnetic waves. The temporary computer-readable

medium can supply the program to the computer via a wired communication path such as an electric wire or an optical fiber, or via a wireless communication path.

[0110] <Other embodiments>

The above-described embodiments may be implemented independently, or may be implemented in appropriate combination.

[0111] The protocol stacks described in the above embodiments are merely examples, and other protocol stacks may be adopted for interworking between the LTE RAT and the New 5G RAT. In some implementations, the existing LTE/LTE-Advanced Carrier Aggregation (CA) or Dual Connectivity (DC) protocol stacks, or suitable modifications thereof, may be adopted for interworking between the LTE RAT and the New 5G RAT. For example, in a co-located deployment or a co-located RAN, an integrated MAC layer (sub-layer) may be used instead of an integrated PDCP layer (sub-layer). In this case, the integrated MAC layer may control the LTE PHY layer and the New PHY layer and perform CA between the LTE cell and the New 5G cell.

[0112] The base station, base station system, Integrated eNB2, LTE+ eNB5, 5G specific eNB6, BBU (or DU), and RRH (or RU) described in the above embodiments can be referred to as radio stations or Radio Access Network (RAN) nodes. In other words, the processes and operations performed by the base station, base station system, Integrated eNB2, LTE+ eNB5, 5G specific eNB6, BBU (DU), or RRH (RU) described in the above embodiments may be provided by any one or more radio stations (RAN nodes).

[0113] Furthermore, the above-described embodiments are merely examples of applications of the technical ideas obtained by the inventors of the present invention. In other words, the technical concept is not limited to the above-described embodiment, and various modifications are possible.

[0114] For example, some or all of the above embodiments may be described as, but are not limited to, the following supplementary notes.

[0115] (Note 1)

A radio station system comprising:

one or more radio stations configured to simultaneously provide one or more first cells

according to a first radio access technology and one or more second cells according to a second radio access technology used subordinately in addition to the one or more first cells to a radio terminal; and

configured to transmit or receive control plane messages in the one or more second cells to the radio terminal when a predetermined condition is satisfied,

the control plane messages including non-access stratum (NAS) messages or radio resource control (RRC) messages or both,

the predetermined condition relating to at least one of (a) content or type of the control plane messages, (b) a type of signaling radio bearer used to transmit the control plane messages, (c) a transmission cause of the control plane messages, and (d) a type of core network associated with the NAS messages.

[0116] (Note 2)

The radio station system described in Supplementary Note 1,

wherein the specified condition relates to a content or type of the control plane message, and the one or more radio stations are configured to transmit or receive the control plane message in the one or more second cells when the control plane message includes a request to the radio terminal for terminal measurements regarding the one or more second cells or a report of measurement results from the radio terminal regarding the one or more second cells

[0117] (Note 3)

The radio station system described in Supplementary Note 1,

The one or more radio stations are configured to transmit or receive the control plane message in the one or more second cells when the control plane message includes a request to the radio terminal for terminal information of the radio terminal related to the second radio access technology or a report of the terminal information from the radio terminal.

[0118] (Note 4)

The radio station system described in Supplementary Note 1,

The one or more wireless stations transmit the control plane message to the control plane message when the control plane message includes access stratum (AS) security configuration information for the one or more second cells. The radio station system according to Note 1, configured to transmit in one or more second cells.

[0119] (Note 5)

The radio station system described in Supplementary Note 1,

The one or more wireless stations may be configured such that the control plane message is a request to the wireless terminal for activation of access stratum (AS) security for the one or more second cells, or the wireless station system according to Note 1, wherein the wireless station system is configured to transmit or receive the control plane message in the one or more second cells when it includes a response from a wireless terminal.

[0120] (Note 6)

The radio station system described in Supplementary Note 1,

The one or more radio stations are configured to transmit the control plane message in the one or more second cells if the control plane message includes configuration information specific to the second radio access technology.

[0121] (Note 7)

The predetermined condition relates to a type of signaling radio bearer used for transmitting the control plane message,

and the one or more radio stations are configured to transmit or receive the control plane message in the one or more second cells if the control plane message is transmitted via a particular signaling radio bearer associated to the second radio access technology.

[0122] (Note 8)

The predetermined condition relates to a cause of transmission of the control plane message,

and the one or more radio stations are configured to receive the control plane message in the one or more second cells when the control plane message is transmitted due to deterioration of radio quality in the one or more second cells.

[0123] (Note 9)

The predetermined condition relates to a type of a core network associated with the NAS message,

and the one or more radio stations are configured to transmit or receive the control plane message including the NAS message in the one or more second cells when the core network is a new type of core network resulting from the introduction of the second radio access technology.

[0124] (Note 10)

The one or more radio stations are configured to provide a Radio Link Control (RLC) and Medium Access Control (MAC) layer for communicating with the radio terminal according to the first radio access technology, a Radio Link Control (RLC) and Medium Access Control (MAC) layer for communicating with the radio terminal according to the second radio access technology, a common Packet Data Convergence Protocol (PDCP) layer associated with both of the two RLC layers, and a common RRC layer associated with the common PDCP layer.

[0125] (Note 11)

The one or more radio stations of the radio station system described in any one of Notes 1 to 9 include a first radio station for the first radio access technology and a second radio station for the second radio access technology;

the second radio station providing a Radio Link Control (RLC) and Medium Access Control (MAC) layer for communicating with the radio terminal according to the second radio access technology;

and the first radio station configured to provide a Radio Link Control (RLC) and Medium Access Control (MAC) layer for communicating with the radio terminal according to the first radio access technology, a common Packet Data Convergence Protocol (PDCP) layer associated

with both of the two RLC layers, and a common RRC layer associated with the common PDCP layer

[0126] (Note 12)

The radio station system according to any one of Supplementary Notes 1 to 11, wherein the first radio access technology is a continuing evolution of LTE and LTE-Advanced, and the second radio access technology is a new 5G radio access technology

[0127] (Note 13)

A method in a radio station system including one or more radio stations, comprising: simultaneously providing one or more first cells according to a first radio access technology and one or more second cells according to a second radio access technology used subordinately in addition to the one or more first cells to a radio terminal;

transmitting or receiving a control plane message in the one or more second cells to the radio terminal when a predetermined condition is satisfied; and

the control plane messages including non-access stratum (NAS) messages or radio resource control (RRC) messages or both,

the predetermined condition relating to at least one of: (a) a content or type of the control plane message; (b) a type of signaling radio bearer used to transmit the control plane message; (c) a transmission cause of the control plane message; and (d) a type of core network associated with the NAS message

[0128] (Note 14)

A memory, at least one processor coupled to the memory, and

the at least one processor in addition to one or more first cells according to a first radio access technology and the one or more first cells;

configured to communicate with a wireless station system including one or more wireless stations simultaneously in one or more second cells according to a second wireless access technology used in a dependent manner; and

a wireless terminal configured to transmit or receive a control plane message to or from the wireless station system in the one or more second cells when a predetermined condition is met

the control plane messages including non-access stratum (NAS) messages or radio resource control (RRC) messages or both,

the predetermined condition relating to at least one of: (a) a content or type of the control plane message; (b) a type of signaling radio bearer used to transmit the control plane message; (c) a transmission cause of the control plane message; and (d) a type of core network associated with the NAS message

[0129] (Note 15)

The radio station system described in Supplementary Note 1,

The wireless terminal of Note 14, wherein the at least one processor is configured to receive or transmit the control plane message in the one or more second cells when the control plane message includes a request to the wireless terminal for terminal measurements regarding the one or more second cells or a report of measurement results from the wireless terminal regarding the one or more second cells

[0130] (Note 16)

The radio station system described in Supplementary Note 1,

At least one processor is configured to receive or transmit the control plane message in the one or more second cells when the control plane message includes a request to the wireless terminal for terminal information of the wireless terminal related to the second radio access technology or a report of the terminal information from the wireless terminal.

- [0131] (Note 17)
The radio station system described in Supplementary Note 1,
At least one processor is configured to receive the control plane message at the one or more second cells when the control plane message includes security configuration information of an access stratum (AS) for the one or more second cells.
- [0132] (Note 18)
The radio station system described in Supplementary Note 1,
At least one processor is configured to receive or transmit the control plane message in the one or more second cells when the control plane message includes a request to the wireless terminal or a response to the request from the wireless terminal for activation of access stratum (AS) security for the one or more second cells.
- [0133] (Note 19)
The radio station system described in Supplementary Note 1,
At least one processor is configured to receive the control plane message in the one or more second cells if the control plane message includes configuration information specific to the second radio access technology.
- [0134] (Note 20)
The predetermined condition relates to a type of signaling radio bearer used for transmitting the control plane message,
At least one processor is configured to receive or transmit the control plane message in the one or more second cells when the control plane message is transmitted over a particular signaling radio bearer associated with the second radio access technology.
- [0135] (Note 21)
The predetermined condition relates to a cause of transmission of the control plane message,
At least one processor is configured to transmit the control plane message in the one or more second cells when the control plane message is transmitted due to deterioration of radio quality of the one or more second cells.
- [0136] (Note 22)
The predetermined condition relates to a type of a core network associated with the NAS message,
At least one processor is configured to receive or transmit the control plane message including the NAS message in the one or more second cells when the core network is a new type of core network associated with the introduction of the second radio access technology.
- [0137] (Note 23)
The wireless terminal as described in any one of Notes 14 to 22, wherein at least one processor is configured to provide a Radio Link Control (RLC) and Medium Access Control (MAC) layer for communicating with the wireless station system according to the first radio access technology, a Radio Link Control (RLC) and Medium Access Control (MAC) layer for communicating with the wireless station system according to the second radio access technology, a common Packet Data Convergence Protocol (PDCP) layer associated with both of the two RLC layers, and a common RRC layer associated with the common PDCP layer
- [0138] (Note 24)
The radio station system according to any one of Supplementary Notes 1 to 11, wherein the first radio access technology is a continuing evolution of LTE and LTE-Advanced,
and the second radio access technology is a new 5G radio access technology
A wireless terminal according to any one of Notes 14 to 23.
- [0139] (Note 25)

A method in a wireless terminal, comprising:

communicating with a wireless station system including one or more wireless stations simultaneously in one or more first cells according to a first wireless access technology and in one or more second cells according to a second wireless access technology used subordinately in addition to the one or more first cells; and

transmitting or receiving a control plane message to or from the wireless station system in the one or more second cells when a predetermined condition is satisfied.

and

the control plane messages including non-access stratum (NAS) messages or radio resource control (RRC) messages or both,

the predetermined condition relating to at least one of: (a) a content or type of the control plane message; (b) a type of signaling radio bearer used to transmit the control plane message; (c) a transmission cause of the control plane message; and (d) a type of core network associated with the NAS message

[0140] (Note 26)

A non-transitory computer-readable medium storing a program for causing a computer to perform a method in a wireless terminal,

wherein

communicating with a wireless station system including one or more wireless stations simultaneously in one or more first cells according to a first wireless access technology and in one or more second cells according to a second wireless access technology used subordinately in addition to the one or more first cells; and

transmitting or receiving a control plane message to or from the wireless station system in the one or more second cells when a predetermined condition is satisfied.

and

the control plane messages including non-access stratum (NAS) messages or radio resource control (RRC) messages or both,

the predetermined condition relates to at least one of: (a) the content or type of the control plane message, (b) the type of signaling radio bearer used to transmit the control plane message, (c) the transmission cause of the control plane message, and (d) the type of core network associated with the NAS message.

[0141] This application claims priority based on Japanese Patent Application No. 2016-002879, filed on January 8, 2016, the disclosure of which is incorporated herein in its entirety.

Reference Signs List

- [0142]
- 1 wireless terminal (5G UE)
 - 2 Base stations (integrated eNB)
 - 3 RRH
 - 5 LTE+ eNB
 - 6 5G Specific eNB
 - 41 Integrated EPC
 - 42 5G specific EPC
 - 1201 LTE transceiver
 - 1203 New 5G transceiver
 - 1205 Baseband processor
 - 1206 Application processor
 - 1208 Memory
 - 1301 LTE transceiver
 - 1303 New 5G transceiver
 - 1306 Processor
 - 1307 Memory

SCOPE OF CLAIMS

- [Claim 1] A radio station system comprising one or more radio stations and one or more radio stations configured to simultaneously provide one or more first cells
 configured to simultaneously provide one or more first cells conforming to a first radio access technology and one or more second cells conforming to a second radio access technology used subordinately in addition to the one or more first cells to one radio terminal,
 configured to transmit or receive control plane messages in the one or more second cells to the radio terminal when a predetermined condition is satisfied,
 the control plane messages including non-access stratum (NAS) messages or radio resource control (RRC) messages or both,
 wherein the predetermined condition relates to at least one of (a) the content or type of the control plane message, (b) the type of signaling radio bearer used to transmit the control plane message, (c) the transmission cause of the control plane message, and (d) the type of core network associated with the NAS message
- [Claim 2] The radio station system according to claim 1, wherein the predetermined condition relates to a content or a type of the control plane message
 wherein the specified condition relates to a content or type of the control plane message, and the one or more radio stations are configured to transmit or receive the control plane message in the one or more second cells when the control plane message includes a request to the radio terminal for terminal measurements regarding the one or more second cells or a report of measurement results from the radio terminal regarding the one or more second cells
- [Claim 3] The predetermined condition is related to the content or type of the control plane message.
 The one or more radio stations are configured to transmit or receive the control plane message in the one or more second cells when the control plane message includes a request to the radio terminal for terminal information of the radio terminal related to the second radio access technology or a report of the terminal information from the radio terminal.
- [Claim 4] The predetermined condition is related to the content or type of the control plane message,
 and the one or more radio stations are configured to transmit the control plane message in the one or more second cells if the control plane message includes security configuration information of an access stratum (AS) for the one or more second cells.
- [Claim 5] The predetermined condition is related to the content or type of the control plane message,
 and the one or more radio stations are configured to transmit or receive the control plane message in the one or more second cells if the control plane message includes a request to the radio terminal or a response to the request from the radio terminal for activation of access stratum (AS) security for the one or more second cells.
- [Claim 6] The predetermined condition is related to the content or type of the control plane message.
 The one or more radio stations are configured to transmit the control plane message in the one or more second cells if the control plane message includes configuration information specific to the second radio access technology.
- [Claim 7] The predetermined condition relates to a type of signaling radio bearer used for transmitting the control plane message.

and the one or more radio stations are configured to transmit or receive the control plane message in the one or more second cells if the control plane message is transmitted via a particular signaling radio bearer associated to the second radio access technology.

[Claim 8] The predetermined condition relates to a cause for transmitting the control plane message,
and the one or more radio stations are configured to receive the control plane message in the one or more second cells when the control plane message is transmitted due to deterioration of radio quality in the one or more second cells.

[Claim 9] The predetermined condition relates to a type of a core network associated with the NAS message.
and the one or more radio stations are configured to transmit or receive the control plane message including the NAS message in the one or more second cells when the core network is a new type of core network resulting from the introduction of the second radio access technology.

[Claim 10] The radio station system according to any one of Claims 1 to 9, wherein the one or more radio stations are configured to provide a Radio Link Control (RLC) and Medium Access Control (MAC) layer for communicating with the radio terminal according to the first radio access technology, a Radio Link Control (RLC) and Medium Access Control (MAC) layer for communicating with the radio terminal according to the second radio access technology, a common Packet Data Convergence Protocol (PDCP) layer associated with both of the two RLC layers, and a common RRC layer associated with the common PDCP layer

[Claim 11] The one or more radio stations include a first radio station for the first radio access technology and a second radio station for the second radio access technology,
the second radio station providing a Radio Link Control (RLC) and Medium Access Control (MAC) layer for communicating with the radio terminal according to the second radio access technology;
the first radio station configured to provide a Radio Link Control (RLC) and Medium Access Control (MAC) layer for communicating with the wireless terminal according to the first radio access technology, a common Packet Data Convergence Protocol (PDCP) layer associated with both of the two RLC layers, and a common RRC layer associated with the common PDCP layer.

[Claim 12] The radio station system according to any one of claims 1 to 11, wherein the first radio access technology is a continuation of LTE and LTE-Advanced.
and the second radio access technology is a new 5G radio access technology

[Claim 13] A method in a radio station system including one or more radio stations, comprising:
simultaneously providing one or more first cells according to a first radio access technology and one or more second cells according to a second radio access technology used in addition to and subordinate to the one or more first cells to a radio terminal; and
transmitting or receiving a control plane message in the one or more second cells to the radio terminal when a predetermined condition is satisfied;
and
the control plane messages including non-access stratum (NAS) messages or radio resource control (RRC) messages or both,
wherein the predetermined condition relates to at least one of (a) the content or type of the control plane message, (b) the type of signaling radio bearer used to transmit the control plane message, (c) the transmission cause of the control plane message, and (d) the type of core network associated with the NAS message

- [Claim 14] A memory,
 at least one processor coupled to the memory,
 and
 the at least one processor in addition to one or more first cells according to a first radio access technology and the one or more first cells;
 configured to communicate with a radio station system including one or more radio stations simultaneously in one or more first cells according to a first radio access technology and one or more second cells according to a second radio access technology used in addition to and subordinate to the one or more first cells; and
 a wireless terminal configured to transmit or receive a control plane message to or from the wireless station system in the one or more second cells when a predetermined condition is met
 the control plane messages including non-access stratum (NAS) messages or radio resource control (RRC) messages or both,
 wherein the predetermined condition relates to at least one of (a) the content or type of the control plane message, (b) the type of signaling radio bearer used to transmit the control plane message, (c) the transmission cause of the control plane message, and (d) the type of core network associated with the NAS message
- [Claim 15] The wireless terminal according to claim 14, wherein the predetermined condition relates to content or type of the control plane message
 The wireless terminal of Note 14, wherein the at least one processor is configured to receive or transmit the control plane message in the one or more second cells when the control plane message includes a request to the wireless terminal for terminal measurements regarding the one or more second cells or a report of measurement results from the wireless terminal regarding the one or more second cells
- [Claim 16] The predetermined condition is related to the content or type of the control plane message.
 At least one processor is configured to receive or transmit the control plane message in the one or more second cells when the control plane message includes a request to the wireless terminal for terminal information of the wireless terminal related to the second radio access technology or a report of the terminal information from the wireless terminal.
- [Claim 17] The predetermined condition is related to the content or type of the control plane message.
 At least one processor is configured to receive the control plane message at the one or more second cells when the control plane message includes security configuration information of an access stratum (AS) for the one or more second cells.
- [Claim 18] The predetermined condition is related to the content or type of the control plane message.
 At least one processor is configured to receive or transmit the control plane message in the one or more second cells when the control plane message includes a request to the wireless terminal or a response to the request from the wireless terminal for activation of access stratum (AS) security for the one or more second cells.
- [Claim 19] The predetermined condition is related to the content or type of the control plane message.
 At least one processor is configured to receive the control plane message in the one or more second cells if the control plane message includes configuration information specific to the second radio access technology.
- [Claim 20] The predetermined condition relates to a type of signaling radio bearer used for

transmitting the control plane message.

At least one processor is configured to receive or transmit the control plane message in the one or more second cells when the control plane message is transmitted over a particular signaling radio bearer associated with the second radio access technology.

[Claim 21] The predetermined condition relates to a cause for transmitting the control plane message,
 and at least one processor is configured to transmit the control plane message in the one or more second cells when the control plane message is transmitted due to deterioration of radio quality of the one or more second cells.

[Claim 22] The predetermined condition relates to a type of a core network associated with the NAS message,
 and the at least one processor is configured to receive or transmit the control plane message including the NAS message in the one or more second cells when the core network is a new type of core network associated with the introduction of the second radio access technology.

[Claim 23] At least one processor of the radio terminal according to any one of claims 14 to 22 is configured to provide a Radio Link Control (RLC) and Medium Access Control (MAC) layer for communicating with the radio station system according to the first radio access technology, a Radio Link Control (RLC) and Medium Access Control (MAC) layer for communicating with the radio station system according to the second radio access technology, a common Packet Data Convergence Protocol (PDCP) layer associated with both of the two RLC layers, and a common RRC layer associated with the common PDCP layer

[Claim 24] The radio terminal according to any one of Claims 14 to 23, wherein the first radio access technology is a further evolution of LTE and LTE-Advanced
 and the second radio access technology is a new 5G radio access technology

[Claim 25] A method in a wireless terminal, comprising:
 communicating with a wireless station system including one or more wireless stations simultaneously in one or more first cells according to a first wireless access technology and in one or more second cells according to a second wireless access technology used subordinately in addition to the one or more first cells; and transmitting or receiving a control plane message to or from the wireless station system in the one or more second cells when a predetermined condition is satisfied.

and

the control plane messages including non-access stratum (NAS) messages or radio resource control (RRC) messages or both,

wherein the predetermined condition relates to at least one of (a) the content or type of the control plane message, (b) the type of signaling radio bearer used to transmit the control plane message, (c) the transmission cause of the control plane message, and (d) the type of core network associated with the NAS message

[Claim 26] A non-transitory computer-readable medium having stored thereon a program for causing a computer to perform a method in a wireless terminal, the method comprising:
 wherein

communicating with a wireless station system including one or more wireless stations simultaneously in one or more first cells conforming to a first wireless access technology and one or more second cells conforming to a second wireless access technology used subordinately in addition to the one or more first cells,

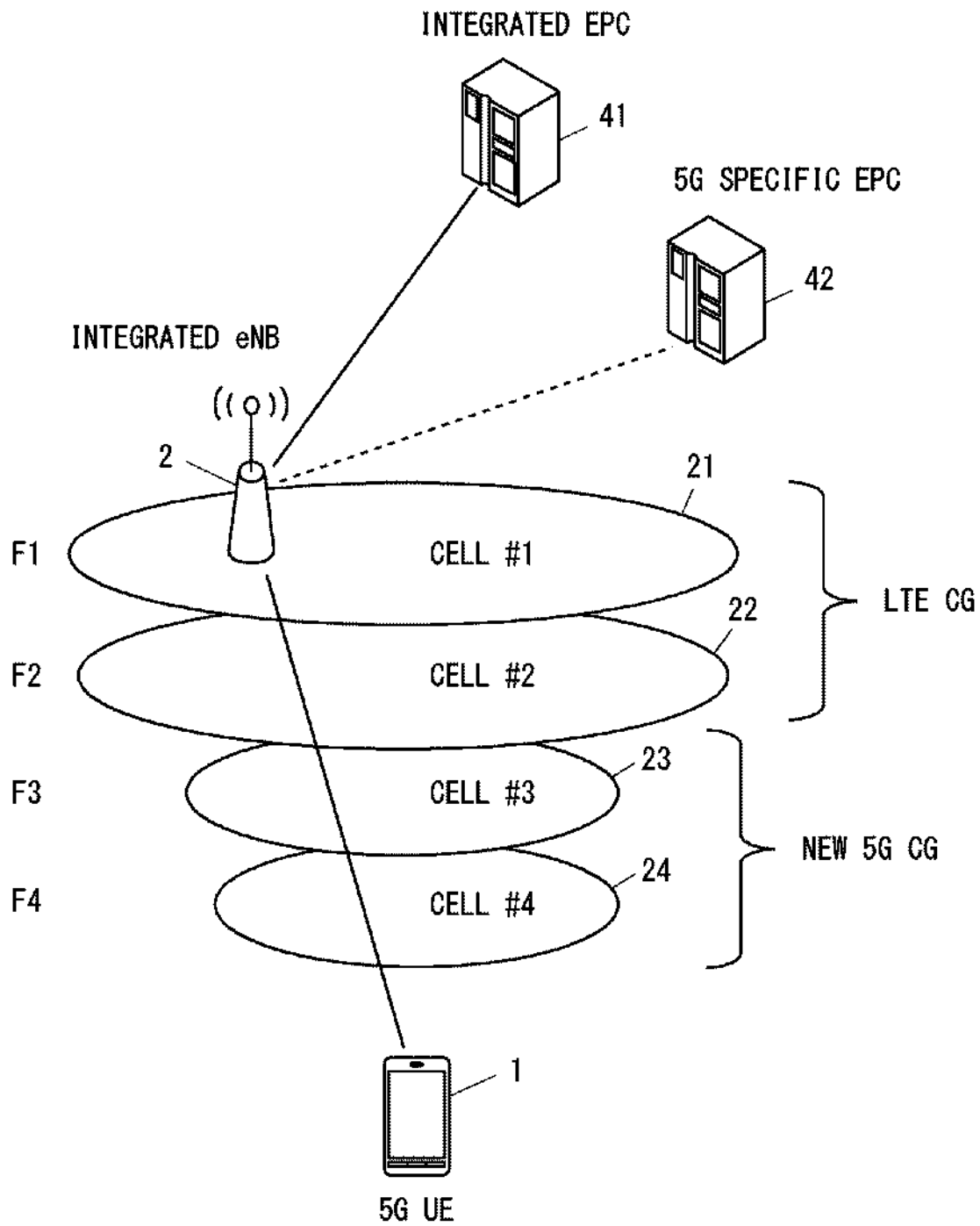
transmitting or receiving a control plane message to or from the wireless station system in the one or more second cells when a predetermined condition is satisfied.

and

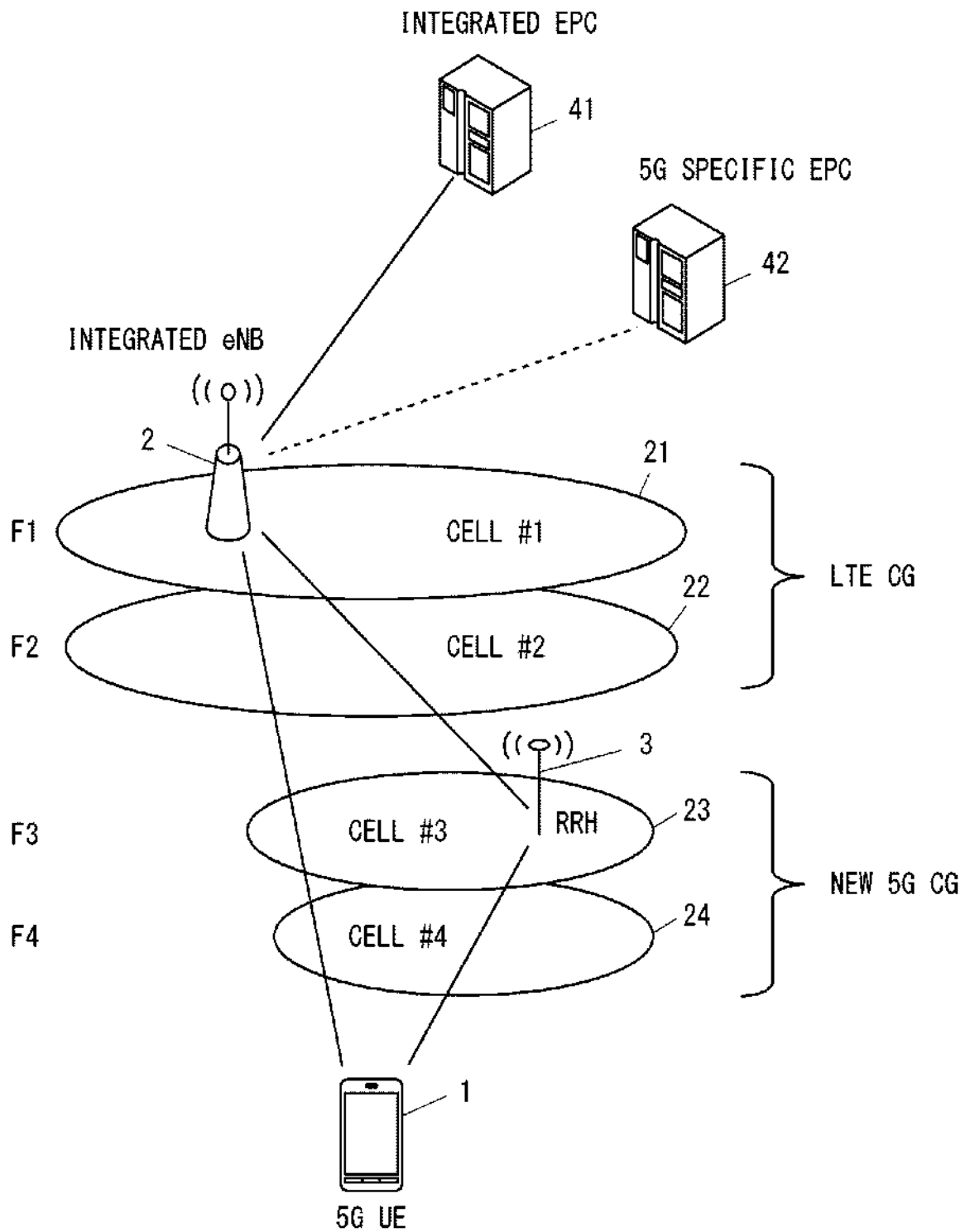
the control plane messages including non-access stratum (NAS) messages or radio resource control (RRC) messages or both,

wherein the predetermined condition relates to at least one of (a) the content or type of the control plane message, (b) the type of signaling radio bearer used to transmit the control plane message, (c) the transmission cause of the control plane message, and (d) the type of core network associated with the NAS message
the non-transitory computer-readable medium.

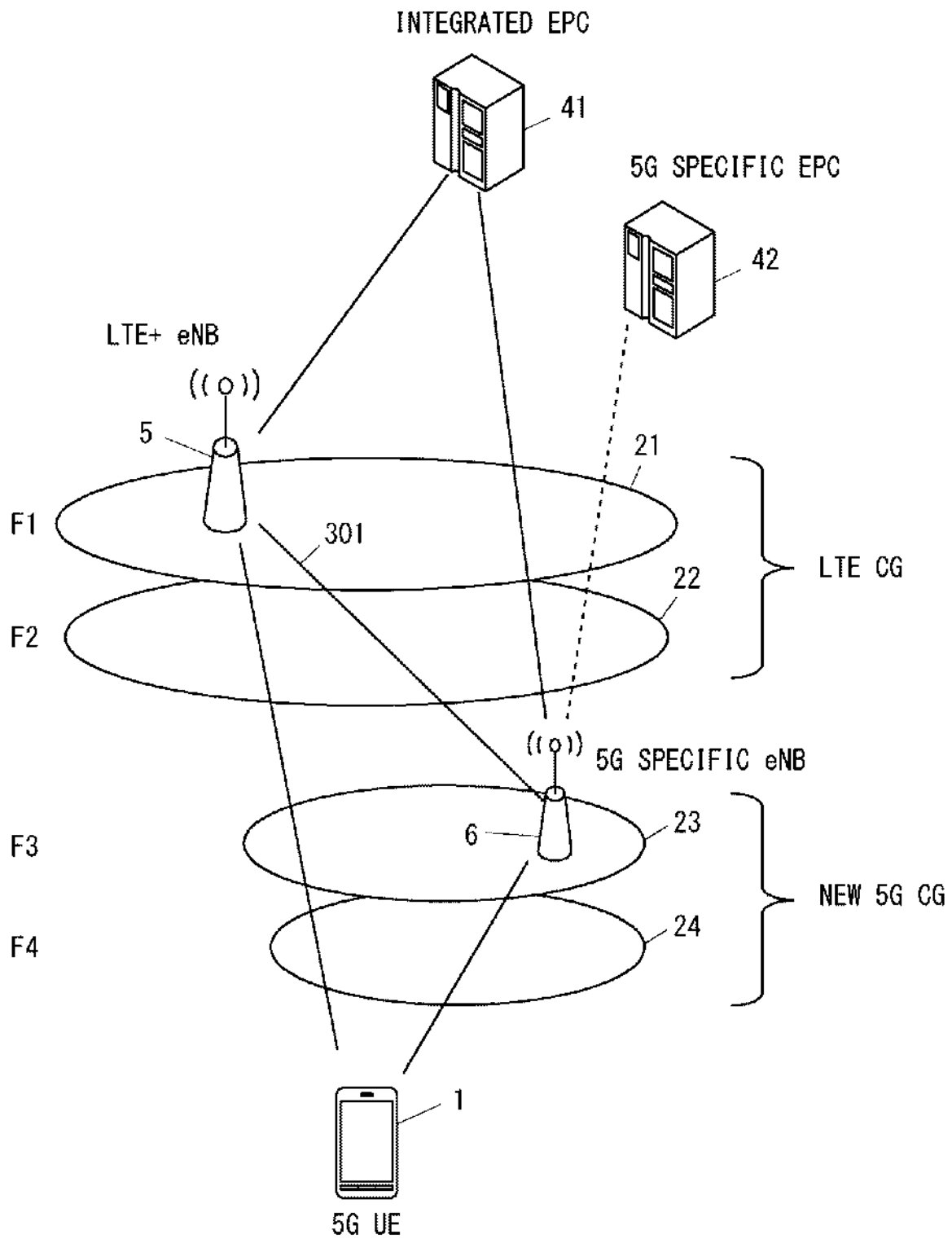
[FIG. 1]



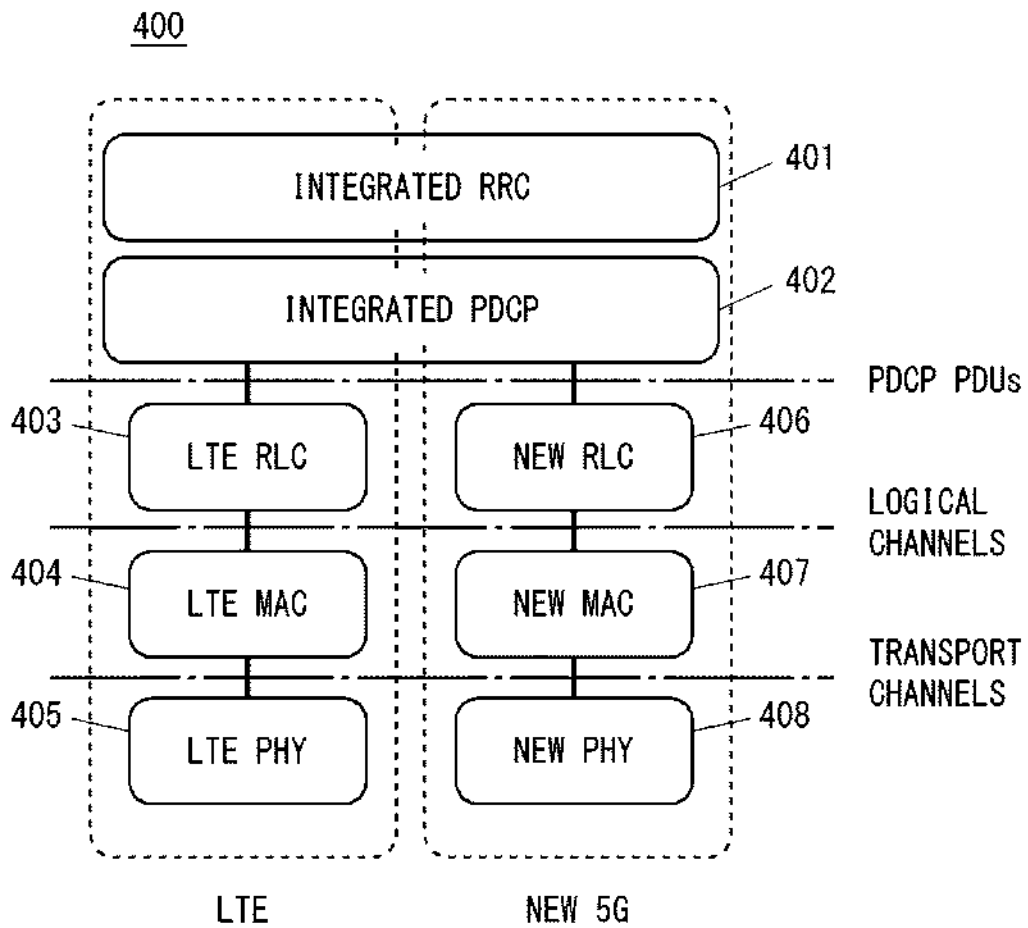
[FIG. 2]



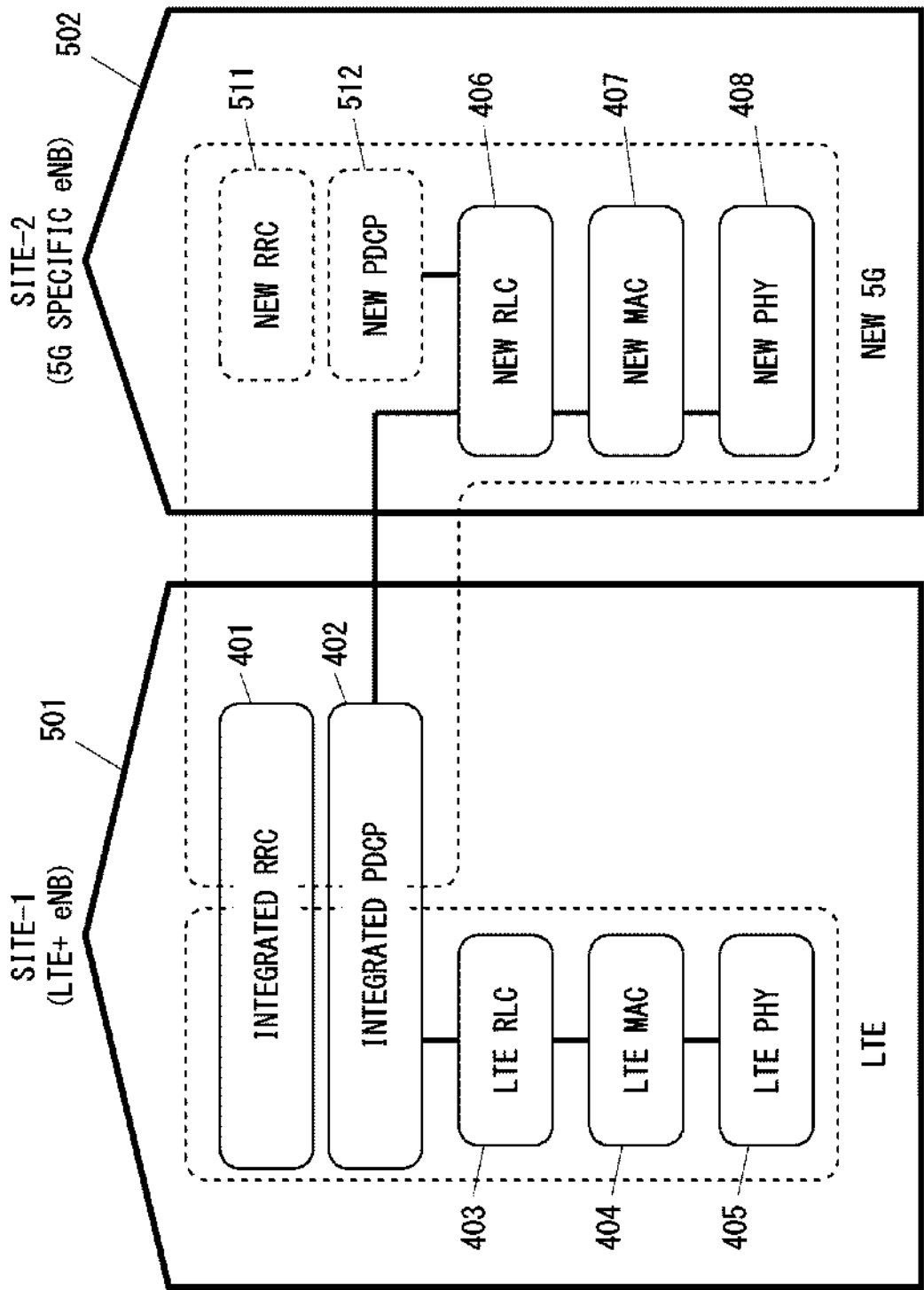
[FIG. 3]



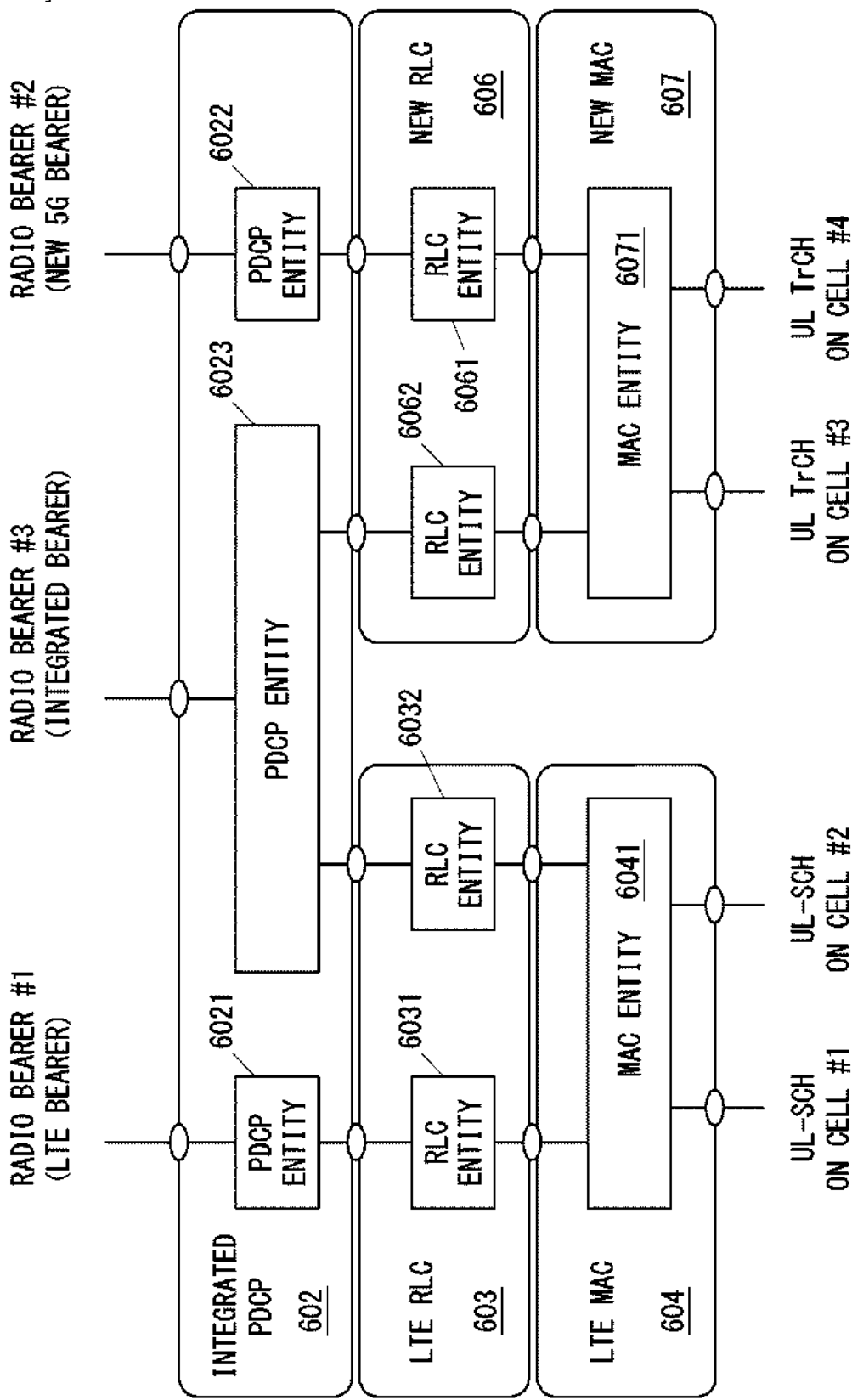
[FIG. 4]



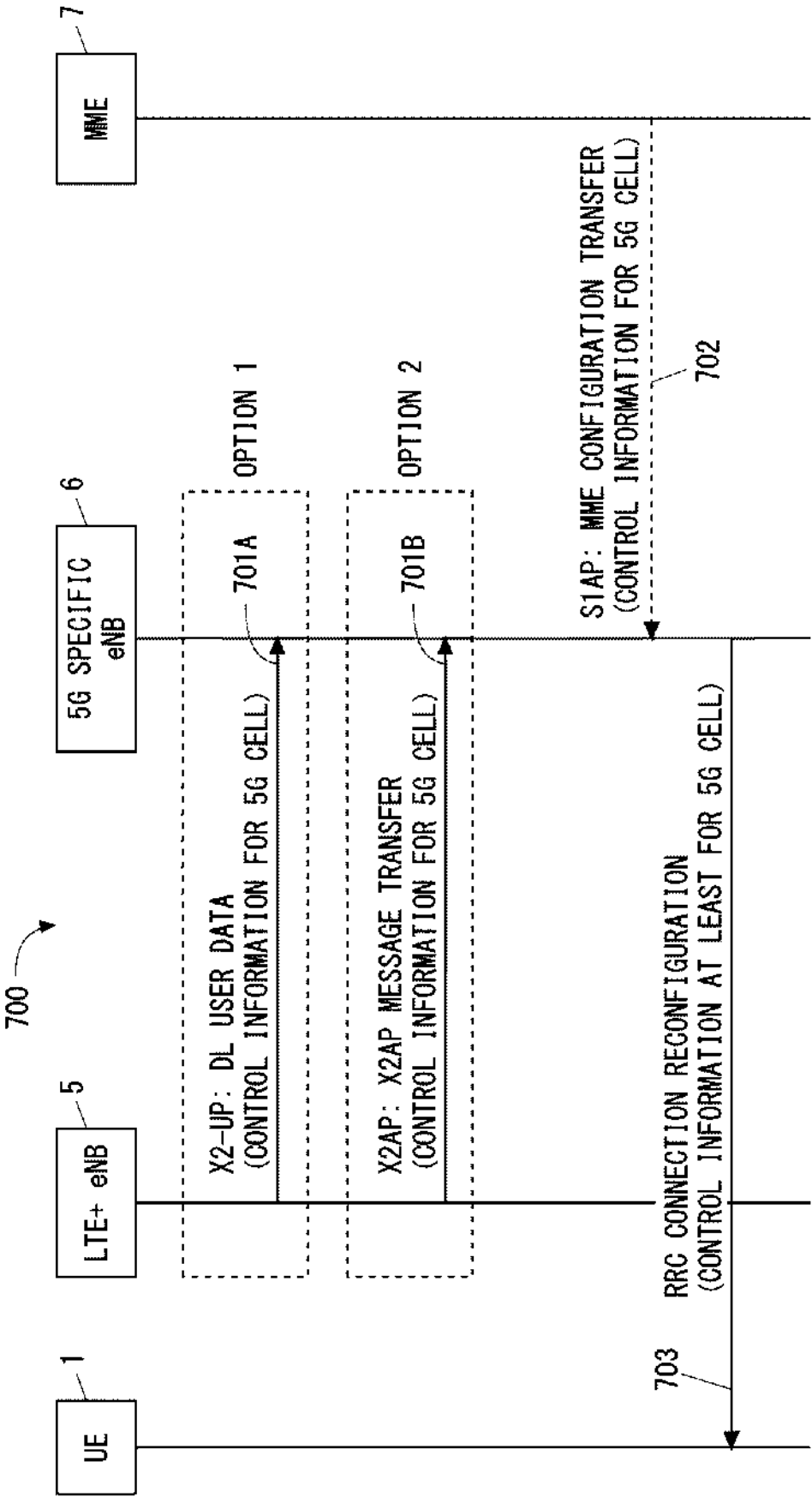
[FIG. 5]



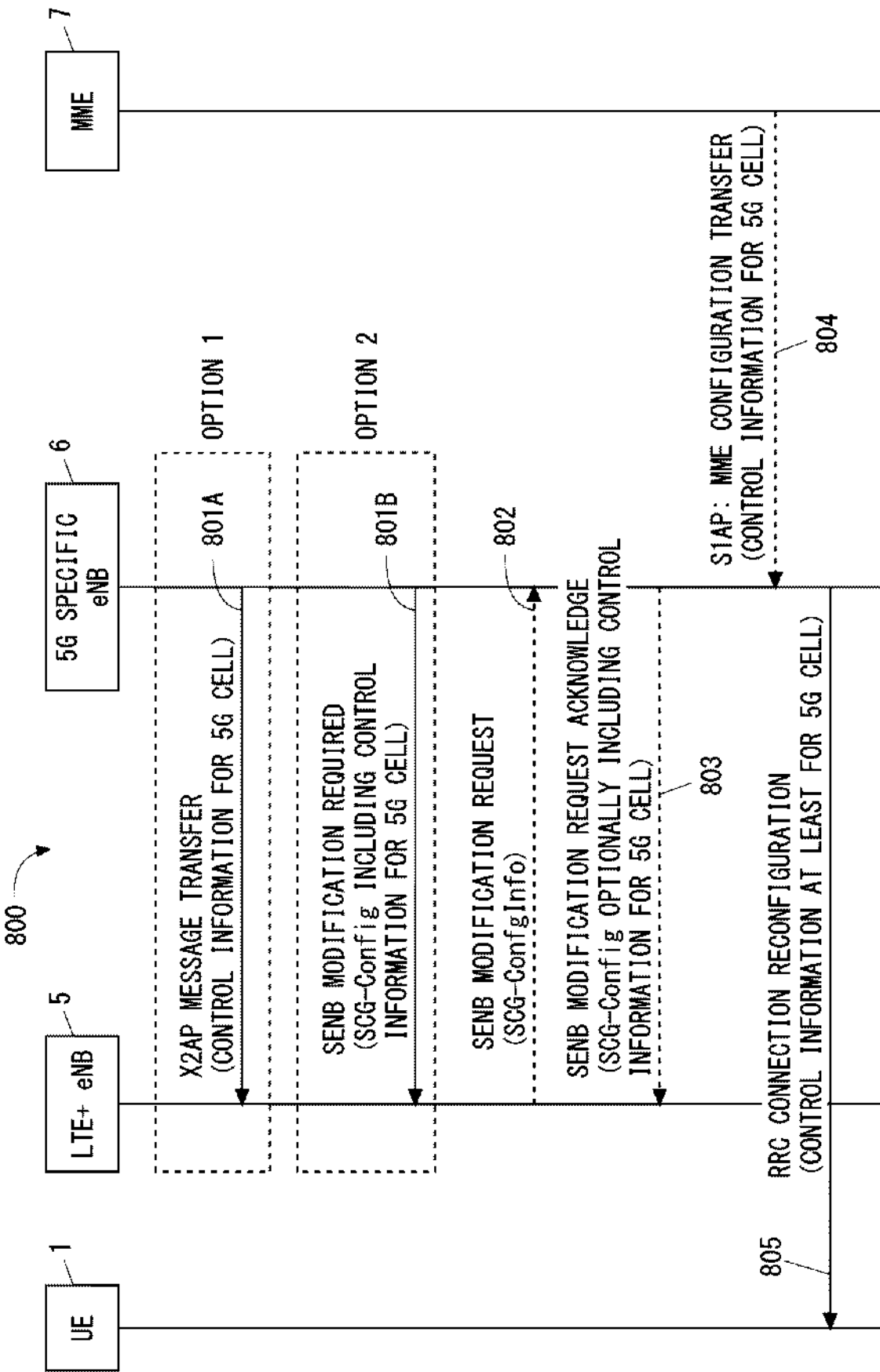
[FIG. 6]



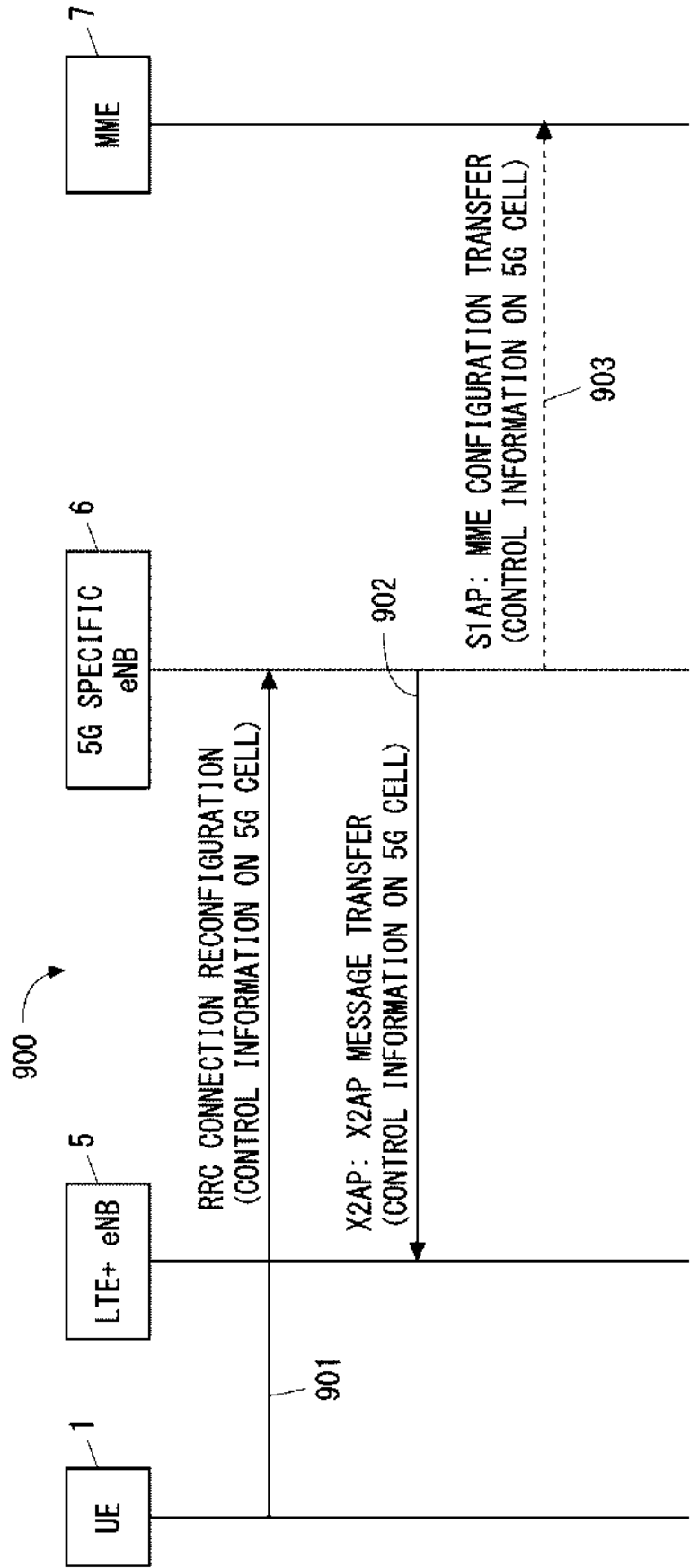
[FIG. 7)]



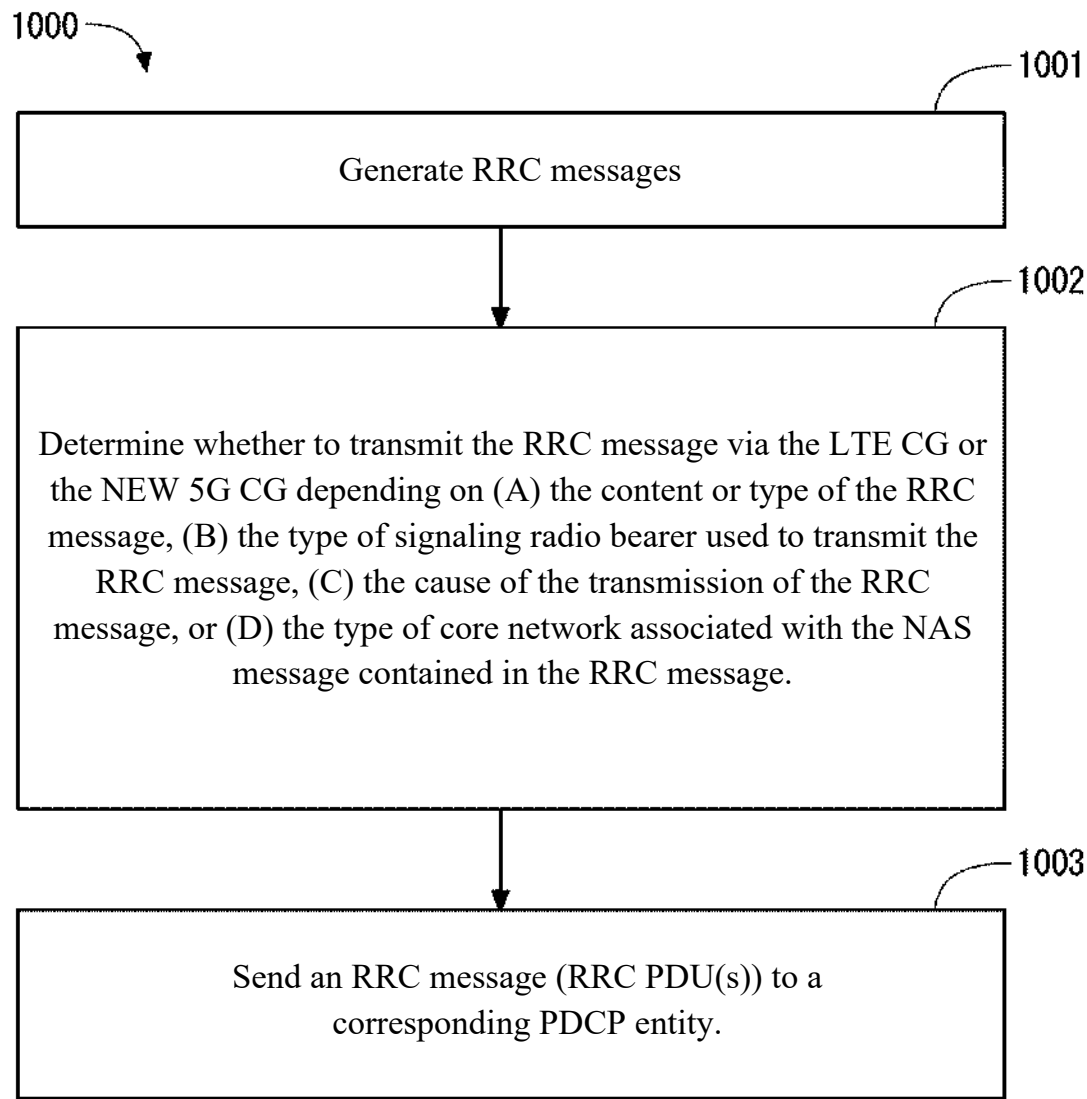
[FIG. 8]



[FIG. 9]



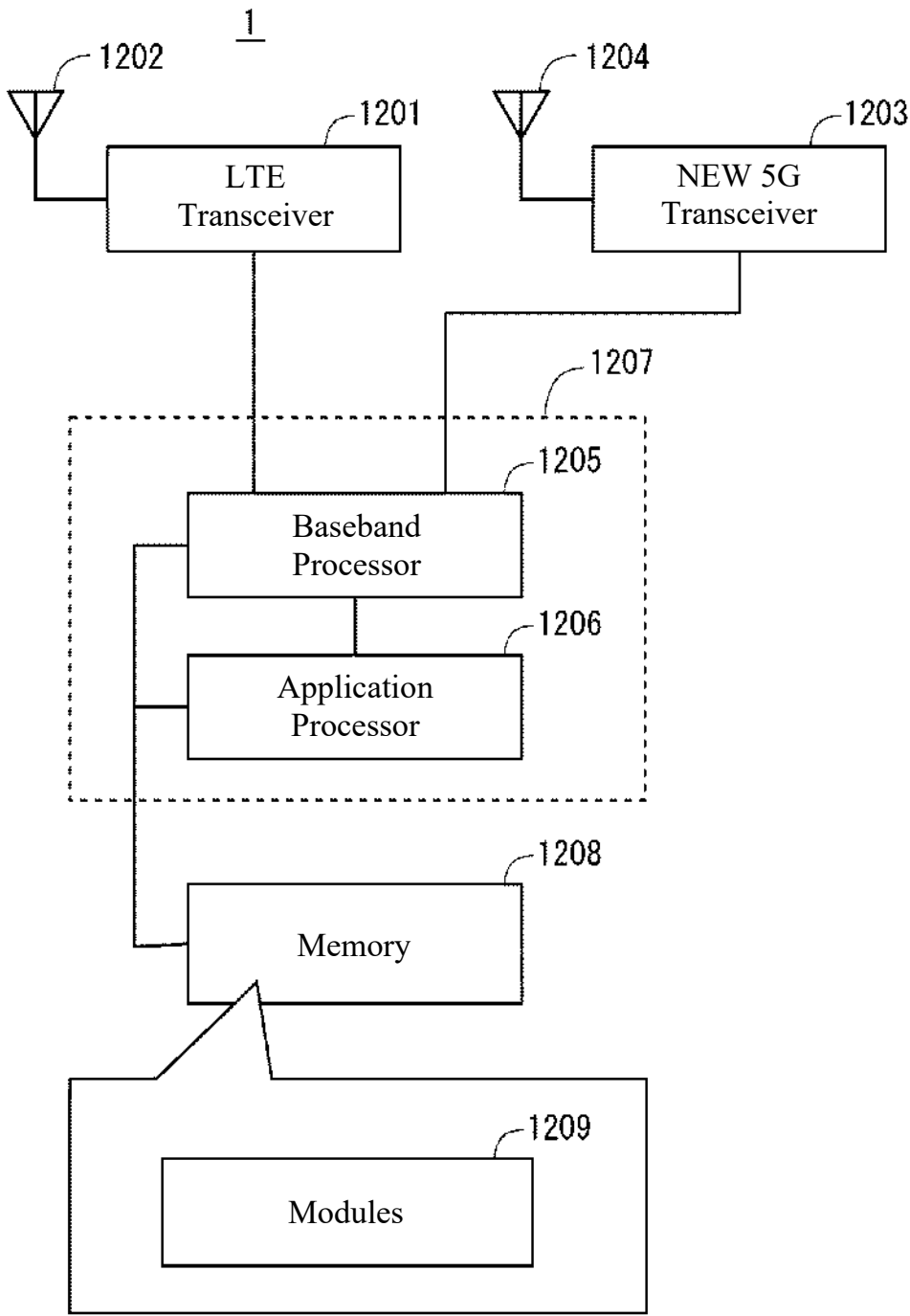
[FIG. 10]



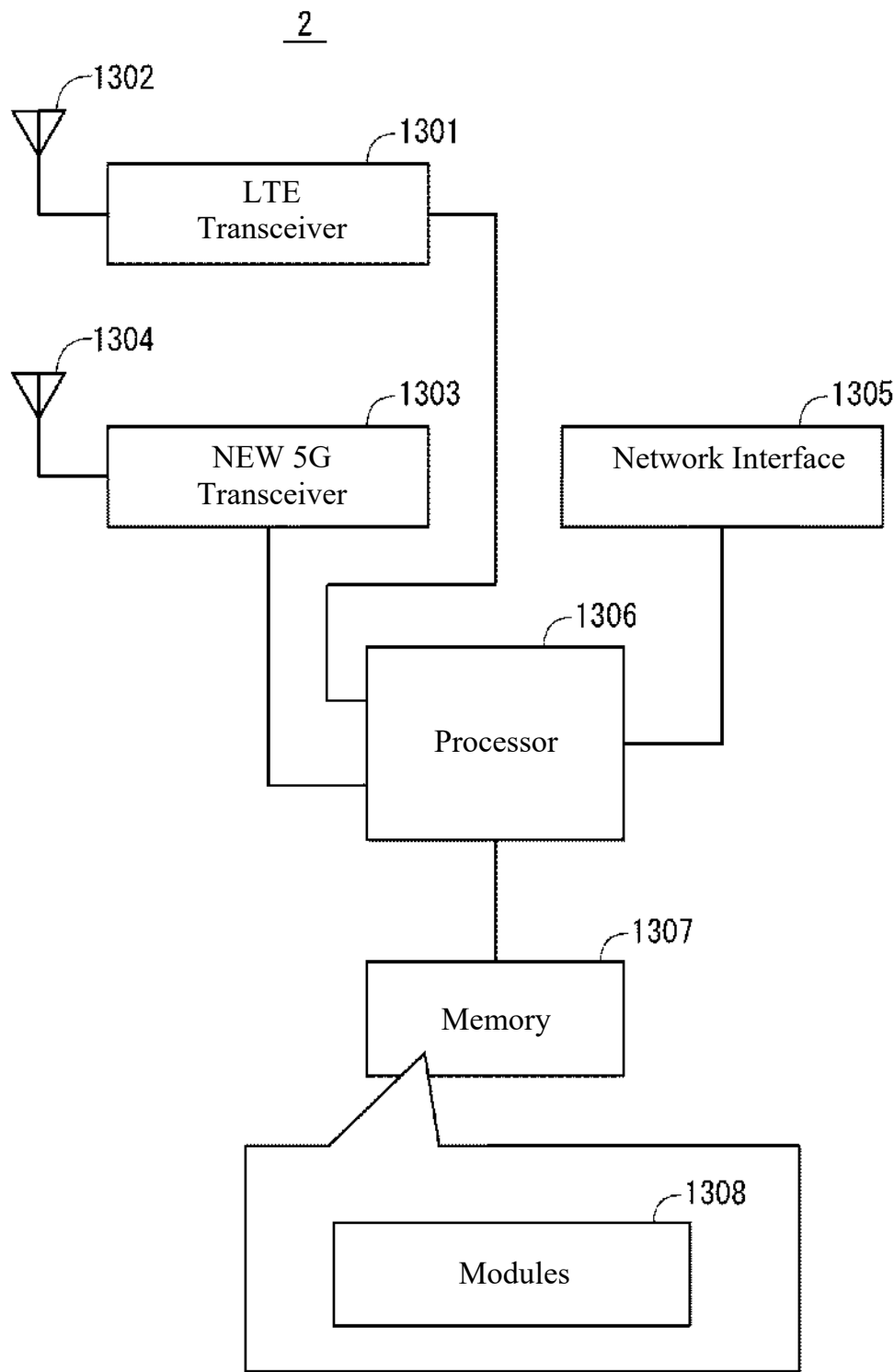
[FIG. 11]

	LTE BEARER	INTEGRATED BEARER	NEW 5G BEARER
KEY FOR DERIVING TEMPORARY KEYS TO CIPHER/DECIPHER UP AND RRC TRAFFIC	K_{eNB}		sub- K_{eNB}

[FIG. 12]



[FIG. 13]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/087143

A. CLASSIFICATION OF SUBJECT MATTER

H04W72/04(2009.01)i, H04L29/00(2006.01)i, H04L29/02(2006.01)i, H04W16/32(2009.01)i, H04W24/10(2009.01)i, H04W88/06(2009.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W4/00-H04W99/00, H04B7/24-H04B7/26, H04L29/00, H04L29/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2015/158370 A1 (TELEFONAKTIEBOLAGET L M ERICSSON(PUBL)), 22 October 2015 (22.10.2015), page 5, lines 4 to 21; page 6, line 29 to page 7, line 22; fig. 1, 4 (Family: none)	1-26
Y	Ryuji NAKAMURA, 5GMF ga Tenbo suru '5G no Subete'(Musen Access Hen), Subete Wakaru 5G Daizen, 12 November 2015 (12.11.2015), pages 74 to 81	1-26

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

☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search
16 January 2017 (16.01.17)

Date of mailing of the international search report
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Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/087143

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2014/109602 A1 (LG ELECTRONICS INC.), 17 July 2014 (17.07.2014), paragraphs [0094], [0101] to [0109], [0128] to [0137] & JP 2016-512660 A paragraphs [0083], [0090] to [0098], [0117] to [0126] & US 2015/0358813 A1	4, 5, 17, 18
Y	WO 2015/146825 A1 (NTT Docomo Inc.), 01 October 2015 (01.10.2015), paragraphs [0054] to [0060] & JP 2015-186049 A	6, 19
Y	Ericsson, L2 transport of SRBs and relation to RLF handling[online], 3GPP TSG-RAN WG2#84 3GPP TSG-RAN WG2#84 R2-134221, Internet<URL:http:// www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_84/Docs/ R2-134221.zip>, 2013.11.11	7, 10, 11, 20, 23
Y	CATT, CATR, RLM considerations for dual connectivity[online], 3GPP TSG-RAN WG2#84 3GPP TSG-RAN WG2#84 R2-134053, Internet<URL:http:// www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_84/Docs/ R2-134053.zip>, 2013.11.11	8, 21
Y	WO 2015/085273 A1 (INTERDIGITAL PATENT HOLDINGS, INC.), 11 June 2015 (11.06.2015), paragraphs [0031] to [0042]; fig. 1A & JP 2016-540441 A paragraphs [0015] to [0026]; fig. 1A	9, 22
Y	3GPP TSG RAN, Draft Letter to ITU on final submission for IMT-2000 CDMA DS and IMT-2000 CDMA TDD toward Rev. 13 of Rec. ITU-R M.1457 [online], 3GPP TSG-RAN#70 RP-152244, Internet <URL:http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/ TSGR_70/Docs/RP-152244.zip>, 2015.12.07	10, 11, 23

International Search Report		International Application No. PCT/JP2016/087143	
A. Classification of the field to which the invention belongs (International Patent Classification (IPC))			
Int.Cl. H04W72/04 (2009. 01) i, H04L29/00 (2006. 01) i, H04L29/02 (2006. 01) i, H04W16/32 (2009. 01) i, H04W24/10 (2009. 01) i, H04W88/06 (2009. 01) i			
B. Fields searched			
Minimum documentation searched (International Patent Classification (IPC))			
Int.Cl. H04W4/00-H04W99/00, H04B7/24-H04B7/26, H04L29/00, H04L29/02			
Documentation searched other than the minimum documentation that may be included in the fields searched			
Japanese Utility Model Publication 1922-1996			
Japanese Public Utility Model Publication 1971-2017			
Japanese Utility Model Registration Publication 1996-2017			
Japanese Registered Utility Model Publication 1994-2017			
Electronic database used in the international search (name of the database and terms used in the search)			
C. Literature considered to be relevant			
Category of References*	Name of the cited literature and indication of the relevant location when part of the literature is relevant	Relevant No. in the Scope of Patent Claims	
Y	WO 2015/158370 A1 (TELEFONAKTIEBOLAGET L M ERICSSON(PUBL)) 2015.10.22, P5L4-21, P6L29-P7L22, FIG. 1, FIG. 4 (without family)	1-26	
Y	Ryuji Nakamura, 5 GMF's Outlook on "All about 5G" (Wireless Access Edition), Everything You Need to Know about 5G, November 12, 2015, P74-P81	1-26	
The literature is also listed in column C. ☒ ☐ See Appendix on patent families.			
* Category of references		“T” Document published after the international filing date or priority date that is not inconsistent with the patent application, but that is cited to enable understanding of the principles or theory of the patent	
“A” Document that describes the general state of the art, and that is not of particular relevance		“X” Document of particular relevance; the invention is not believed to be novel or have an inventive step based solely on this document	
“E” A patent or application prior to the international filing date, but published after the international filing date		“Y” Document of particular relevance; the invention is not believed to have an inventive step when this document is combined with at least one other document wherein this combination will be obvious to a person skilled in the art	
“L” Document that raises doubts regarding the priority claim(s), or literature cited to establish the publication date of other literature or another special reason (describe the reasons)		“&” Document in the same patent family	
“O” Document referring to an oral disclosure, use, or exhibition, etc.			
“P” Documents published prior to the date of the international application and after the date of the application upon which the claim of priority is based			
Date of the completion of the international search 01/16/2017		Date of the mailing of the international search report 01/24/2017	
Name and mailing address of the international search organization Japan Patent Office (ISA/JP) Postal Code 100-8915 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo		Patent Office Examiner (authorized employee)	5 J 4101
		Akitoshi Mochizuki Phone number: 03-3581-1101 Extension: 3534	

C. (continued) - Literatures deemed to be relevant		
Category of References*	Name of the cited literature and indication of the relevant location when part of the literature is relevant	Relevant No. in the Scope of Patent Claims
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Y	WO 2015/146825 A1 (NTT DOCOMO, INC.) 2015.10.01, [0054]-[0060] & JP 2015-186049 A	6, 19
Y	Ericsson, L2 transport of SRBs and relation to RLF handling[online], 3 GPP TSG-RAN WG 2 # 84 3GPP TSG-RAN WG2#84 R2-134221, Internet <URL: http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_84/Docs/R2-134221.zip >, 2013. 11. 11	7, 10, 11, 20, 23
Y	CATT, CATR, RLM considerations for dual connectivity[online], 3 GPP TSG-RAN WG 2 # 84 3GPP TSG-RAN WG2#84 R2-134053, Internet<URL: http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_84/Docs/R2-134053.zip >, 2013.11.11	8, 21
Y	WO 2015/085273 A1 (INTERDIGITAL PATENT HOLDINGS, INC.) 2015. 11, [0031]-[0042], FIGIA & JP 2016-540441 A ([0015]-[0026]), FIG. 1 A)	9, 22
Y	3GPP TSG RAN, Draft Letter to ITU on final submission for IMT-2000 CDMA DS and IMT-2000 CDMA TDD toward Rev. 13 of Rec. ITU-RM.1457[online], 3GPP TSG-RAN#70 RP-152244, Internet <URL: http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_70/Docs/RP-152244.zip >, 2015. 12. 07	10, 11, 23