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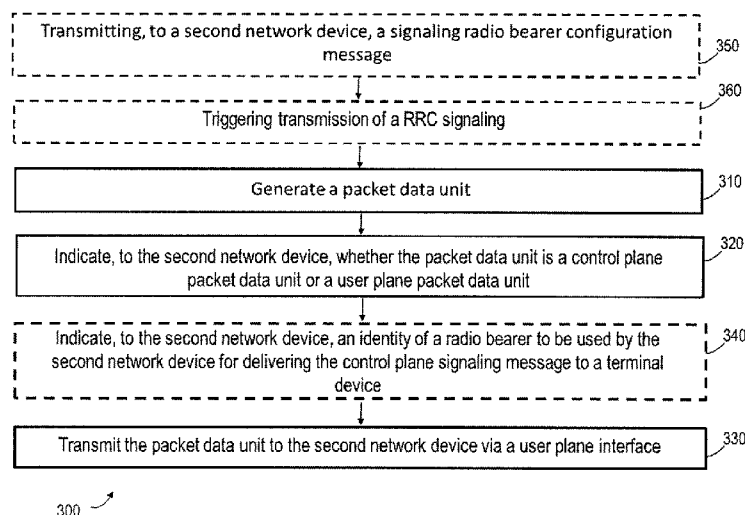


FIG. 3

(57) Abstract: Embodiments of the present disclosure provide methods, apparatus and computer program products for signaling transmission in a wireless communication system. One method comprises generating a packet data unit at a first network device; indicating, to a second network device, whether the packet data unit is a control plane packet data unit or a user plane packet data unit; and transmitting the packet data unit to the second network device via a user plane interface. Embodiments of the disclosure may enable efficient signaling transmission/processing in a wireless communication system.

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METHOD AND APPARATUS FOR SIGNALING TRANSMISSION/PROCESSING IN A WIRELESS COMMUNICATION SYSTEM

TECHNICAL FIELD

[0001] The non-limiting and example embodiments of the present disclosure generally relate to the technical field of wireless communications, and specifically to methods, apparatuses and computer programs for signaling transmission in a wireless communication system.

BACKGROUND

[0002] This section introduces aspects that may facilitate better understanding of the disclosure. Accordingly, the statements of this section are to be read in this light and are not to be understood as admissions about what is in the prior art or what is not in the prior art.

[0003] With the evolution of wireless communication, a requirement for improved throughput and mobility robustness has been proposed. A concept of "dual connectivity" developed in the Third Generation Partnership Project (3GPP) provides a potential solution to meet the requirement. According to a definition in a 3GPP standard, e.g., 3GPP TS 36.842, v10.0.0, Section 7.1, a term "dual connectivity" is used to refer to operation where a given user equipment (UE) consumes radio resources provided by at least two different network nodes connected with non-ideal backhaul. One of the two network nodes may be called a master network node, and the other may be called a secondary network node. In such a deployment scenario, the master network node UE may communicate with the UE directly or through the secondary network node, however, it is still open as to how to enable an efficient signaling transmission to the UE.

SUMMARY

[0004] Various embodiments of the present disclosure mainly aim at providing methods, apparatuses and computer programs for enabling efficient signaling transmission in a wireless communication system, particularly in a multiple connectivity deployment scenario, for example a dual connectivity deployment scenario. Other features and advantages of embodiments of the present disclosure will also be understood from the

following description of specific embodiments when read in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of embodiments of the present disclosure.

[0005] In a first aspect of the disclosure, there is provided a method implemented at a first network device. The method comprises: generating a packet data unit; indicating, to a second network device, whether the packet data unit is a control plane packet data unit or a user plane packet data unit; and transmitting the packet data unit to the second network device via a user plane interface.

[0006] In one embodiment, the first network device may indicate the packet data unit as a control plane packet data unit if the packet data unit includes a control plane signaling message.

[0007] In another embodiment, the first network device may indicate whether the packet data unit is a control plane packet data unit or a user plane packet data unit via an indication in a header of the packet data unit or via an additional signaling to the second network device.

[0008] In still another embodiment, the method may further comprise: indicating, to the second network device, an identity of a radio bearer to be used by the second network device for delivering the control plane signaling message to a terminal device. In a further embodiment, the first network device may transmit the identity in one of: a header of the packet data unit, and, an additional signaling to the second network device. In another embodiment, the first network device may indicate a first identity of a radio bearer if the packet data unit includes a radio resource control, RRC, configuration message, and indicate a second different identity of a radio bearer if the packet data unit includes a non-access stratum, NAS, message. In some embodiments, the identity of a radio bearer may be a signaling radio bearer identity or a signaling radio flow identity.

[0009] In one embodiment, the method may further comprise: transmitting, to the second network device, a signaling radio bearer configuration message for setting a set of parameters for a signaling radio bearer.

[0010] In another embodiment, the method may further comprise: triggering transmission of a radio resource control, RRC, signaling based on a measurement report from a terminal device; and wherein the generating a packet data unit includes generating the packet data unit including the RRC signaling.

[0011] In a second aspect of the disclosure, there is provided a method implemented at a second network device. The method comprises: receiving a packet data unit from a first network device via a user plane interface; determining whether the packet data unit is a control plane packet data unit or a user plane packet data unit; and processing the received packet data unit accordingly based on the determination.

[0012] In one embodiment, processing the received packet data unit accordingly based on the determination may include: delivering a control plane signaling message included in the received packet data unit to a terminal device via a signaling radio bearer, if the packet data unit is determined as a control plane packet data unit; and/or delivering the received packet data unit to a terminal device via a data radio bearer, if the packet data unit is determined as a user plane packet data unit.

[0013] In another embodiment, the second network device may determine whether the packet data unit is a control plane packet data unit or a user plane packet data unit based on detection of an indication in a header of the packet data unit, or an additional signaling from the first network device.

[0014] In still another embodiment, the method may further comprise: receiving, from the first network device, an identity of a radio bearer for the delivering; and wherein the delivering a control plane signaling message included in the packet data unit to a terminal device via a signaling radio bearer may include: delivering the control plane signaling message to the terminal device via a signaling radio bearer indicated by the received identity. In a further embodiment, the second network device may receive the identity in one of: a header of the packet data unit, and an additional signaling from the first network device. In one embodiment, the identity of a radio bearer may be one of a signaling radio bearer identity and a signaling radio flow identity.

[0015] In one embodiment, the method may further comprise: receiving, from the first network device, a signaling radio bearer configuration message for setting a set of parameters for a signaling radio bearer.

[0016] In another embodiment, the determining may include determining based on detection of an indication in a header of the packet data unit, and wherein the delivering a control plane signaling message included in the received packet data unit to a terminal device may include: delivering the control plane signaling message to the terminal device without transmitting the indication in the header of the received packet data unit.

[0017] In a third aspect of the disclosure, there is provided an apparatus that may be implemented in or as part of a first network device. The apparatus comprises a generating unit, configured to generate a packet data unit; a first indicating unit, configured to indicate, to a second network device, whether the packet data unit is a control plane packet data unit or a user plane packet data unit; and a transmitting unit, configured to transmit the packet data unit to the second network device via a user plane interface.

[0018] In a fourth aspect of the disclosure, there is provided an apparatus that may be implemented in or as at least part of a second network device. The apparatus comprises a first receiving unit, configured to receive a packet data unit from a first network device via a user plane interface; a determining unit, configured to determine whether the packet data unit is a control plane packet data unit or a user plane packet data unit; and a processing unit, configured to process the received packet data unit accordingly based on the determination.

[0019] In a fifth aspect of the disclosure, there is provided an apparatus that may be implemented at or as at least part of a first network device. The apparatus may comprise at least one processor and at least one memory including computer program code; the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to perform the method according to the first aspect of the present disclosure.

[0020] In a sixth aspect of the present disclosure, there is provided an apparatus that may be implemented at or as at least part of a second network device. The apparatus may comprise at least one processor and at least one memory including computer program code; the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to perform the method according to the second aspect of the present disclosure.

[0021] In a seventh aspect of the present disclosure, there is provided an apparatus that may be implemented at or as at least part of a first network device. The apparatus may comprise processing means adapted to perform the method in accordance with the first aspect of the disclosure.

[0022] In an eighth aspect of the disclosure, there is provided an apparatus that may be implemented at or as at least part of a second network device. The apparatus may comprise processing means adapted to perform the method in accordance with the second aspect of the disclosure.

[0023] In a ninth aspect of the disclosure, there is provided a computer program. The computer program comprises instructions which, when executed on at least one processor, cause the at least one processor to carry out the method according to the first aspect of the disclosure.

5 [0024] In a tenth aspect of the disclosure, there is provided another computer program. The computer program comprises instructions which, when executed on at least one processor, cause the at least one processor to carry out the method according to the second aspect of the disclosure.

10 [0025] According to the various aspects and embodiments as mentioned above, efficient signaling transmission to UE in a wireless communication system can be enabled.

BRIEF DESCRIPTION OF THE DRAWINGS

15 [0026] The above and other aspects, features, and benefits of various embodiments of the present disclosure will become more fully apparent, by way of example, from the following detailed description with reference to the accompanying drawings, in which like reference numerals or letters are used to designate like or equivalent elements. The drawings are illustrated for facilitating better understanding of the embodiments of the disclosure and not necessarily drawn to scale, in which:

[0027] FIG. 1A illustrates schematically a wireless communication system in which embodiments of the present disclosure may be implemented;

20 [0028] FIG. 1B illustrates schematically a RRC diversity scheme for handover;

[0029] FIG. 2 illustrates a schematic diagram for transmitting a control plane signalling via a user plane interface according to an embodiment of the present disclosure;

[0030] FIG. 3 illustrates a flowchart of a method implemented at a network device according to an embodiment of the present disclosure;

25 [0031] FIG. 4 illustrates an example of a PDU header according to an embodiment of the present disclosure;

[0032] FIGs. 5A-5B illustrate flowcharts of a method implemented at another network device according to an embodiment of the present disclosure;

30 [0033] FIG. 6 illustrates a flow of operations performed at a MeNB and a SeNB according to an embodiment of the present disclosure;

[0034] FIG. 7 illustrates a simplified block diagram of an apparatus implemented in/as part of a first network device according to an embodiment of the present disclosure;

[0035] FIG. 8 illustrates a simplified block diagram of an apparatus implemented in/as part of a second network device according to an embodiment of the present disclosure;

[0036] FIG. 9 illustrates simplified block diagrams of an apparatus in a first network device and a second network device, according to an embodiment of the present disclosure.

5 DETAILED DESCRIPTION

[0037] Hereinafter, the principle and spirit of the present disclosure will be described with reference to illustrative embodiments. It should be understood that all these embodiments are given merely for one skilled in the art to better understand and further practice the present disclosure, but not for limiting the scope of the present disclosure. For example, features illustrated or described as part of one embodiment may be used with another embodiment to yield still a further embodiment. For clarity, not all features of an actual implementation are described in this specification.

[0038] References in the specification to “one embodiment,” “an embodiment,” “an example embodiment,” etc. indicate that the embodiment described may include a particular feature, structure, or characteristic, but it is not necessary that every embodiment includes the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

[0039] It shall be understood that although the terms “first” and “second” etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first element could be termed a second element, and similarly, a second element could be termed a first element, without departing from the scope of example embodiments. As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed terms.

[0040] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of example embodiments. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises”, “comprising”, “has”, “having”, “includes” and/or “including”, when

used herein, specify the presence of stated features, elements, and/or components etc., but do not preclude the presence or addition of one or more other features, elements, components and/ or combinations thereof.

[0041] In the following description and claims, unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

[0042] As used herein, the term “wireless communication system” or “wireless communication network” refers to a network following any suitable wireless communication standards, such as LTE-Advanced (LTE-A), LTE, Wideband Code Division Multiple Access (WCDMA), High-Speed Packet Access (HSPA), and so on. Furthermore, the communications between network devices in the wireless communication network may be performed according to any suitable generation communication protocols, including, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G) communication protocols, and/or any other protocols either currently known or to be developed in the future.

[0043] As used herein, the term “network device” refers to a device in a wireless communication network via which a terminal device accesses the network and receives services therefrom. The network device may refer to a base station (BS), a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a Remote Radio Unit (RRU), a radio head (RH), a remote radio head (RRH), a TRP(Transmission Reception Point), AN(access Node), a relay node (RN), or a low power node (LPN) such as a femto, a pico, an access point (AP) and so forth, depending on the applied terminology and technology.

[0044] The term “terminal device” refers to any end device having wireless communication capabilities. By way of example and not limitation, a terminal device may be referred to as user equipment (UE), which may be a Subscriber Station (SS), a Portable Subscriber Station, a Mobile Station (MS), or an Access Terminal (AT). The terminal device may include, but not limited to, mobile phones, cellular phones, smart phones, or personal digital assistants (PDAs), portable computers, image capture terminal devices such as digital cameras, gaming terminal devices, music storage and playback appliances, wearable terminal devices, vehicle-mounted wireless terminal devices and the like. In the following description, the terms “terminal device”, “terminal”, “user equipment” and “UE” may be used interchangeably.

[0045] For illustrative purposes, several embodiments of the present disclosure will be described in the context of a 3GPP LTE system. Those skilled in the art will appreciate, however, that the concept and principle of embodiments of the present disclosure may be more generally applicable to other wireless networks, for example 3G CDMA-based network or a 5G system or New Radio (NR) system.

[0046] FIG. 1A illustrates schematically a wireless communication system in which embodiments of the present disclosure may be implemented. As shown in FIG. 1A, the wireless communication network 100 may include a plurality of network devices, for example APs 101-103, which may be in a form of an eNB. It would be appreciated that the APs 101, 102, or 103 could also be in a form of a Node B, BTS (Base Transceiver Station), and/or BSS (Base Station Subsystem), and the like. Each of the APs may provide radio connectivity to a set of terminal devices within its coverage. A terminal device (e.g., terminal device 104) may access the wireless communication network via an AP (e.g., AP 101).

[0047] In a multiple connectivity deployment, a terminal device may be served by a plurality of network devices. For example, the terminal device 104 may connect to the APs 101-103 via links 111-113 respectively. In such a case, one AP (e.g., AP 101) may be designated as a master AP (also referred to as master Node B, or MeNB), while other APs (e.g., APs 102 and 103) are secondary APs (also referred to as secondary Node B, or SeNB). In particular, one option for control plane transmission for the terminal device 104 may be that a radio resource control (RRC) message from the MeNB (AP 101) may be delivered to the terminal device 104 directly or via one or more SeNBs (AP 102 and/or 103). This is also known as a RRC diversity scheme where the RRC message may be generated at the AP 101, transmitted to the AP 102 and/or AP 103, and then delivered to the UE 104 via a radio interface between the UE 104 and the AP 102/103. In this way, flexibility of RRC transmission path selection can be offered during RRC procedures. The RRC diversity scheme can be considered as an important option for 5G multi-connectivity since it provides robustness for control plane in multi-connectivity operation and is a light solution compared with other alternatives which require complicated processing at the SeNBs.

[0048] A general RRC diversity concept has been captured in 3GPP TS 36.842 Vc.0.0, during the study item phase of a dual connectivity topic in 3GPP. According to the captured RRC diversity concept, a mobility critical RRC message, e.g., a HO command,

may be sent to UE via a radio interface between a SeNB and the UE, and the UE may be able to receive the HO command message from the SeNB even if it misses the HO command from a MeNB. An example is shown in FIG. 1B, where a terminal device 121 located in a RRC diversity region 122 may receive HO command from both the Macro eNB 123 and the Pico eNB 124. Such a scheme improves mobility robustness during mobility procedures. Currently, the RRC diversity concept only applies to a handover procedure where a handover command message is duplicated and transmitted via both the MeNB and the SeNB's links as shown in FIG. 1B. Such a limitation is not desirable, and a multi-connectivity solution is expected to provide more flexibility for delivering RRC messages in a 5G wireless system. In other words, the RRC diversity scheme should be applicable not only to a handover scenario, but also to regular RRC configurations and re-configurations within lifetime of a RRC connection. In this regard, a more advanced radio resource configuration and operation mode is required to enable a more flexible RRC diversity concept in 5G.

[0049] It has been observed by the inventors of the present disclosure that a RRC diversity scheme may be more widely applied to benefit a regular control plane signalling by transmitting the regular control plane message via a user plane (UP) interface, e.g., an X2-U interface specified in 3GPP, between two network devices (e.g., AP 101 and AP 102) rather than transmitting the control plane message using control plane (CP) over an X2-C interface as a RRC container. For instance, a control plane message may be handled by a packet data convergence protocol (PDCP) first at the AP 101, so that the generated PDCP PDUs may be treated as user plane data at the X2 interface. A schematic diagram for illustrating an example of this concept is shown in FIG. 2. As shown in FIG. 2, a network convergence sublayer control plane (NCS-CP, 211) signalling may be generated at AP 1 (denoted as 201 in FIG. 2), handled by the PDCP, and then transmitted to AP 2 (denoted as 202 in FIG. 2) via an X2-U interface (213) using a General Packet Radio Service (GPRS) Tunnelling Protocol (GTP) or a Generic Routing Encapsulation (GRE,) 212. Then the AP2 may deliver the message to UE (203) via a radio interface.

[0050] Currently, a RRC message will be transmitted to a terminal device using a signalling radio bearer (also referred to as SRB or SRF hereafter) over a radio interface to convey control plane message/data, and in the example shown in FIG. 2, the AP2 202 will provide radio resources to convey the RRC message to/from UE. In contrast, user plane data will be transmitted to the terminal device using a data radio bearer (also referred to as

DRB). However, once a RRC message is transmitted over an X2-U interface as a PDCP PDU after being handled by the PDCP at the AP1, it appears to be user plane data seen from an X2 interface perspective. That is, conventionally, all PDUs coming out of an X2-U interface will be regarded as UP traffic. It means that the AP2 is not aware of whether the received PDU contains control plane signalling message or user plane data. It is due to a fact that no mechanism is available currently for the AP2 to differentiate a RRC message from a UP PDU if the RRC message is not received over an X2-C interface but received over an X2-U interface as a PDCP PDU. Consequently, the control plane signalling message (e.g., a RRC configuration message) included in the received PDU may not be transmitted by the AP2 to a target terminal device using a proper SRB or SRF. As a result, the control plane signalling message may not be processed properly by the target terminal device and then corresponding quality of service (QoS) requirement may not be satisfied.

[0051] Furthermore, currently no assisting information is available at the SeNB (e.g., AP2 202 shown in FIG. 2) side for the SeNB to choose a proper radio resource (i.e., a SRB/SRF) for transmitting the received PDU to a terminal device even if it knows the PDU contains a RRC message from the X2-U interface.

[0052] In the present disclosure, methods, apparatuses and computer program products are provided to enable more efficient signaling transmission in a wireless communication network. With the methods, apparatuses or computer program products, at least part of the above problems may be solved; however, embodiments of the present disclosure are not limited to being applied in a RRC diversity scheme or a deployment scenario as illustrated in FIG. 1 or FIG. 2. It can be appreciated that, embodiments of the present disclosure may be more widely applied in any wireless communication systems where similar problems exist.

[0053] Reference is now made to FIG. 3, which shows a flowchart of a method 300 according to an embodiment of the present disclosure. The method 300 may be implemented at a network device (e.g., the network device 101-103 as shown in FIG. 1A, or AP1 201-202 shown in FIG. 2). For the sake of simplicity, the method 300 will be described below with reference to the network device 101 as shown in FIG. 1A. However, it is to be understood that the method 300 may also be implemented by other suitable network devices. That is, scope of the present disclosure is not limited to any specific network device or network infrastructure.

[0054] As shown in FIG. 1A, at block 310, the network device 101 (also referred to as a first network device) generates a packet data unit. The network device 101 may serve a terminal device (e.g., UE 104 shown in FIG. 1A) via dual connectivity (or multiple connectivity), together with another network device (also referred to as a second network device), e.g., the network device 102 and/or 103 shown in FIG. 1A. At block 320, the network device 101 indicates to the second network device (e.g., the network device 102), whether the packet data unit is a control plane (CP) packet data unit (PDU) or a user plane (UP) PDU; and at block 330, the network device 101 transmits the packet data unit to the second network device via a user plane interface, e.g., an X2-U interface. It can be appreciated that depending on the wireless communication network type or technology being used, the user plane interface may vary.

[0055] The method 300 enables the second network device to identify whether a PDU received over the UP interface (e.g., X2-U interface) is a CP PDU or UP PDU, thereby facilitating proper processing of the CP PDU which carries a CP signaling message.

[0056] In one embodiment, at block 320, the network device 101 may indicate a PDU as a CP PDU if the PDU includes a CP signaling message, for example a RRC signaling message, or a non-access stratum (NAS) message. It can be appreciated that the indicating operation of block 320 may be performed before, after or concurrently with the operation of block 330. In an embodiment, the network device 101 may indicate whether the PDU is a CP PDU or a UP PDU via an indication in a header of the PDU. That is, the indication is transmitted together with the PDU at block 330. An example for the indication is shown in FIG. 4, where a reserved bit, i.e., the C/U field 401, in the PDU header of a PDU 400 is used for the indication. Just for illustration rather than limitation, the C/U field may be set as "0" if the PDU transmitted at block 330 is a UP PDU, and set as "1" if the PDU transmitted at block 330 is a CP PDU, or vice versa.

[0057] Alternatively, in another embodiment, the network device 101 may indicate whether the PDU is a CP PDU or a UP PDU via transmitting an additional signaling to the second network device at block 320. For instance, the additional signaling may be an X2-AP signaling, which indicate which PDU is a CP PDU (e.g., a RRC PDU). The X2-AP signaling may indicate, for example, a sequence number of a CP PDU.

[0058] As shown in FIG. 3, in one embodiment, the method may optionally comprise a block 340 where the network device 101 indicates, to the second network device, an identity of a radio bearer to be used by the second network device for delivering the CP

signaling message to a terminal device. This embodiment further refines resource allocation for a signaling transmission. Considering that different CP signaling may have different QoS requirements, the network device 101 may select a proper radio bearer (e.g., a SRB) based on a QoS requirement or a type of the signaling message included in the PDU, and indicate the selected radio bearer to the second network device at block 340, such that the QoS requirement of the signaling can be satisfied when the second network device delivers the signaling to a terminal device using the indicated radio bearer.

[0059] Similar to block 320, at block 340, the network device 101 may transmit the identity of the radio bearer in a header of the PDU using one or more reserved bits or in an additional signaling to the second network device. As one example, the identity may be transmitted as a “SRB/SRF ID” field 402 in the header of the PDU 400, along with the “C/U” field 401 as shown in FIG. 4. Just for illustration rather than limitation, the network device 101 may indicate a first identity of a radio bearer, if the PDU includes a RRC configuration message, and indicate a second identity of a radio bearer, if the PDU includes a NAS message. That is, a value of “0” of the SRB/SRF ID field may indicate, for example, a SRB ID1, which may correspond to a SRB/SRF for carrying RRC configuration message, and a value of “1” of the SRB/SRF ID field may indicate, for example, a different SRB ID2, which may correspond to a SRB/SRF for carrying NAS PDU/message. In one embodiment, the SRB ID1 may be assigned a higher priority for transmission than the SRB ID2.

[0060] Alternatively, the identity of the radio bearer may be transmitted via an additional signaling to the second network device at block 340. For instance, an X2-AP signaling may be used for this purpose. In one embodiment, an X2-AP signaling may be transmitted by the network device 101 at block 320 to indicate both a sequence number for a CP PDU and a SRB ID for the CP signaling included in the CP PDU. That is, the block 340 may be combined with block 320 in this example. In another embodiment, the identity may be transmitted via a separate signaling. Though an X2-AP signaling is used in the embodiments as an example, embodiments are not limited thereto, and any suitable signaling may be used for this purpose.

[0061] In one embodiment, as shown in FIG. 3, the method 300 may further comprise a block 350 where the network device 101 may transmit, to the second network device, a SRB configuration message for setting a set of parameters for the SRB. The set of parameters may include, for example but not limited to, one or more of an associated radio

resource, an associated media access control (MAC) logical channel, a transmission mode, and a PDCP security configuration, etc. This enables the network device 101 (e.g., a MeNB) to further configure/control SRB-based signaling transmission from the second network device (e.g., a SeNB).

5 [0062] Optionally, in another embodiment, the network device 101 may trigger transmission of a RRC signaling based on a measurement report from a terminal device at block 360, as shown in FIG. 3; and at block 310, the network device generates the PDU including the RRC signaling. It should be appreciated that, however, embodiments of the present application are not limited to any specific trigger for the RRC signaling
10 transmission, i.e., the network device may trigger the RRC signaling based on other signal from the terminal device or based on any trigger event.

[0063] Though in some embodiments, the method 300 may be used for a downlink (DL) RRC signaling transmission, where the first network device may be a master network device and the second network device may be a secondary network device, it can be
15 appreciated by those skilled in the art that embodiments of the present disclosure are not limited thereto. For example, in one embodiment, the method 300 may be used for an uplink (UL) signaling transmission, where the first network device may be a SeNB. In this example, the first network device may receive a UL RRC signaling from a terminal device (e.g., terminal device 104 shown in FIG. 1A), then generates a PDU including the
20 RRC signaling (e.g., at block 310 of FIG. 3) and transmits it to a second network device which may be a MeNB, via an user plane interface (e.g., at block 330). Similar to the DL case, the first network device (e.g., AP 102 shown in FIG. 1A) may indicate to the second network device (e.g., AP 101 shown in FIG. 1A) whether PDU is a CP PDU or a UP PDU (e.g., at block 320), thereby enabling proper processing at the second network device.

25 [0064] Reference is now made to FIG. 5A, which shows a flowchart of a method 500 according to an embodiment of the present disclosure. The method 500 may be implemented at a network device (e.g., the AP 101-103 shown in FIG. 1A). For the sake of simplicity, the method 500 will be described below with reference to the network device 102 shown in FIG. 1A. However, it is to be understood that the method 500 may also be
30 implemented by any other suitable network devices.

[0065] As shown in FIG. 5A, at block 510, the network device 102 (also referred to as a second network device) receives a PDU from another network device (e.g., the AP 101 shown in FIG. 1A, also referred to as a first network device) via a UP interface, for

example but not limited to, an X2-U interface specified in 3GPP. The network device 102 may serve a terminal device (e.g., the terminal device 104 shown in FIG. 1A) together with the first network device 101 via dual connectivity or multiple connectivity.

[0066] At block 520, the network device 102 determines whether the received PDU is a normal UP PDU or a CP PDU. In one embodiment, the network device 102 may determine whether the PDU is a CP PDU by detecting an indication in a header of the PDU. For example, the network device 102 may detect a C/U field 401 in the header as shown in FIG. 4 to determine a type of the PDU.

[0067] Alternatively, at block 520, the network device 102 may detect an additional signaling, e.g., an X2-AP signaling, from the first network device, and thereby determining the type of the PDU (i.e., CP or UP) based on the additional signaling. Embodiments are not limited to any specific signaling used for this purpose.

[0068] At block 530, the second network device processes the received packet data unit accordingly based on the determination. In one embodiment, the method 500 may be used for DL CP signaling (e.g., RRC signaling) transmission, and some example implementations of block 530 are shown in FIG. 5B for this embodiment. As shown in FIG. 5B, if the packet data unit is determined as a CP PDU, the network device 102 may deliver a CP signaling message included in the received PDU to a terminal device via a SRB at block 5301. In another embodiment, if the PDU is determined as a UP PDU at block 520, the network device may deliver it to the terminal device via a data radio bearer (DRB) at block 5302.

[0069] Now referring back to FIG. 5A. In one embodiment, the SRB used for delivering the CP signaling at block 530 may be selected by the network device 102 from a set of preconfigured SRBs. Alternatively, in another embodiment, at block 540 shown in FIG. 5A, the network device 102 may receive, from the first network device, an identity of a radio bearer for the delivery of the CP signaling, and at block 530, the network device may deliver the CP signaling message to the terminal device via a SRB indicated by the received identity.

[0070] The identity received at block 540 may be an identity transmitted by the first network device 101 at block 340 according method 300, and therefore, descriptions related to the identity provided with reference to method 300 also apply here. For example, the network device 102 may receive the identity in a header of the packet data unit (e.g., a SRB/SRB ID field 402 shown in FIG. 4), or in an additional signaling (e.g., an X2-AP

signaling) from the first network device. The identity may be in a form of a SRB ID, or SRF ID, for example.

[0071] As shown in FIG. 5A, the method 500 may optionally include a block 550, where the network device 102 receives, from the first network device 101, a SRB configuration message for setting a set of parameters for a SRB. The set of parameters may include one or more parameters. At block 530, the network device 102 may deliver the CP signaling according to the SRB configuration received at block 550. The reception at block 550 may correspond to the transmission of the network device 101 at block 350, and therefore, related descriptions provided with reference to block 350 also apply here and details will not be repeated.

[0072] In one embodiment, at block 530, before delivering the CP signaling, the network device may optionally remove the C/I field 401 and/or the SRB/SRF ID field 402 from the header of the CP PDU. That is, the network device 102 may deliver the CP signaling message to the terminal device without transmitting the indication in the header of the PDU. The removing operation is not mandatory, however, since the terminal may ignore the indication even if it is transmitted.

[0073] Though in some embodiments, the method 500 may be used for facilitating a DL RRC signaling transmission, where the first network device may be a master network device (e.g., a MeNB) and the second network device may be a secondary network device (e.g., a SeNB), it can be appreciated by those skilled in the art that embodiments of the present disclosure are not limited thereto. For example, in one embodiment, the method 500 may be used for an UL signaling transmission, where the first network device may be a SeNB and the second network device may be a MeNB. In this embodiment, the PDU received by the second network device at block 510 may or may not contain a RRC signaling from a terminal device, and then at block 530, the second network device may process the PDU as a CP PDCU or a UP PDU according to the determination made at block 520.

[0074] With various embodiments of method 500, a network device (e.g., the AP 102 shown in FIG. 1A) is able to map a CP PDU (received from another network device, e.g., a MeNB) to a correct SRB/SRF, or, process the CP PDU properly, even if the PDU is relayed over an X2-U interface.

[0075] The method 300 and 500 provide a solution for facilitating a more flexible CP signalling transmission, and may enable a more general solution for RRC diversity operation between a MeNB and a SeNB.

[0076] Reference is now made to FIG. 6, which shows a flow of operations performed at a MeNB and a SeNB according to an embodiment of the present disclosure. In this example, at block 610, a RRC diversity transmission is triggered at the MeNB (e.g., AP 101 shown in FIG. 1A or AP 201 shown in FIG2). The trigger may be based on, for example, a measurement report from a UE. At block 620, the MeNB checks whether it has pre-configure SRB for the SeNB, and if not the SRB configuration procedure of performed at block 630 to provide the SRB resources for the SeNB. Then at block 640, the MeNB generates a RRC message and ciphering and/or integrity-protection related processing may be performed in NCS or PDCP of the MeNB. At block 650, the MeNB indicate the generated PDU as a CP PDU by configuring a field of a NCS/PDCP header of the PDU. Optionally, the MeNB may also indicate via the header a SRB identity associated with the RRC PDU. At block 660, the MeNB sends the RRC PDU via an X2-U interface to the SeNB. At block 670, upon receiving the RRC PDU, the SeNB recognizes it as a CP PDU based on detection of its header, and maps this PDU to a proper SRB/SRF, for example, a SRB indicated by the identity transmitted by the MeNB. At block 680, the SeNB forward the PDU to a terminal device, and optionally, the SeNB may remove the CP PDU indication bit(s) from the header before the delivery.

[0077] Please note that at block 660, the MeNB may send the PDU to the SeNB according to a GTP protocol, however, embodiments are not limited thereto. For example, in another embodiment, a GRE may be utilized instead.

[0078] Reference is now made to FIG. 7, which illustrates a schematic block diagram of an apparatus 700 implemented in/as part of a network device, for example, the network device 101, 102 or 103 shown in FIG. 1A. The apparatus 700 is operable to carry out the example method 300 described with reference to FIG. 3 and possibly any other processes or methods. It is also to be understood that the method 300 is not necessarily carried out by the apparatus 700. At least some steps of the method 300 can be performed by one or more other entities.

[0079] As illustrated in FIG. 7, the apparatus 700 includes a generating unit 701, configured to generate a packet data unit; a first indicating unit 702, configured to indicate, to a second network device, whether the packet data unit is a control plane packet data unit

or a user plane packet data unit; and a transmitting unit 703, configured to transmit the packet data unit to the second network device via a user plane interface.

[0080] In one embodiment, the generating unit 701, the first indicating unit 702, and the transmitting unit 703 may be configured to perform functions/operations described with reference to blocks 310 to 330 of method 300 respectively, and therefore descriptions with respect to the generating, indicating and transmitting provided with reference to method 300 also apply here and details will not be repeated for simplicity.

[0081] Just for illustration, in one embodiment, the first indicating unit 702 may be configured to indicate whether the packet data unit is a control plane packet data unit or a user plane packet data unit via an indication in a header of the packet data unit (e.g., via a C/I field 401 as shown in FIG. 4), or via an additional signaling to the second network device.

[0082] In one embodiment, the apparatus 700 may further comprise a second indicating unit 704, configured to indicate to the second network device, an identity of a radio bearer to be used by the second network device for delivering a CP signaling message to the terminal device. As one example, the second indicating unit 704 may be configured to indicate the identity of a radio bearer by transmitting the identity in a header of the PDU (e.g., as a SRB/SRF ID field 402 as shown in FIG. 4) or in an additional signaling (e.g., an X2-AP signaling) to the second network device.

[0083] In another embodiment, the second indicating unit 704 may be configured to indicate the identity of a radio bearer depending on a type of the signaling carried by the PDU. For example, it may indicate a first identity of a radio bearer (e.g., SRB ID 1), if the packet data unit includes a RRC configuration message, and indicate a second identity of a radio bearer (e.g., SRB ID 2), if the PDU includes a non-access stratum (NAS) message.

[0084] As shown in FIG. 7, the apparatus 700 may optionally comprise a configuring unit 705 configured to transmit, to the second network device, a SRB configuration message for setting a set of parameters for a SRB which may include one or more parameters. The configuring unit 705 may also be configured to transmit or receive other signaling involved in a SRB configuration procedure.

[0085] In still another embodiment, the apparatus 700 may comprise a triggering unit 706 which is configured to trigger transmission of a RRC signaling, for example, based on a measurement report from a terminal device; and the generating unit 701 may be configured to generate the packet data unit including the RRC signaling.

[0086] In another embodiment, the apparatus 700 may be used for facilitating an UL RRC signaling transmission, and in this embodiment, the apparatus 700 may be implemented in/as a SeNB, and may include a receiving unit not shown in FIG. 7, configured for receiving a RRC signaling from a terminal device. The generating unit 701 may be

5 configured to generate the PDU including the received RRC signaling.

[0087] Reference is now made to FIG. 8, which illustrates a schematic block diagram of an apparatus 800 implemented in/as part of a second network device, for example, the network device 101, 102 or 103 shown in FIG. 1A or the network device 201 or 202 shown in FIG. 2. The apparatus 800 is operable to carry out the example method 500 described with reference to FIGs. 5A-5B and possibly any other processes or methods. It is also to be understood that the method 500 is not necessarily carried out by the apparatus 800. At least some steps of the method 500 can be performed by one or more other entities.

[0088] As illustrated in FIG. 8, the apparatus 800 includes a first receiving unit 801, configured to receive a PDU from a first network device via a user plane interface; a determining unit 802, configured to determine whether the packet data unit is a control plane packet data unit or a user plane packet data unit; and a processing unit 813, configured to process the received packet data unit accordingly based on the determination.

[0089] In one embodiment, the apparatus 800 may be used for DL CP signaling (e.g., RRC signaling) transmission, and in this embodiment, the processing unit 813 may include a delivering unit 803, configured to deliver a control plane signaling message included in the received packet data unit to a terminal device via a SRB, if the packet data unit is determines as a control plane packet data unit. In one embodiment, the delivering unit 803 may be configured to deliver the PDU to the terminal device via a DRB, if the PDU is determines as a UP PDU.

[0090] In one embodiment, the first receiving unit 801, the determining unit 802, processing unit 813 (and the delivering unit 803 therein) may be configured to perform functions/operations described with reference to blocks 510 to 530 of method 500 respectively, and therefore descriptions with respect to the generating, indicating and processing/delivering provided with reference to method 500 also apply here and details will not be repeated for simplicity.

[0091] Just for illustration, in one embodiment, the determining unit 802 may be configured to determine whether the packet data unit is a control plane packet data unit or a

user plane packet data unit based on detecting an indication in a header of the packet data unit, or an additional signaling from the first network device.

[0092] In another embodiment, the apparatus 800 may further comprise a second receiving unit 804, configured to receive, from the first network device, an identity of a radio bearer for the delivering; and the delivering unit 803 may be is configured to deliver the control plane signaling message to the terminal device via a SRB indicated by the received identity. In one embodiment, the second receiving unit 804 may be configured to receive the identity in a header of the packet data unit, or in an additional signaling from the first network device. The identity of a radio bearer may be, for example but not limited to, a SRB ID of a SRF ID.

[0093] As shown in FIG. 8, in one embodiment, the apparatus 800 may optionally comprise a third receiving unit 805, configured to receive, from the first network device, a signaling radio bearer configuration message for setting a set of parameters for a signaling radio bearer. The SRB configuration message described with reference to block 350 of method 300, block 550 of method 500 and unit 705 of apparatus 700 also apply here.

[0094] In one embodiment, the determining unit 802 is configured to determine type of the PDU (i.e., CP or UP) based on detection of an indication in a header of the PDU, and the delivering unit 803 may be configured to remove the indication from the header of the PDU before delivering the CP signaling message to the terminal device. That is, the delivering unit 803 may be configured to deliver the CP signaling without transmitting the indication in the header of the packet data unit.

[0095] It would be appreciated that apparatuses 700 - 800 may comprise other units not shown in FIGs. 7-8. In addition, some units or modules in the apparatus 700-800 can be combined in an implementation, or may be omitted in another embodiment. For example, in one embodiment, the PDU and the identity which are illustrated as being received by the first receiving unit 801 and the second receiving unit 804 respectively may be received by a single receiving unit. In another embodiment, the delivering unit 803 may be omitted if the apparatus 800 is used for UL RRC signaling transmission.

[0096] FIG. 9 illustrates a simplified block diagram of an apparatus 910 that may be embodied in/as part of a first network device, e.g., the network device 101 shown in FIG. 1A, and an apparatus 920 that may be embodied in/as part of a second network device, e.g., one of the network devices 102 -103 shown in FIG. 1A.

[0097] The apparatus 910 may include at least one processor 911, such as a data processor (DP) and at least one memory (MEM) 912 coupled to the processor 911. The apparatus 910 may further include a transmitter TX and receiver RX 913 coupled to the processor 911. The MEM 912 may be non-transitory machine/ processor/ computer readable storage medium and it may store a program (PROG) 914. The PROG 914 may include instructions that, when executed on the associated processor 911, enable the apparatus 910 to operate in accordance with the embodiments of the present disclosure, for example to perform the method 300. A combination of the at least one processor 911 and the at least one MEM 912 may form processing means 915 adapted to implement various embodiments of the present disclosure.

[0098] The apparatus 920 includes at least one processor 921, such as a DP, and at least one MEM 922 coupled to the processor 921. The apparatus 920 may further include a suitable TX/ RX 923 coupled to the processor 921. The MEM 922 may be non-transitory machine/ processor/ computer readable storage medium and it may store a PROG 924. The PROG 924 may include instructions that, when executed on the associated processor 921, enable the apparatus 920 to operate in accordance with the embodiments of the present disclosure, for example to perform the method 500. A combination of the at least one processor 921 and the at least one MEM 922 may form processing means 925 adapted to implement various embodiments of the present disclosure.

[0099] Various embodiments of the present disclosure may be implemented by computer program executable by one or more of the processors 911 and 921, software, firmware, hardware or in a combination thereof.

[00100] The MEMs 912 and 922 may be of any type suitable to the local technical environment and may be implemented using any suitable data storage technology, such as semiconductor based memory terminal devices, magnetic memory terminal devices and systems, optical memory terminal devices and systems, fixed memory and removable memory, as non-limiting examples.

[00101] The processors 911 and 921 may be of any type suitable to the local technical environment, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors DSPs and processors based on multicore processor architecture, as non-limiting examples.

[00102] Although some of the above description is made in the context of a multiple connectivity scenario, it should not be construed as limiting the spirit and scope of the

present disclosure. The principle and concept of the present disclosure may be more generally applicable to other scenarios.

[00103] In addition, the present disclosure may also provide a memory containing the computer program as mentioned above, which includes machine-readable media and machine-readable transmission media. The machine-readable media may also be called computer-readable media, and may include machine-readable storage media, for example, magnetic disks, magnetic tape, optical disks, phase change memory, or an electronic memory terminal device like a random access memory (RAM), read only memory (ROM), flash memory devices, CD-ROM, DVD, Blue-ray disc and the like. The machine-readable transmission media may also be called a carrier, and may include, for example, electrical, optical, radio, acoustical or other form of propagated signals – such as carrier waves, infrared signals, and the like.

[00104] The techniques described herein may be implemented by various means so that an apparatus implementing one or more functions of a corresponding apparatus described with an embodiment includes not only prior art means, but also means for implementing the one or more functions of the corresponding apparatus described with the embodiment and it may include separate means for each separate function, or means that may be configured to perform two or more functions. For example, these techniques may be implemented in hardware (one or more apparatuses), firmware (one or more apparatuses), software (one or more modules or units), or combinations thereof. For a firmware or software, implementation may be made through modules or units (e.g., procedures, functions, and so on) that perform the functions described herein.

[00105] Example embodiments herein have been described above with reference to block diagrams and flowchart illustrations of methods and apparatuses. It will be understood that each block of the block diagrams and flowchart illustrations, and combinations of blocks in the block diagrams and flowchart illustrations, respectively, can be implemented by various means including hardware, software, firmware, and a combination thereof. For example, in one embodiment, each block of the block diagrams and flowchart illustrations, and combinations of blocks in the block diagrams and flowchart illustrations can be implemented by computer program instructions. These computer program instructions may be loaded onto a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions which execute on the computer or other programmable data processing

apparatus create means for implementing the functions specified in the flowchart block or blocks.

[00106] Further, while operations are depicted in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Likewise, while several specific implementation details are contained in the above discussions, these should not be construed as limitations on the scope of the subject matter described herein, but rather as descriptions of features that may be specific to particular embodiments. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable sub-combination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a sub-combination or variation of a sub-combination.

[00107] It will be obvious to a person skilled in the art that, as the technology advances, the inventive concept can be implemented in various ways. The above described embodiments are given for describing rather than limiting the disclosure, and it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the disclosure as those skilled in the art readily understand. Such modifications and variations are considered to be within the scope of the disclosure and the appended claims. The protection scope of the disclosure is defined by the accompanying claims.

WHAT IS CLAIMED IS:

1. A method implemented at a first network device, comprising:

generating a packet data unit;

5 indicating, to a second network device, whether the packet data unit is a control plane packet data unit or a user plane packet data unit; and

transmitting the packet data unit to the second network device via a user plane interface.

10 2. The method according to Claim 1, wherein the indicating, to a second network device, whether the packet data unit is a control plane packet data unit or a user plane packet data unit comprises: indicating the packet data unit as a control plane packet data unit if the packet data unit includes a control plane signaling message.

15 3. The method according to Claim 1, wherein the indicating comprises: indicating whether the packet data unit is a control plane packet data unit or a user plane packet data unit via an indication in a header of the packet data unit or via an additional signaling to the second network device.

20 4. The method according to Claim 2, further comprising: indicating, to the second network device, an identity of a radio bearer to be used by the second network device for delivering the control plane signaling message to a terminal device.

25 5. The method according to Claim 4, wherein the indicating, to the second network device, an identity of a radio bearer comprises: transmitting the identity in one of:
a header of the packet data unit, and
an additional signaling to the second network device.

30 6. The method according to Claim 4, wherein the indicating, to the second network device, an identity of a radio bearer comprises:

indicating a first identity of a radio bearer, if the packet data unit includes a radio resource control, RRC, configuration message, and

indicating a second different identity of a radio bearer, if the packet data unit

includes a non-access stratum, NAS, message.

7. The method according to Claim 4, wherein the identity of a radio bearer is a signaling radio bearer identity, or a signaling radio flow identity.

5

8. The method according to Claim 1, further comprising:
transmitting, to the second network device, a signaling radio bearer configuration message for setting a set of parameters for a signaling radio bearer.

10

9. The method according to Claim 1, further comprising:
triggering transmission of a radio resource control, RRC, signaling based on a measurement report from a terminal device; and
wherein the generating a packet data unit comprises:
generating the packet data unit including the RRC signaling.

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10. A method implemented at a second network device, comprising:
receiving a packet data unit from a first network device via a user plane interface;
determining whether the packet data unit is a control plane packet data unit or a user plane packet data unit; and

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processing the received packet data unit accordingly based on the determination.

11. The method according to Claim 10, wherein the processing the received packet data unit accordingly based on the determination comprises:

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delivering a control plane signaling message included in the received packet data unit to a terminal device via a signaling radio bearer, if the packet data unit is determined as a control plane packet data unit; and/or

delivering the received packet data unit to a terminal device via a data radio bearer, if the packet data unit is determined as a user plane packet data unit.

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12. The method according to Claim 10, wherein the determining whether the packet data unit is a control plane packet data unit or a user plane packet data unit is based on detecting one of:

an indication in a header of the packet data unit, and

an additional signaling from the first network device.

13. The method according to Claim 10, further comprising:

receiving, from the first network device, an identity of a radio bearer for the
5 delivering; and

wherein the delivering a control plane signaling message included in the packet data unit to a terminal device via a signaling radio bearer comprises: delivering the control plane signaling message to the terminal device via a signaling radio bearer indicated by the received identity.

10 14. The method according to Claim 13, wherein the receiving, from the first network device, an identity of a radio bearer comprises: receiving the identity in one of:

a header of the packet data unit, and

an additional signaling from the first network device.

15 15. The method according to Claim 13, wherein the identity of a radio bearer is one of a signaling radio bearer identity and a signaling radio flow identity.

20 16. The method according to Claim 10, further comprising: receiving, from the first network device, a signaling radio bearer configuration message for setting a set of parameters for a signaling radio bearer.

17. The method according to Claim 11, wherein the determining comprises determining by detecting an indication in a header of the packet data unit, and

25 wherein the delivering a control plane signaling message included in the received packet data unit to a terminal device comprises: delivering the control plane signaling message to the terminal device without transmitting the indication in the header of the received packet data unit.

30 18. A first network device, comprising:

a generating unit, configured to generate a packet data unit;

a first indicating unit, configured to indicate, to a second network device, whether the packet data unit is a control plane packet data unit or a user plane packet data unit; and

a transmitting unit, configured to transmit the packet data unit to the second network device via a user plane interface.

19. The first network device according to Claim 18, wherein the first indicating unit is further configured to indicate the packet data unit as a control plane packet data unit if the packet data unit includes a control plane signaling message.

20. The first network device according to Claim 19, wherein the first indicating unit is configured to indicate whether the packet data unit is a control plane packet data unit or a user plane packet data unit via an indication in a header of the packet data unit or via an additional signaling to the second network device.

21. The first network device according to Claim 19, further comprising:
a second indicating unit, configured to indicate to the second network device, an identity of a radio bearer to be used by the second network device for delivering the control plane signaling message to a terminal device.

22. The first network device according to Claim 21, wherein the second indicating unit is configured to indicate the identity of a radio bearer by transmitting the identity in one of:

a header of the packet data unit, and
an additional signaling to the second network device.

23. The first network device according to Claim 21, wherein the second indicating unit is configured to:

indicate a first identity of a radio bearer, if the packet data unit includes a radio resource control, RRC, configuration message, and

indicate a second different identity of a radio bearer, if the packet data unit includes a non-access stratum, NAS, message.

24. The first network device according to Claim 21, wherein the identity of a radio bearer is one of a signaling radio bearer identity and a signaling radio flow identity.

25. The first network device according to Claim 18, further comprising:

a configuring unit, configured to transmit, to the second network device, a signaling radio bearer configuration message for setting a set of parameters for a signaling radio bearer.

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26. The first network device according to Claim 18, further comprising:

a triggering unit, configured to trigger transmission of a radio resource control, RRC, signaling based on a measurement report from a terminal device; and

10 wherein the generating unit is configured to generate the packet data unit including the RRC signaling.

27. A second network device, comprising:

a first receiving unit, configured to receive a packet data unit from a first network device via a user plane interface;

15 a determining unit, configured to determine whether the packet data unit is a control plane packet data unit or a user plane packet data unit; and

a processing unit, configured to process the received packet data unit accordingly based on the determination.

20 28. The second network device according to Claim 27, wherein the processing unit comprises a delivering unit, configured to:

deliver control plane signaling message included in the received packet data unit to a terminal device via a signaling radio bearer, if the packet data unit is determined as a control plane packet data unit; and/or

25 deliver the received packet data unit to a terminal device via a data radio bearer, if the packet data unit is determined as a user plane packet data unit.

29. The second network device according to Claim 27, wherein the determining unit is configured to determine whether the packet data unit is a control plane packet data unit or a user plane packet data unit based on detecting one of:

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an indication in a header of the packet data unit, and
an additional signaling from the first network device.

30. The second network device according to Claim 27, further comprising:

a second receiving unit, configured to receive, from the first network device, an identity of a radio bearer for the delivering; and

wherein the delivering unit is configured to deliver the control plane signaling message to the terminal device via a signaling radio bearer indicated by the received identity.

31. The second network device according to Claim 30, wherein the second receiving unit is configured to receive the identity in one of:

a header of the packet data unit, and

an additional signaling from the first network device.

32. The second network device according to Claim 30, wherein the identity of a radio bearer is one of a signaling radio bearer identity and a signaling radio flow identity.

33. The second network device according to Claim 27, further comprising:

a third receiving unit, configured to receive, from the first network device, a signaling radio bearer configuration message for setting a set of parameters for a signaling radio bearer.

34. The second network device according to Claim 27, wherein the determining unit is configured to determine by detecting an indication in a header of the packet data unit, and

wherein the delivering unit is configured to deliver the control plane signaling message to the terminal device without transmitting the indication in the header of the packet data unit.

35. An apparatus implemented at a first network device, the apparatus comprising at least one processor and at least one memory including computer program code; the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

generate a packet data unit;

indicate, to a second network device, whether the packet data unit is a control

plane packet data unit or a user plane packet data unit; and

transmit the packet data unit to the second network device via a user plane interface.

36. An apparatus implemented at a second network device, the apparatus comprising at least one processor and at least one memory including computer program code; the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

receive a packet data unit from a first network device via a user plane interface;

determine whether the packet data unit is a control plane packet data unit or a user plane packet data unit; and

process the received packet data unit accordingly based on the determination.

37. An apparatus implemented at a first network device, the apparatus comprising processing means adapted to:

generate a packet data unit;

indicate, to a second network device, whether the packet data unit is a control plane packet data unit or a user plane packet data unit; and

transmit the packet data unit to the second network device via a user plane interface.

38. An apparatus implemented at a first network device, the apparatus comprising processing means adapted to:

receive a packet data unit from a first network device via a user plane interface;

determine whether the packet data unit is a control plane packet data unit or a user plane packet data unit; and

process the received packet data unit accordingly based on the determination.

39. A computer program, comprising instructions which, when executed on at least one processor, cause the at least one processor to carry out the method according to any of claims 1 to 9.

40. A computer program, comprising instructions which, when executed on at least one processor, cause the at least one processor to carry out the method according to any of claims 10 to 17.

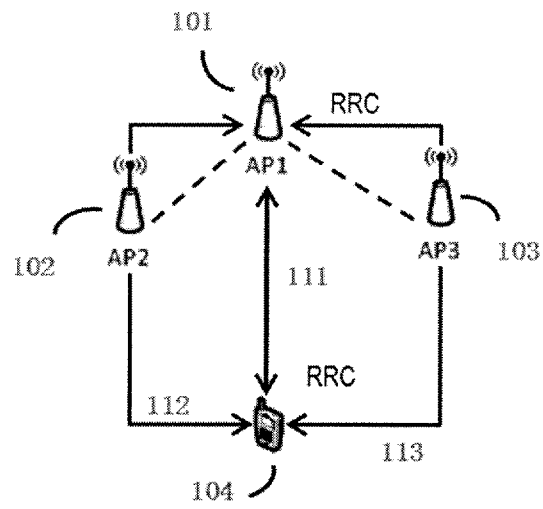


FIG. 1A

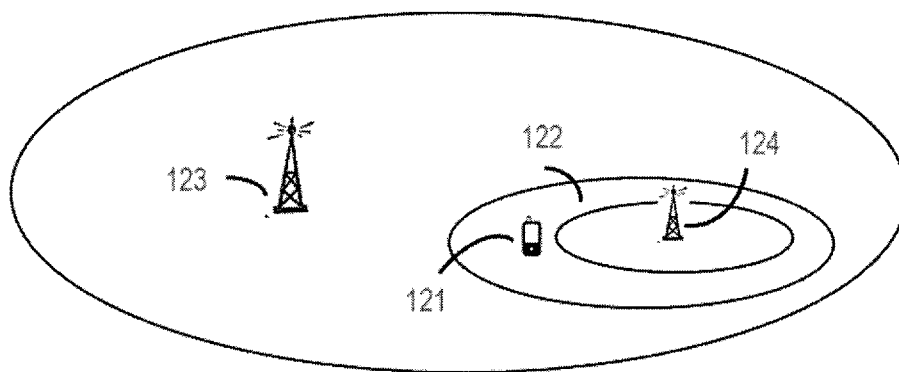


FIG. 1B

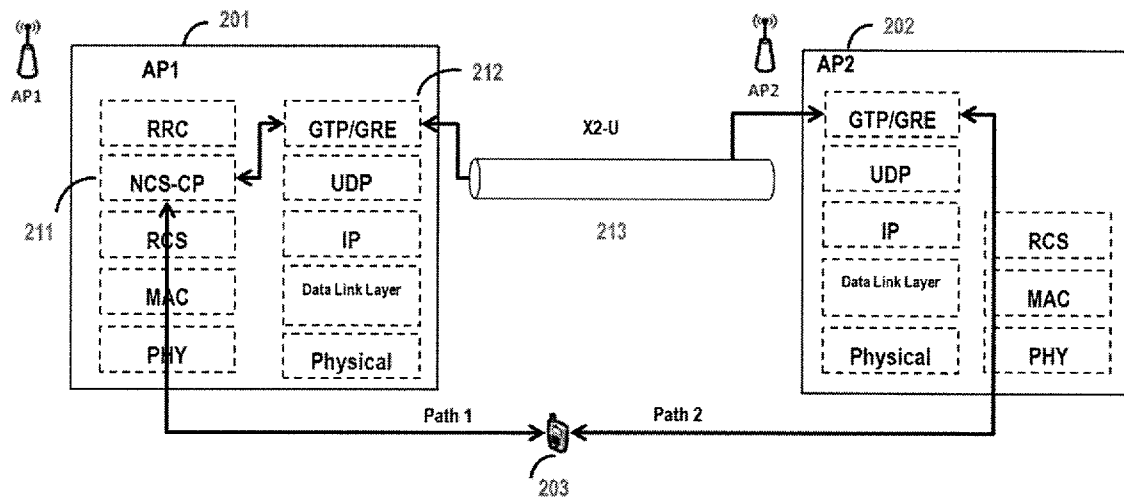


FIG. 2

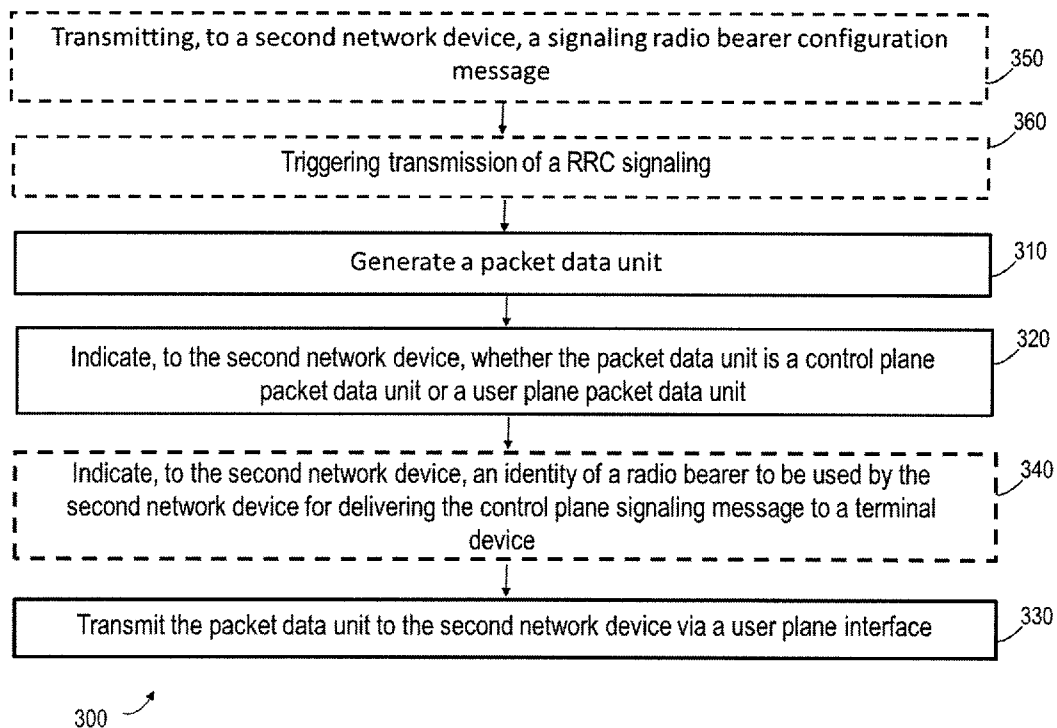


FIG. 3

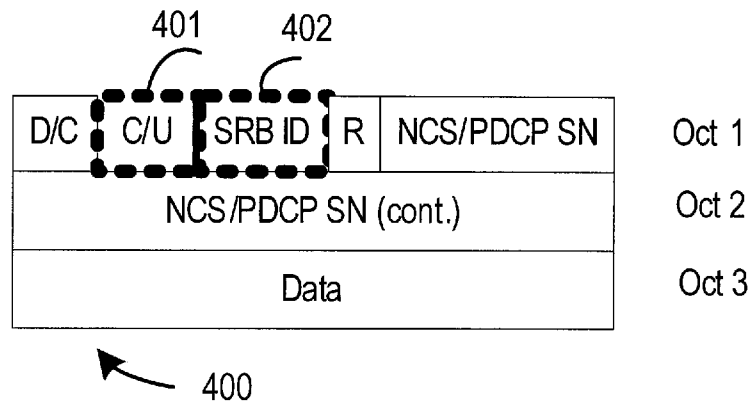


FIG. 4

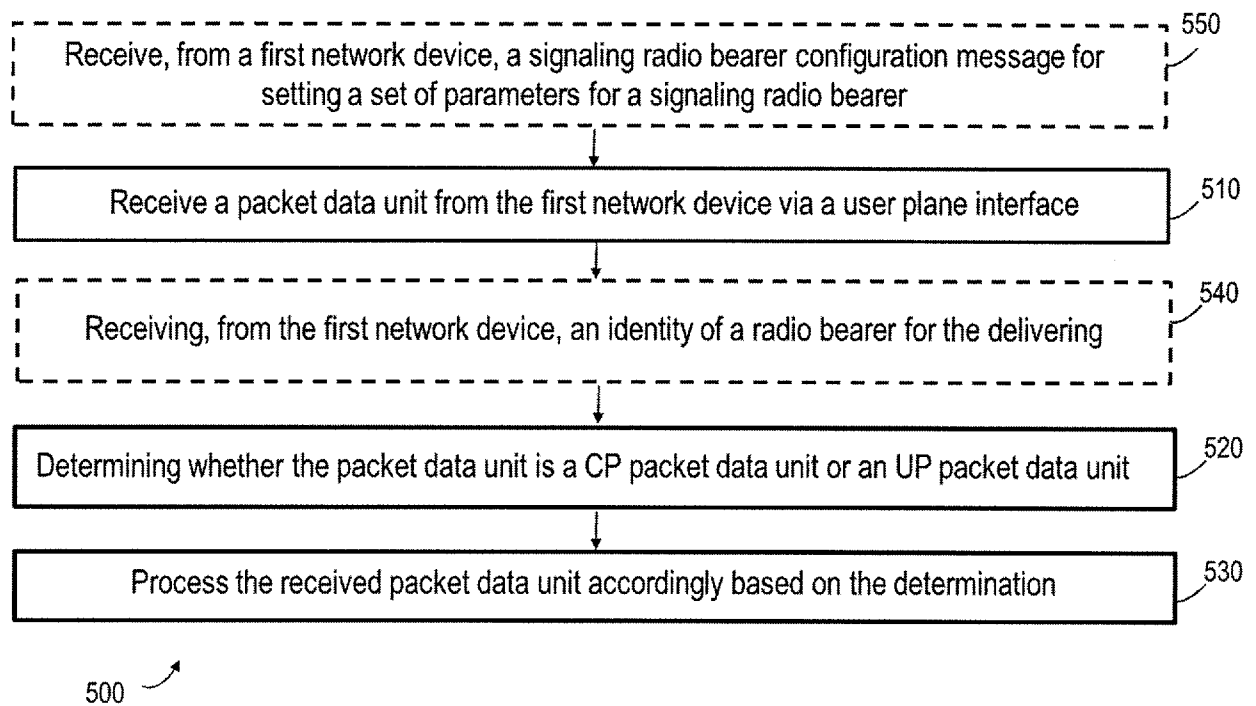


FIG. 5A

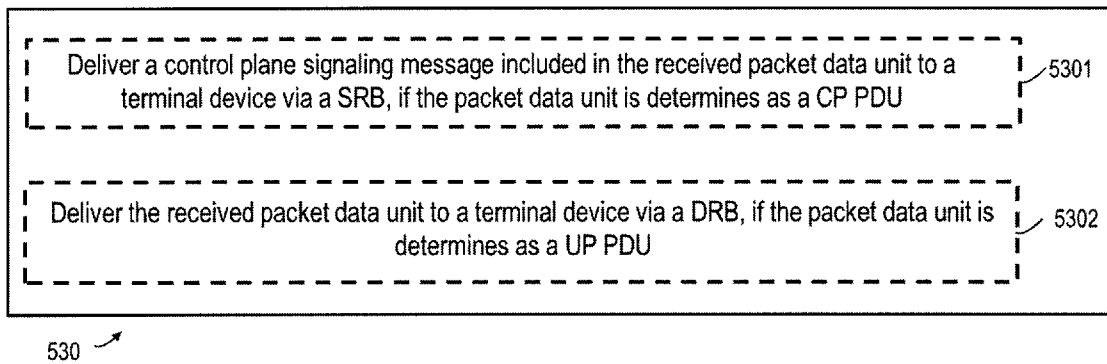


FIG. 5B

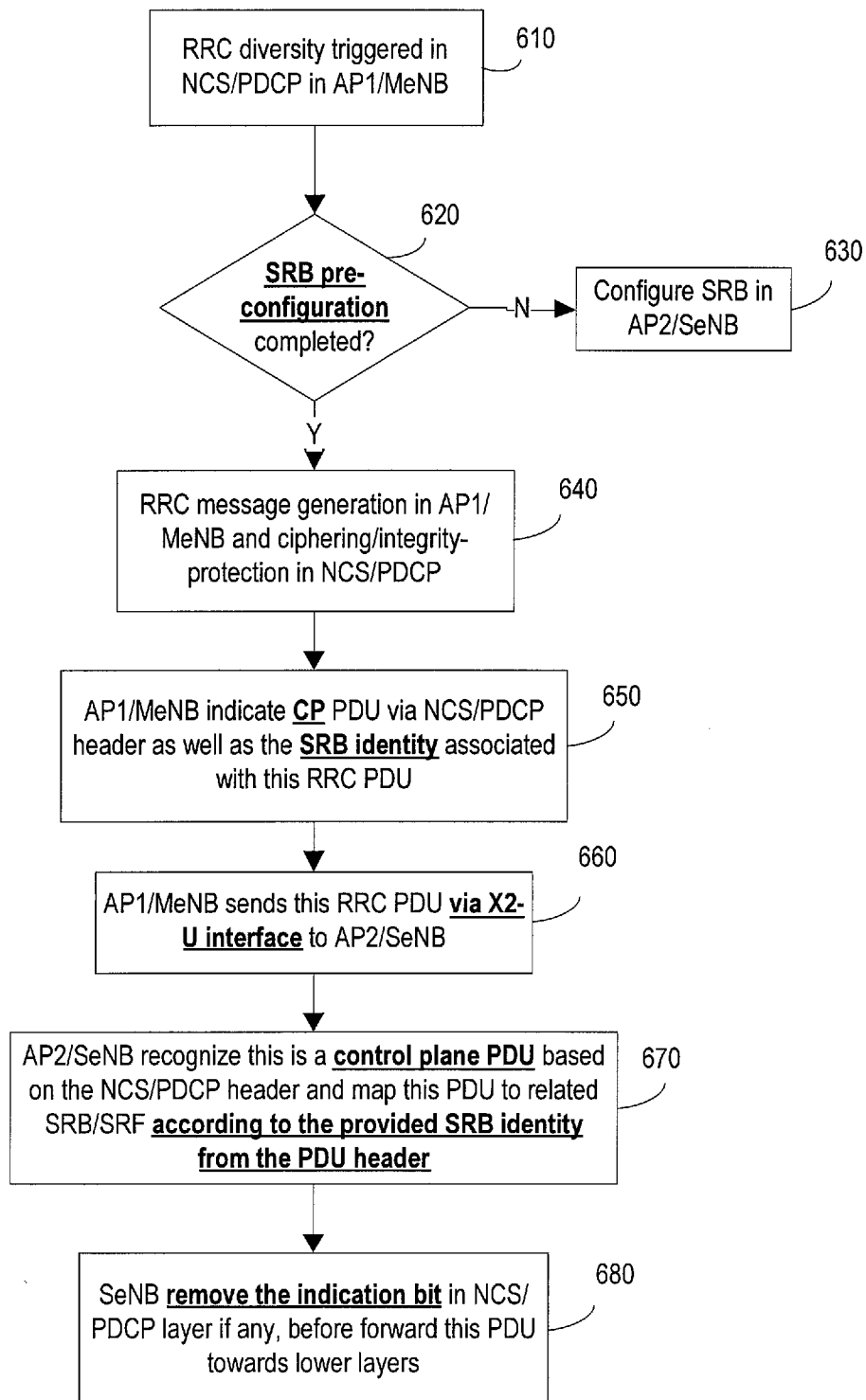


FIG. 6

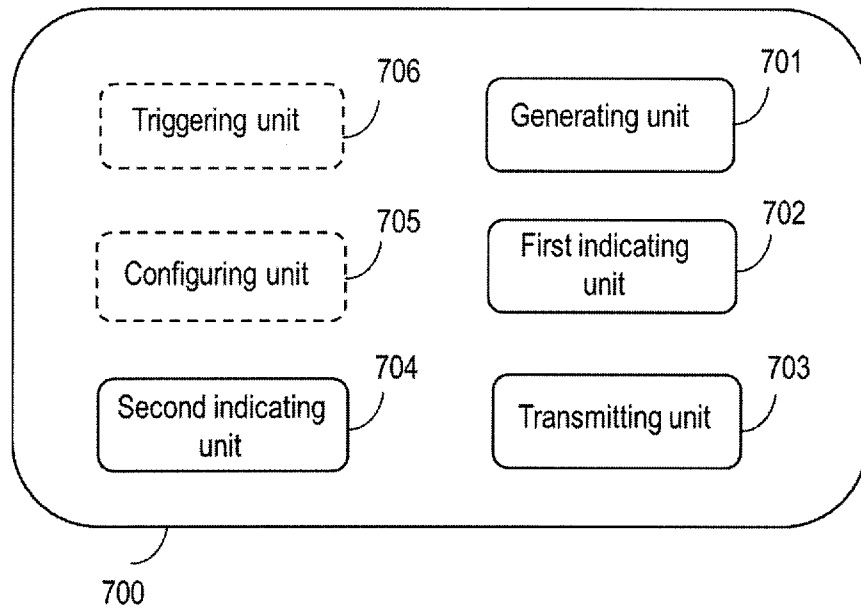


FIG. 7

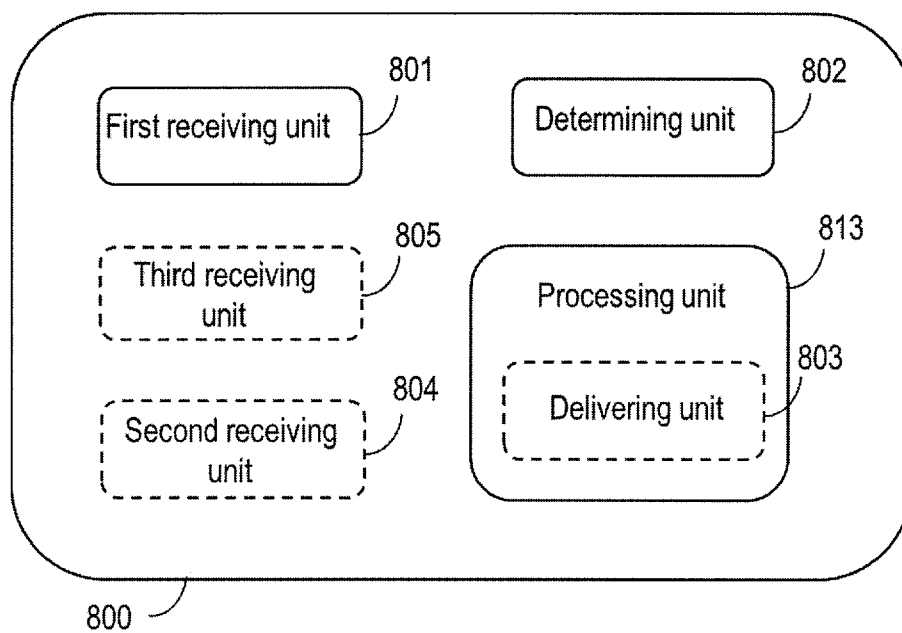


FIG. 8

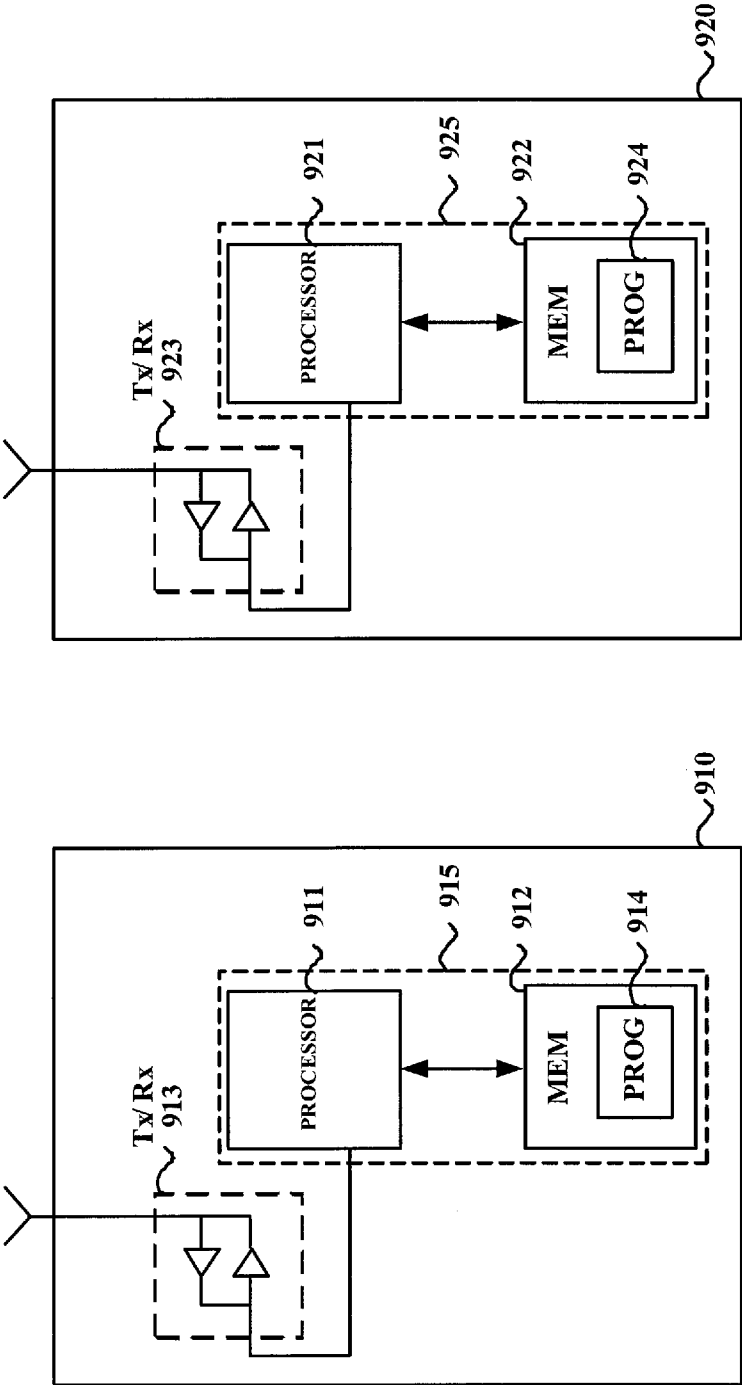


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/093579

A. CLASSIFICATION OF SUBJECT MATTER

H04W 76/02(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)

H04W; H04Q

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

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

CNPAT,CNKI,WPI,EPODOC: dual connectivity, packet data, control plane, user plane, identity, radio bearer, signaling message

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 104105221 A (ZTE CORPORATION) 15 October 2014 (2014-10-15) description, paragraphs [0058]-[0070]	1-40
Y	CN 102036256 A (HUAWEI TECHNOLOGIES CO., LTD.) 27 April 2011 (2011-04-27) description, paragraphs [0061]-[0070]	1-40
A	CN 104202768 A (CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY) 10 December 2014 (2014-12-10) the whole document	1-40
A	WO 2010125982 A1 (SHARP KABUSHIKI KAISHA) 04 November 2010 (2010-11-04) the whole document	1-40

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

10 April 2017

Date of mailing of the international search report

27 April 2017

Name and mailing address of the ISA/CN

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Telephone No. (86-10)62413350

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2016/093579

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	104105221	A	15 October 2014	EP	2947951	A1	25 November 2015
				WO	2014169748	A1	23 October 2014
				US	2016044540	A1	11 February 2016
CN	102036256	A	27 April 2011	EP	2900033	A1	29 July 2015
				WO	2011035733	A1	31 March 2011
				CN	103188681	A	03 July 2013
				US	2012182929	A1	19 July 2012
				EP	2485561	A1	08 August 2012
CN	104202768	A	10 December 2014	None			
WO	2010125982	A1	04 November 2010	JP	2012525720	A	22 October 2012
				US	2012044836	A1	23 February 2012
				GB	0907213	D0	10 June 2009