

METHOD AND APPARATUS FOR BACKHAUL LINK TRANSMISSION IN A WIRELESS ACCESS BACKHAUL NETWORK

TECHNICAL FIELD

[0001] Embodiments of the present disclosure generally relate to wireless communication technology, and more particularly to wireless communication in a wireless access backhaul (WAB) network or a mobile WAB network.

BACKGROUND

[0002] A wireless communication system may include one or multiple network communication devices, such as base stations (BSs), which may support wireless communication for one or multiple user communication devices, which may be otherwise known as user equipment (UE), or other suitable terminology. The wireless communication system may support wireless communication with one or multiple user communication devices by utilizing resources of the wireless communication system (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers, or the like). Additionally, the wireless communication system may support wireless communication across various radio access technologies including third generation (3G) radio access technology, fourth generation (4G) radio access technology, fifth generation (5G) (which is also known as new radio (NR) or next generation (NG)) radio access technology, among other suitable radio access technologies beyond 5G (e.g., sixth generation (6G)).

SUMMARY

[0003] An article "a" before an element is unrestricted and understood to refer to "at least one" of those elements or "one or more" of those elements. The terms "a," "at least one," "one or more," and "at least one of one or more" may be interchangeable. As used herein, including in the claims, "or" as used in a list of items (e.g., a list of

items prefaced by a phrase such as "at least one of" or "one or more of" or "one or both of") indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C). Also, as used herein, the phrase "based on" shall not be construed as a reference to a closed set of conditions. For example, an example step that is described as "based on condition A" may be based on both a condition A and a condition B without departing from the scope of the present disclosure. In other words, as used herein, the phrase "based on" shall be construed in the same manner as the phrase "based at least in part on." Further, as used herein, including in the claims, a "set" may include one or more elements.

[0004] Some embodiments of the present disclosure provide a wireless network node. The wireless network node may include: at least one memory; and at least one processor coupled with the at least one memory and configured to cause the wireless network node to: at least one memory; and at least one processor coupled with the at least one memory and configured to cause the wireless network node to: support a BS part and a mobile terminal (MT) part; receive uplink (UL) user plane (UP) traffic from a UE served by the wireless network node, or generate first UL control plane (CP) signaling to a core network (CN), wherein the wireless network node accesses the CN via a donor BS; and map the UL UP traffic or the first UL CP signaling to a protocol data unit (PDU) session of the wireless network node based on a mapping configuration from the donor BS or the CN.

[0005] Some embodiments of the present disclosure provide a first user plane function (UPF) entity. The first UPF entity may include: at least one memory; and at least one processor coupled with the at least one memory and configured to cause the first UPF entity to: establish a first PDU session for transporting UL traffic and downlink (DL) traffic associated with a wireless network node, wherein the first PDU session anchors at the first UPF entity; transmit the UL traffic associated with the wireless network node to either an access and mobility management function (AMF) entity or a second UPF entity which establishes a second PDU session with a UE served by the wireless network node; and transmit the DL traffic associated with the wireless network node to the wireless network node over the first PDU session via a donor BS of the wireless network node.

[0006] Some embodiments of the present disclosure provide a method for wireless communication, including: receiving UL UP traffic from a UE served by a wireless network node, or generating first UL CP signaling to a CN, wherein the wireless network node supports a BS part and an MT part and accesses the CN via a donor BS; and mapping the UL UP traffic or the first UL CP signaling to a PDU session of the wireless network node based on a mapping configuration from the donor BS or the CN.

[0007] Some embodiments of the present disclosure provide a method for wireless communication, including: establishing a first PDU session for transporting UL traffic and DL traffic associated with a wireless network node, wherein the first PDU session anchors at a first UPF entity; transmitting the UL traffic associated with the wireless network node to either an AMF entity or a second UPF entity which establishes a second PDU session with a UE served by the wireless network node; and transmitting the DL traffic associated with the wireless network node to the wireless network node over the first PDU session via a donor BS of the wireless network node.

[0008] Some embodiments of the present disclosure provide an apparatus. According to some embodiments of the present disclosure, the apparatus may include: at least one non-transitory computer-readable medium having stored thereon computer-executable instructions; at least one receiving circuitry; at least one transmitting circuitry; and at least one processor coupled to the at least one non-transitory computer-readable medium, the at least one receiving circuitry and the at least one transmitting circuitry, wherein the at least one non-transitory computer-readable medium and the computer executable instructions may be configured to, with the at least one processor, cause the apparatus to perform a method according to some embodiments of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] In order to describe the manner in which the advantages and features of the disclosure can be obtained, a description of the disclosure is rendered by reference to specific embodiments thereof, which are illustrated in the appended drawings. These drawings depict only exemplary embodiments of the disclosure and are not

therefore to be considered limiting of its scope.

[0010] FIG. 1 illustrates a schematic diagram of a wireless communication system in accordance with some embodiments of the present disclosure;

[0011] FIG. 2 illustrates an example block diagram of various connections in a WAB network in accordance with some embodiments of the present disclosure;

[0012] FIGs. 3A and 4B illustrate example block diagrams of a protocol stack for a WAB network in accordance with some embodiments of the present disclosure;

[0013] FIGs. 5A and 5B illustrate example UL UP traffic at various entities of a WAB network in accordance with some embodiments of the present disclosure;

[0014] FIGs. 6 and 7 illustrate flowcharts of methods for wireless communication in accordance with some embodiments of the present disclosure;

[0015] FIG. 8 illustrates an example of network equipment (NE) in accordance with some embodiments of the present disclosure; and

[0016] FIG. 9 illustrates an example of a processor in accordance with some embodiments of the present disclosure.

DETAILED DESCRIPTION

[0017] The detailed description of the appended drawings is intended as a description of the preferred embodiments of the present disclosure and is not intended to represent the only form in which the present disclosure may be practiced. It should be understood that the same or equivalent functions may be accomplished by different embodiments that are intended to be encompassed within the spirit and scope of the present disclosure.

[0018] Reference will now be made in detail to some embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. To facilitate understanding, embodiments are provided under a specific network

architecture(s) and new service scenarios, such as the 3rd generation partnership project (3GPP) 5G NR or 6G, 3GPP LTE, and so on. It is contemplated that along with the developments of network architectures and new service scenarios, all embodiments in the present disclosure are also applicable to similar technical problems; and moreover, the terminologies recited in the present disclosure may change, which should not affect the principles of the present disclosure.

[0019] In a WAB network, a wireless network node such as a relay node (RN) or a WAB node, a wireless backhaul node, or a wireless backhaul device can provide wireless access services for UEs. For example, a UE can connect to a BS (i.e., a WAB donor) relayed by one or more WAB nodes. The WAB donor may also be called a donor node or a donor base station (e.g., DgNB, Donor gNodeB). In addition, the wireless link between a WAB donor and a WAB node, or the wireless link between different WAB nodes can be referred to as a "backhaul link." It should be noted that although, for convenience, some embodiments of the present disclosure use WAB node and WAB donor to describe the WAB network, the scope of the embodiments is not limited in this respect. For example, the entities in a WAB network may have different terminologies but the embodiments may still apply.

[0020] A WAB node may include an MT part (i.e., WAB-MT) and a BS part (i.e., WAB-BS). In some examples, the WAB-MT may be a mobile terminal. When a WAB node connects to its parent node (which may be another WAB node or a WAB donor), it can be regarded as a UE, i.e., the role of an MT. In some examples, the WAB-MT can be called WAB-UE. That is, the MT part may be referred to as a UE part or UE component. When a WAB node provides service to its child node (which may be another WAB node or a UE), it can be regarded as a network device, i.e., the role of a BS (e.g., a gNB).

[0021] In some embodiments, a WAB node may be referred to as a "mobile WAB node (MWAB)," which is a mobile base station acting as a relay between a UE and the network (e.g., a mobile gNB with wireless access backhauling). The MT part or UE component of the MWAB may be referred to as MWAB-UE and the BS part or BS component of the MWAB may be referred to as MWAB-BS (e.g., MWAB-gNB). For example, the WAB node may provide a NR access link to UEs and connected

wirelessly (using NR) through a donor NG-radio access network (RAN) (NG-RAN) to the 5G Core. In some examples, such mobile base station relay may be mounted on a vehicle and may serve UEs that can be located inside (onboard) or outside (surrounding) the vehicle, or UEs that enter or leave the vehicle.

[0022] A WAB donor or the WAB-BS can be an access network element with a complete base station function, or an access network element with a separate form of a centralized unit (CU) and a DU. The WAB donor or the WAB-BS may be connected to the core network (for example, connected to the 5G core (5GC) network), and provide the wireless backhaul function for the WAB nodes. For example, the CU of a WAB donor may be referred to as a "WAB donor-CU" (or directly referred to as a "CU"), and the DU of the WAB donor may be referred to as a "WAB donor-DU." The WAB donor-CU or the CU of the WAB-BS may be separated into a control plane (CP) and a user plane (UP). For example, a CU may include one CU-CP and one or more CU-UPs.

[0023] Considering the limited coverage of a high frequency band, and in order to ensure coverage performance of the network, multi-hop networking may be adopted in a WAB network. Taking into account the requirements of service transmission reliability, WAB nodes can support dual connectivity (DC) or multi-connectivity to improve transmission reliability, so as to deal with abnormal situations that may occur on the backhaul (BH) link, such as radio link failure (RLF) or blockage, load fluctuations, etc.

[0024] In the case where a WAB network supports multi-hop and dual-connection networking, there may be multiple transmission paths between the UE and the WAB donor. A transmission path may include multiple nodes, such as a UE, one or more WAB nodes, and a WAB donor (if the WAB donor is in the form of a separate CU and DU, it may also contain a WAB donor-DU and a WAB donor-CU). Each WAB node may treat the neighboring node that provides backhaul services for it as a parent node (or parent WAB node), and each WAB node can be regarded as a child node (or child WAB node) of its parent node.

[0025] Technologies for facilitating communications in a WAB network are desired. For example, embodiments of the present disclosure provide various protocol stacks

to support PDU session backhauling. For example, solutions for handling UL and DL transmissions (e.g., CP and UP traffic) at entities in a WAB network are provided. For example, mapping rules for UL transmission are provided at a WAB node. For example, methods for transferring the UL traffic are provided at an MT-UPF. For example, methods for mapping DL UP traffic to a corresponding PDU session are provided.

[0026] FIG. 1 illustrates a schematic diagram of wireless communication system 100 in accordance with some embodiments of the present disclosure.

[0027] As shown in FIG. 1, wireless communication system 100 may include some base stations (e.g., WAB donor 110A and WAB donor 110B), some WAB nodes (e.g., WAB node 120A, WAB node 120B, and WAB node 120C), and some UEs (e.g., UE 130A and UE 130B). Although a specific number of UEs, WAB nodes, and WAB donors is depicted in FIG. 1, it is contemplated that any number of UEs, WAB nodes, and WAB donors may be included in wireless communication system 100. Each of WAB donor 110A, WAB donor 110B, WAB node 120A, WAB node 120B, and WAB node 120C may be directly connected to one or more WAB nodes in accordance with some other embodiments of the present disclosure. Each of WAB donor 110A, WAB donor 110B, WAB node 120A, WAB node 120B, and WAB node 120C may be directly connected to one or more UEs in accordance with some other embodiments of the present disclosure.

[0028] Wireless communication system 100 may be compatible with any type of network that is capable of transmitting and receiving wireless communication signals. Wireless communication system 100 may support various radio access technologies. In some implementations, wireless communication system 100 may be a 4G network, such as an LTE network or an LTE-Advanced (LTE-A) network. In some other implementations, wireless communication system 100 may be a NR network, such as a 5G network, a 5G-Advanced (5G-A) network, or a 5G ultra-wideband (5G-UWB) network. In other implementations, wireless communication system 100 may be a combination of a 4G network and a 5G network, or other suitable radio access technology including Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), and IEEE 802.20. Wireless communication

system 100 may support radio access technologies beyond 5G, for example, 6G. Additionally, wireless communication system 100 may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

[0029] In the context of the present disclosure, a WAB node (e.g., WAB node 120A, WAB node 120B, or WAB node 120C in FIG. 1) or a WAB donor (e.g., WAB donor 110A and WAB donor 110B in FIG. 1) may also be referred to an NE. An NE may be dispersed throughout a geographic region to form wireless communication system 100. An NE may provide a geographic coverage area for which the NE may support services for one or more UEs within the geographic coverage area. For example, an NE and a UE may support wireless communication of signals related to services (e.g., voice, video, packet data, messaging, broadcast, etc.) according to one or multiple radio access technologies. In some implementations, an NE may be moveable, for example, a satellite associated with a non-terrestrial network (NTN) or a relay mounted on a moving vehicle. In some implementations, different geographic coverage areas associated with the same or different radio access technologies may overlap, but the different geographic coverage areas may be associated with a different NE.

[0030] UE 130A and UE 130B may be dispersed throughout a geographic region of wireless communication system 100. UE 130A and UE 130B may be any type of device configured to operate and/or communicate in a wireless environment. For example, UE 130A or UE 130B may include or may be referred to as a remote unit, a mobile device, a wireless device, a remote device, a subscriber device, a transmitter device, a receiver device, or some other suitable terminology. In some implementations, UE 130A or UE 130B may be referred to as a unit, a station, a terminal, or a client, among other examples. Additionally, or alternatively, UE 130A or UE 130B may be referred to as an Internet-of-Things (IoT) device, an Internet-of-Everything (IoE) device, or machine-type communication (MTC) device, among other examples.

[0031] UE 130A and UE 130B may be able to support wireless communication directly with each other or other UEs over a communication link. For example, UE

130A may support wireless communication directly with UE 130B over a device-to-device (D2D) communication link. In some implementations, such as vehicle-to-vehicle (V2V) deployments, vehicle-to-everything (V2X) deployments, or cellular-V2X deployments, the communication link between two UEs may be referred to as a sidelink. For example, UE 130A may support wireless communication directly with UE 130B over a PC5 interface. Similarly, an MT of a WAB node and an MT of another WAB node may communication directly with each other over a sidelink.

[0032] A WAB donor may support communication with a core network (CN), or with another WAB donor, or both. For example, WAB donor 110A may interface with WAB donor 110B or the CN (not shown in FIG. 1) through one or more backhaul links (e.g., S1, X2, NG, Xn, or other network interface). In some implementations, WAB donors may communicate with each other directly. In some other implementations, WAB donors may communicate with each other indirectly (e.g., via the CN).

[0033] The CN may support user authentication, access authorization, tracking, connectivity, and other access, routing, or mobility functions. The CN may be an evolved packet core (EPC), or a 5G core (5GC), which may include a control plane entity that manages access and mobility (e.g., a mobility management entity (MME), an access and mobility management functions (AMF)) and a user plane entity that routes packets or interconnects to external networks (e.g., a serving gateway (S-GW), a Packet Data Network (PDN) gateway (P-GW), or a user plane function (UPF)). In some implementations, the control plane entity may manage non-access stratum (NAS) functions, such as mobility, authentication, and bearer management (e.g., data bearers, signal bearers, etc.) for UEs served by a WAB node or a WAB donor associated with the CN.

[0034] The CN may communicate with a packet data network over one or more backhaul links (e.g., via an N6 or another network interface). The packet data network may include an application server. In some implementations, one or more UEs may communicate with the application server. A UE may establish a session (e.g., a protocol data unit (PDU) session, or the like) with the CN via, for example, a

WAB donor. The CN may route traffic (e.g., control information, data, and the like) between the UE and the application server using the established session (e.g., the established PDU session). The PDU session may be an example of a logical connection between the UE and the CN (e.g., one or more network functions of the CN).

[0035] In wireless communication system 100, NEs (e.g., WAB donors and WAB nodes) and UEs may use resources of wireless communication system 100 (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers)) to perform various operations (e.g., wireless communication).

[0036] In wireless communication system 100, an electromagnetic (EM) spectrum may be split, based on frequency or wavelength, into various classes, frequency bands, frequency channels, etc. By way of example, wireless communication system 100 may support one or multiple operating frequency bands, such as frequency range designations FR1 (410 MHz – 7.125 GHz), FR2 (24.25 GHz – 52.6 GHz), FR3 (7.125 GHz – 24.25 GHz), FR4 (52.6 GHz – 114.25 GHz), FR4a or FR4-1 (52.6 GHz – 71 GHz), and FR5 (114.25 GHz – 300 GHz). In some implementations, NEs and UEs may perform wireless communication over one or more of the operating frequency bands. In some implementations, FR1 may be used by NEs and UEs, among other equipment or devices for cellular communication traffic (e.g., control information, data). In some implementations, FR2 may be used by NEs and UEs, among other equipment or devices for short-range, high data rate capabilities.

[0037] A UE may include computing devices, such as desktop computers, laptop computers, personal digital assistants (PDAs), tablet computers, smart televisions (e.g., televisions connected to the Internet), set-top boxes, game consoles, security systems (including security cameras), vehicle on-board computers, network devices (e.g., routers, switches, and modems), vehicles or the like. According to some embodiments of the present disclosure, a UE may include a portable wireless communication device, a smart phone, a cellular telephone, a flip phone, a device having a subscriber identity module, a personal computer, a selective call receiver, or any other device that is capable of sending and receiving communication signals on a

wireless network. In some embodiments of the present disclosure, a UE includes wearable devices, such as smart watches, fitness bands, optical head-mounted displays, or the like. Moreover, a UE may be referred to as a subscriber unit, a mobile, a mobile station, a user, a terminal, a mobile terminal, a wireless terminal, a fixed terminal, a subscriber station, a user terminal, or a device, or described using other terminology used in the art. A UE may communicate with an NE (e.g., a WAB donor or a WAB node) via uplink (UL) communication signals. An NE may communicate with a UE via downlink (DL) communication signals.

[0038] In some embodiments of the present disclosure, an NE (e.g., a wireless network node, a BS, a WAB donor or a WAB node) and a UE may communicate over licensed spectrums, whereas in some other embodiments, an NE and a UE may communicate over unlicensed spectrums. The present disclosure is not intended to be limited to the implementation of any particular wireless communication system architecture or protocol.

[0039] Persons skilled in the art should understand that as technology develops and advances, the terminologies described in the present disclosure may change, but should not affect or limit the principles and spirit of the present disclosure.

[0040] Referring to FIG. 1, WAB node 120A can be directly connected to WAB donors 110A and 110B, and WAB node 120B can be directly connected to WAB donor 110A. WAB donors 110A and 110B are parent nodes of WAB node 120A, and WAB donor 110A is a parent node of WAB node 120B. In other words, WAB nodes 120A and 120B are child WAB nodes of WAB donor 110A, and WAB node 120A is also a child WAB node of WAB donor 110B. WAB node 120C can reach WAB donor 110A by hopping through WAB node 120B. WAB node 120B is a parent WAB node of WAB node 120C. In other words, WAB node 120C is a child WAB node of WAB node 120B.

[0041] In some other embodiments of the present disclosure, a WAB node may be connected to WAB node 120C so it can reach WAB donor 110A by hopping through WAB node 120C and WAB node 120B. This WAB node and WAB node 120C may be referred to as the descendant WAB nodes of WAB node 120B.

[0042] UEs 130A and 130B can be connected to WAB nodes 120A and 120C, respectively. WAB nodes 120A and 120C may therefore be referred to as access WAB nodes. UL packets (e.g., data or signaling) from UE 130A or UE 130B can be transmitted to a WAB donor (e.g., WAB donor 110A or 110B) via one or more WAB nodes, and then transmitted by the WAB donor to a mobile gateway device (such as the UPF in the 5GC). DL packets (e.g., data or signaling) can be transmitted from the WAB donor (e.g., WAB donor 110A or 110B) after being received by the gateway device, and then transmitted to UE 130A or 130B through one or more WAB nodes.

[0043] For example, referring to FIG. 1, UE 130A may transmit UL data to WAB donor 110A or 110B or receive DL data therefrom via WAB node 120A. UE 130B may transmit UL data to WAB donor 110A or receive DL data therefrom via WAB node 120C and WAB node 120B.

[0044] In a WAB deployment such as the wireless communication system 100, the radio link between a WAB donor (e.g., WAB donor 110A or 110B in FIG. 1) and a WAB node or between two WAB nodes may be referred to as a backhaul link (BL). The radio link between a WAB donor (e.g., WAB donor 110A or 110B in FIG. 1) and a UE or between a WAB node and a UE may be referred to as an access link (AL). For example, in FIG. 1, radio links 140A to 140D are BLs and radio links 150A and 150B are ALs.

[0045] It should be noted that the WAB network shown in FIG. 1 is for illustrative purposes only. There are various WAB networks that support single-hop, single-connection, multi-hop, multi-connection, or any combination thereof. It should be noted that, although embodiments of the present disclosure may be discussed under a specific network architecture (e.g., WAB architecture) and based on certain specific components (e.g., a WAB donor or a WAB node), embodiments of the present disclosure are also applicable to other similar network architectures and new service scenarios.

[0046] In some embodiments of the present disclosure, a WAB network supports an architecture with a BS onboard of a relay and a PDU session between a WAB node and the CN (e.g., 5GC, or more specifically UPF in 5GC) for wireless backhauling of

the NG interfaces (e.g., N2 (or NG-C) and N3 (or NG-U) interfaces) of the WAB node.

[0047] For example, FIG. 2 illustrates an example block diagram of various connections in WAB network 200 in accordance with some embodiments of the present disclosure. Although FIG. 2 shows a single hop, that is, the WAB node in FIG. 2 directly connects to a donor BS (e.g., a gNB), it should be appreciated by persons skilled in the art that WAB network 200 can support multi-hop. For example, the WAB node may hop through one or more WAB nodes before reaching the donor BS.

[0048] As shown in FIG. 2, a UE connects a BS part of a WAB node via an access link (e.g., a NR access link). The UE establishes a PDU session (i.e., access PDU session shown in FIG. 2) with the CN (e.g., 5GC or next-generation core (NGC)), which connects to a data network (DN) via a UPF (also referred to as UE-UPF, which is not shown in FIG. 2) of the CN. An NG interface is established between the BS part of the WAB node and the CN. A BH PDU session is established between the MT part of the WAB node and the BH UPF (also referred to as MT-UPF). The BH UPF can be used to transfer data of the UE's PDU session and is also a part of the CN. A BH link is established between the MT part of the WAB node and the donor BS. Although FIG. 2 shows that the UE and the MT of the WAB node are connected to different CN entities (e.g., different UPFs and different AMFs), it should be appreciated by persons skilled in the art that WAB network 200 can support the same CN entity (e.g., UPF, AMF or both) for both the UE and the MT of the WAB node.

[0049] Embodiments of the present disclosure provide various protocol stacks to support PDU session backhauling (e.g., at the MT part of the WAB node as shown in FIG. 2).

[0050] FIGs. 3A and 3B illustrate example block diagrams of a UP protocol stack for a WAB network according to some embodiments of the present disclosure. These example protocol stacks can enable communication between a WAB node and the CN via PDU session backhauling. Although in FIGs. 3A and 3B a WAB node is directly connected to a WAB donor, it is contemplated that the WAB node may be connected to a WAB donor via more than one WAB node.

[0051] The connections of various entities in FIGs. 3A and 3B can be referred to in FIG. 2. For example, in FIGs. 3A and 3B, a UE is served by a WAB node which accesses a CN via a WAB donor. The UE establishes a PDU session with and anchored at a UE-UPF. The MT part of the WAB node establishes a PDU session with and anchored at an MT-UPF. Both the UE-UPF and the MT-UPF belong to the CN.

[0052] The protocol stacks shown in FIGs. 3A and 3B are for illustrative purposes only. For example, the sequences of some of the protocol layers in the protocol stacks of FIGs. 3A and 3B may be rearranged for illustrative purposes. For example, the application layers and PDU layers are not shown in FIGs. 3A and 3B. For example, the protocol stack of the UE may include a PDU layer above the access network protocol layers and the UE-UPF may include a corresponding PDU layer. For example, the protocol stack of the UE may include may further include an application layer above the PDU layer.

[0053] Referring to FIG. 3A, the Uu interface between the UE and the WAB node (the BS part of the WAB node) and the Uu interface between the WAB node (the MT part of the WAB node) and the WAB donor can include respective service data adaptation protocol (SDAP) layers, respective packet data convergence protocol (PDCP) layers, respective radio link control (RLC) layers, respective medium access control (MAC) layers, and respective physical (PHY) layers at the UE, the WAB node and the WAB donor.

[0054] The NG-U interface between the WAB donor and the MT-UPF can include respective layers 1 (L1s), respective layers 2 (L2s), respective IP layers, respective UDP layers and respective GTP-U layers at the WAB donor and the MT-UPF. The definitions of the above-mentioned layers can be referred to in 3GPP specifications. For example, L1 may include a PHY layer and L2 may include a data link layer.

[0055] The NG-U interface between the WAB node and the UE-UPF can include respective GTP-U layers and respective UDP and IP (UDP/IP) layers at the WAB node and the UE-UPF. Therefore, an IP packet of UP data will be transmitted via the backhaul link, and the MT-UPF and the UE-UPF can use an IP address to target each other. For example, the UP data for the UE can be encapsulated by the GTP-U

layers at the BS part of the WAB node for UL or the UE-UPF for DL. The GTP-U packets are further encapsulated by the UDP/IP layers at the BS part of the WAB node for UL or the UE-UPF for DL. Then, the IP packets can be transmitted over the PDU session between the MT part of the WAB node and the MT-UPF.

[0056] Referring to FIG. 3B, the Uu interface between the UE and the WAB node (the BS part of the WAB node) and the Uu interface between the WAB node (the MT part of the WAB node) and the WAB donor can include respective SDAP layers, respective PDCP layers, respective RLC layers, respective MAC layers and respective PHY layers at the UE, the WAB node and the WAB donor.

[0057] The NG-U interface between the WAB donor and the MT-UPF can include respective L1s, respective L2s, respective IP layers, respective UDP layers and respective GTP-U layers at the WAB donor and the MT-UPF. The definitions of the above-mentioned layers can be referred to in 3GPP specifications.

[0058] The NG-U interface between the WAB node and the UE-UPF can include respective GTP-U layers at the WAB node and the UE-UPF. However, different from FIG. 3A, the NG-U interface between the WAB node and the UE-UPF does not include UDP/IP layers at the WAB node and the UE-UPF. Therefore, a GTP-U packet of UP data (i.e., without UDP/IP header) will be transmitted via the backhaul link. However, IP layers are added between the MT-UPF and the UE-UPF for routing between each other. For example, the UP data for the UE can be encapsulated by the GTP-U layers at the BS part of the WAB node for UL or the UE-UPF for DL. The GTP-U packets are then transmitted over the PDU session at the MT part of the WAB node or the MT-UPF.

[0059] FIGs. 4A and 4B illustrate example block diagrams of a CP protocol stack for a WAB network according to some embodiments of the present disclosure. These example protocol stacks can enable communication between a WAB node and the CN via PDU session backhauling. Although in FIGs. 4A and 4B a WAB node is directly connected to a WAB donor, it is contemplated that the WAB node may be connected to a WAB donor via more than one WAB node.

[0060] The connections of various entities in FIGs. 4A and 4B can be referred to in

FIG. 2. For example, in FIGs. 4A and 4B, a WAB node accesses a CN via a WAB donor. The MT part of the WAB node establishes a PDU session with and anchored at an MT-UPF. Both the MT-UPF and AMF belong to the CN. The protocol stacks shown in FIGs. 4A and 4B are for illustrative purposes only. For example, the sequences of some of the protocol layers in the protocol stacks of FIGs. 4A and 4B may be rearranged for illustrative purposes.

[0061] Referring to FIG. 4A, the Uu interface between the WAB node (the MT part of the WAB node) and the WAB donor can include respective SDAP layers, respective PDCP layers, respective RLC layers, respective MAC layers and respective PHY layers at the WAB node and the WAB donor.

[0062] The NG-U interface between the WAB donor and the MT-UPF can include respective L1s, respective L2s, respective IP layers, respective UDP layers and respective GTP-U layers at the WAB donor and the MT-UPF. The definitions of the above-mentioned layers can be referred to in 3GPP specifications.

[0063] The N2 (or NG-C) interface between the WAB node and the AMF can include respective NGAP layers and respective STCP and IP (STCP/IP) layers at the WAB node and the AMF. Therefore, an IP packet of CP signaling will be transmitted via the backhaul link, and the MT-UPF and AMF can use the IP address to target each other. The CP signaling may include NGAP signaling, SCTP association related signaling and transport network layer association (TNLA) related signaling.

[0064] For example, the CP signaling (e.g., NGAP signaling) can be encapsulated by the STCP/IP layers at the BS part of the WAB node for UL or the AMF for DL. In some embodiments, the STCP/IP packets (also referred to as IP packets) may further includes SCTP association related signaling or TNLA related signaling. Then, the IP packets can be transmitted over the PDU session between the MT part of the WAB node and the MT-UPF.

[0065] Referring to FIG. 4B, the Uu interface between the WAB node (the MT part of the WAB node) and the WAB donor can include respective SDAP layers, respective PDCP layers, respective RLC layers, respective MAC layers and respective PHY layers at the WAB node and the WAB donor.

[0066] The NG-U interface between the WAB donor and the MT-UPF can include respective L1s, respective L2s, respective IP layers, respective UDP layers and respective GTP-U layers at the WAB donor and the MT-UPF. The definitions of the above-mentioned layers can be referred to in 3GPP specifications.

[0067] The N2 (or NG-C) interface between the WAB node and the AMF can include respective NGAP layers at the WAB node and the AMF. However, different from FIG. 4A, the N2 (or NG-C) interface between the WAB node and the AMF does not include STCP/IP layers at the WAB node and the AMF. Therefore, an NGAP packet (i.e., without SCTP/IP header) will be transmitted via the backhaul link. However, IP layers are added between the MT-UPF and AMF for routing between each other. For example, NGAP signaling can be transmitted over the PDU session between the MT part of the WAB node and the MT-UPF.

[0068] It should be appreciated by persons skilled in the art that although FIG. 3A shows a "UDP/IP" layer in a single layer, the "UDP/IP" layer can be two separate protocol layers. Similarly, "STCP/IP" in FIG. 4B can be two separate protocol layers.

[0069] FIG. 5A illustrates example structures of UL UP traffic at various entities of the WAB network shown in FIG. 3A. FIG. 5B illustrates example structures of UL UP traffic at various entities of the WAB network shown in FIG. 3B. Persons skilled in the art can conceive of structures of DL UP traffic at various entities of the WAB network shown in FIGs. 3A and 3B and can conceive of structures of UL and DL CP traffic at various entities of the WAB network shown in FIGs. 4A and 4B.

[0070] With reference to FIG. 5A and in combination with FIG. 3A, the UE may transmit UP traffic (i.e., "DATA" in FIG. 5A) to the WAB node (e.g., the BS part of the WAB node) over the Uu link therebetween. This UP packet may then be encapsulated by the GTP-U and UDP/IP at the WAB node (e.g., the BS part of the WAB node). This GTP-U can be referred to as an inner GTP-U. Therefore, the UP traffic at the WAB node may include an IP/UDP header and a GTP-U header ("GTP-U 1" in FIG. 5A).

[0071] The encapsulated packet can be transmitted to the WAB donor over the Uu

link between the WAB node and the WAB donor over a PDU session configured for the WAB node (e.g., the MT of the WAB node). This PDU session anchors at the MT-UPF. The WAB donor may further transmit the packet to the MT-UPF via the NG-U interface between the WAB donor and the MT-UPF. For example, the packet can be further encapsulated by GTP-U, UDP and IP at the WAB donor. This GTP-U can be referred to as an outer GTP-U. Therefore, the UP traffic at the WAB donor may include an IP/UDP/GTP-U header ("IP/UDP/GTP-U 2" in FIG. 5A), an IP/UDP header and a GTP-U header ("GTP-U 1" in FIG. 5A).

[0072] In response to receiving the packet at the MT-UPF, the outer GTP-U is deleted. As shown in FIG. 5A, the "IP/UDP/GTP-U 2" block is highlighted in grey at the MT-UPF, which means that the header in the grey block will be deleted. Therefore, the UP traffic at the MT-UPF may include an IP/UDP header and a GTP-U header ("GTP-U 1" in FIG. 5A). The MT-UPF may further transmit the packet to the UE-UPF. The UE-UPF may delete the headers and obtain the data from the UE. As shown in FIG. 5A, the "IP/UDP" and "GTP-U 1" blocks are highlighted in grey at the UE-UPF, which means that the header in the grey blocks will be deleted.

[0073] With reference to FIG. 5B and in combination with FIG. 3B, the UE may transmit UP traffic (i.e., "DATA" in FIG. 5B) to the WAB node (e.g., the BS part of the WAB node) over the Uu link therebetween. This UP packet may then be encapsulated by the GTP-U at the WAB node (e.g., the BS part of the WAB node). This GTP-U can be referred to as an inner GTP-U. Therefore, the UP traffic at the WAB node may include a GTP-U header ("GTP-U 1" in FIG. 5B).

[0074] The encapsulated packet can be transmitted to the WAB donor over the Uu link between the WAB node and the WAB donor over a PDU session configured for the WAB node (e.g., the MT of the WAB node). This PDU session anchors at the MT-UPF. The WAB donor may further transmit the packet to the MT-UPF via the NG-U interface between the WAB donor and the MT-UPF. For example, the packet can be further encapsulated by GTP-U, UDP and IP at the WAB donor. This GTP-U can be referred to as an outer GTP-U. Therefore, the UP traffic at the WAB donor may include an IP/UDP/GTP-U header ("IP/UDP/GTP-U 2" in FIG. 5B) and a GTP-U header ("GTP-U 1" in FIG. 5B).

[0075] In response to receiving the packet at the MT-UPF, the outer GTP-U is deleted. As shown in FIG. 5B, the "IP/UDP/GTP-U 2" block is highlighted in grey at the MT-UPF, which means that the header in the grey block will be deleted. Then, the packet may be encapsulated by the IP layer at the MT-UPF. Therefore, the UP traffic at the MT-UPF may include an IP header and a GTP-U header ("GTP-U 1" in FIG. 5B). The MT-UPF may further transmit the packet to the UE-UPF. The UE-UPF may delete the headers and obtain the data from the UE. As shown in FIG. 5B, the "IP" and "GTP-U 1" blocks are highlighted in grey at the UE-UPF, which means that the header in the grey blocks will be deleted.

[0076] The concepts of the inner GTP-U and outer GTP-U can be similarly applied to DL traffic. That is, the inner GTP-U is used for the NG-U between the BS part of a WAB node and a UE-UPF, and the outer GTP-U is used for the NG-U between a WAB donor and an MT-UPF.

[0077] It should be appreciated by persons skilled in the art that although FIG. 5A shows "IP/UDP" in a single block, the "IP/UDP" block in FIG. 5A can refer to an IP header and a UDP header. This principle applies to both FIGs. 5A and 5B.

[0078] As described above, the UL UP traffic of a UE served by a WAB node is not delivered to the UFP of the UE (UE-UPF) from the RAN directly, but is backhauled to the UPF of the WAB node (e.g., the UPF of the MT part of the WAB node (MT-UPF)), which further transmits the traffic to the UE-UPF. The UL CP traffic may be similarly transmitted. That is, the UL CP traffic is backhauled to the UPF of the WAB node (e.g., the MT-UPF), which further transmits the traffic to the AMF. To support the above features or functionalities, the present disclosure provides solutions for handling UL transmission (e.g., CP and UP traffic) at entities in a WAB network, such as a WAB node and an MT-UPF. For example, mapping rules for UL transmission are provided at a WAB node. For example, methods for transferring the UL traffic are provided at an MT-UPF. More details on the embodiments of the present disclosure will be illustrated in the following text in combination with the appended drawings.

[0079] The following embodiments illustrate the transmission of UL UP traffic at a WAB node.

[0080] Referring to any of FIGs. 2-3B, the UE served by the WAB node may transmit UL UP traffic (denoted as "UL UP traffic #A1"), which may belong to a PDU session of the UE (e.g., a PDU session between the UE and the UE-UPF). The PDU session of the UE is hereinafter denoted as PDU session #A1 for clarity. UL UP traffic #A1 may have a QoS flow ID (denoted as "QFI #A1") and may be mapped to a corresponding DRB (denoted as "DRB #A1") between the UE and the WAB node (e.g., the BS of the WAB node).

[0081] In the context of the present disclosure, one PDU session may include a list of QoS flows, and one or more QoS flows may be mapped onto one DRB. One QoS flow can be mapped onto only one DRB at a time in the UL. The traffic of a PDU session can be mapped to one or more DRBs based on a mapping relation between the QoS flows and the DRBs, and a DRB can be only applied to one PDU session. For example, PDU session #A1 may include a list of QoS flows (e.g., one or more QoS flows), which includes a QoS flow having a QoS flow ID (QFI) of QFI #A1. PDU session #A1 (i.e., QoS flows of PDU session #A1) can be mapped to a set of DRBs (e.g., one or more DRBs) between the UE and the WAB node (e.g., the BS of the WAB node). The QoS flow having QFI #A1 can be mapped to DRB #A1 in the set of DRBs.

[0082] In response to receiving UL UP traffic #A1 from the UE, the WAB node may map the received UL traffic to a PDU session of the WAB node (e.g., the MT part of the WAB node) based on a mapping configuration. The mapping configuration may be configured by a parent node of the WAB node, the WAB donor or the CN (e.g., an AMF). In the case of single hopping, the parent node of the WAB node is the WAB donor.

[0083] The PDU session of the WAB node is hereinafter denoted as PDU session #A2 for clarity. PDU session #A2 may refer to the PDU session between the MT of the WAB node and the MT-UPF and can be used for transporting UL traffic and DL traffic associated with the WAB node. PDU session #A2 may include a list of QoS flows (e.g., one or more QoS flows) and these QoS flows can be mapped to a set of DRBs (e.g., one or more DRBs) between the WAB node (e.g., the MT of the WAB node) and the parent node of the WAB node. The list of QoS flows may include a

QoS flow having a QFI of QFI #A2, which can be mapped to a DRB (denoted as "DRB #A2") of the set of DRBs between the WAB node and the parent node of the WAB node.

[0084] The mapping configuration may indicate the mapping relations of a PDU session, a QoS flow, a DRB or any combination thereof between the adjacent two hops (i.e., a first hop between the UE and the WAB node and a second hop between the WAB node and its parent node). The following are some example mapping relations. The mapping configuration may include one or more of the following examples. Persons skilled in the art can conceive of other mapping configurations based on the above principle, which are also within the scope of the present disclosure.

[0085] Option 1: a mapping between a UE DRB of the first hop (e.g., a DRB between the UE and the WAB node) and a PDU session of the second hop (e.g., a PDU session of the WAB node or the MT of the WAB node). For example, the mapping configuration may indicate a mapping between each DRB ID of the UE and each PDU session ID of the WAB node (or the MT of the WAB node).

[0086] For example, the mapping configuration may indicate a mapping between DRB #A1 (i.e., the DRB between the UE and the WAB node via which UL UP traffic #A1 is received by the WAB node) and PDU session #A2. For example, the mapping configuration may indicate a mapping between an ID of DRB #A1 and an ID of PDU session #A2.

[0087] In option 1, the mapping can be a 1:1 or N:1 mapping. For example, 4 UE DRBs can be mapped to the same PDU session of the second hop. In some embodiments, the QFI of the UL traffic remains consistent between the first and second hops. For example, the QFI (e.g., QFI #A2) indicating UL UP traffic #A1 in the second hop may be the same as the QFI (e.g., QFI #A1) indicating UL UP traffic #A1 in the first hop. In some embodiments, the QFI of the UL traffic in the second hop may be configured by, for example, a parent node of the WAB node, the WAB donor or the CN (e.g., an AMF). Each QFI or each QoS flow in the second hop can be mapped to a corresponding DRB of the second hop (e.g., a DRB between the WAB node and its parent node) based on a configuration (e.g., an RRC configuration) from,

for example, the parent node, the WAB donor or the CN (e.g., an AMF).

[0088] Option 2: a mapping between a UE DRB of first hop (e.g., a DRB between the UE and the WAB node) and a QoS flow of the second hop (e.g., a QoS flow between the WAB node and its parent node). For example, the mapping configuration may indicate a mapping relation between DRB #A1 (e.g., an ID of DRB #A1) and QFI #A2. In some embodiments, the QFI of the UL traffic in the second hop may be configured by, for example, a parent node of the WAB node, the WAB donor or the CN (e.g., an AMF). Each QFI or each QoS flow in the second hop can be mapped to a corresponding DRB of the second hop based on a configuration (e.g., an RRC configuration) from, for example, the parent node, the WAB donor or the CN (e.g., an AMF).

[0089] Option 3: a mapping between a UE DRB of the first hop (e.g., a DRB between the UE and the WAB node) and a DRB of the second hop (e.g., a DRB between the WAB node and its parent node). For example, the mapping configuration may indicate a mapping between each DRB ID of the UE and each DRB ID of the second hop. For example, the mapping configuration may indicate a mapping relation between DRB #A1 and DRB #A2. For example, the mapping configuration may indicate a mapping between an ID of DRB #A1 and an ID of DRB #A2.

[0090] In option 3, the mapping can be a 1:1 or N:1 mapping. For example, 4 UE DRBs can be mapped to 1 DRB of the second hop. In some embodiments, the QFI of the UL traffic remains consistent between the first and second hops. For example, the QFI (e.g., QFI #A2) indicating UL UP traffic #A1 in the second hop may be the same as the QFI (e.g., QFI #A1) indicating UL UP traffic #A1 in the first hop. In some embodiments, the QFI of the UL traffic in the second hop may be configured by, for example, a parent node of the WAB node, the WAB donor or the CN (e.g., an AMF). Each QFI or each QoS flow in the second hop can be mapped to a corresponding DRB of the second hop based on a configuration (e.g., an RRC configuration) from, for example, the parent node, the WAB donor or the CN (e.g., an AMF).

[0091] Option 4: a mapping between a PDU session of the first hop (e.g., a PDU

session of the UE) and a PDU session of the second hop (e.g., a PDU session of the WAB node or the MT of the WAB node). For example, the mapping configuration may indicate a mapping between each PDU session ID of the UE and each PDU session ID of the WAB node (or the MT of the WAB node).

[0092] For example, the mapping configuration may indicate a mapping between PDU session #A1 and PDU session #A2. For example, the mapping configuration may indicate a mapping between an ID of PDU session #A1 and an ID of PDU session #A2.

[0093] In option 4, the mapping can be a 1:1 or N:1 mapping. For example, 4 PDU sessions of the first hop can be mapped to the same PDU session of the second hop. In some embodiments, the QFI of the UL traffic remains consistent between the first and second hops. For example, the QFI (e.g., QFI #A2) indicating UL UP traffic #A1 in the second hop may be the same as the QFI (e.g., QFI #A1) indicating UL UP traffic #A1 in the first hop. In some embodiments, the QFI of the UL traffic in the second hop may be configured by, for example, a parent node of the WAB node, the WAB donor or the CN (e.g., an AMF). Each QFI or each QoS flow in the second hop can be mapped to a corresponding DRB of the second hop (e.g., a DRB between the WAB node and its parent node) based on a configuration (e.g., an RRC configuration) from, for example, the parent node, the WAB donor or the CN (e.g., an AMF).

[0094] Option 5: a mapping between a PDU session of the first hop (e.g., a PDU session of the UE) and a QoS flow of the second hop (e.g., a QoS flow between the WAB node and its parent node). For example, the mapping configuration may indicate a mapping relation between PDU session #A1 (e.g., an ID of PDU session #A1) and QFI #A2. In some embodiments, the QFI of the UL traffic in the second hop may be configured by, for example, a parent node of the WAB node, the WAB donor or the CN (e.g., an AMF). Each QFI or each QoS flow in the second hop can be mapped to a corresponding DRB of the second hop based on a configuration (e.g., an RRC configuration) from, for example, the parent node, the WAB donor or the CN (e.g., an AMF).

[0095] Option 6: a mapping between a PDU session of the first hop (e.g., a PDU

session of the UE) and a DRB of the second hop (e.g., a DRB between the WAB node and its parent node). For example, the mapping configuration may indicate a mapping relation between PDU session #A1 (e.g., an ID of PDU session #A1) and DRB #A2 (e.g., an ID of DRB #A2). In some embodiments, the QFI of the UL traffic remains consistent between the first and second hops. In some embodiments, the QFI of the UL traffic in the second hop may be configured by, for example, a parent node of the WAB node, the WAB donor or the CN (e.g., an AMF). Each QFI or each QoS flow in the second hop can be mapped to a corresponding DRB of the second hop based on a configuration (e.g., an RRC configuration) from, for example, the parent node, the WAB donor or the CN (e.g., an AMF).

[0096] On the other hand, as mentioned before, the WAB node may encapsulate the UL UP packet received from the UE as an NG-U packet between the WAB node and the UE-UPF. The mapping configuration may be based on the information in the header(s) of the encapsulated packet. For example, the mapping configuration may include a mapping between the information in the header(s) of the encapsulated packet and at least one of a PDU session of the WAB node or a DRB between the WAB node and the parent node of the WAB node.

[0097] For example, the packet can be encapsulated by a GTP-U layer to include a GTP-U header and further encapsulated by a UDP/IP layer to include an IP header. An example is shown in FIG. 5A. The GTP-U header may include a TEID and the IP header may include an IP address. The mapping configuration may include a mapping between at least one of the IP address in the IP header or the TEID in the GTP-U header and at least one of a PDU session of the WAB node or a DRB between the WAB node and the parent node of the WAB node. In some embodiments, the IP address may refer to the destination IP address.

[0098] For example, the mapping configuration can indicate a mapping relation between the TEID in the GTP-U header (or the IP address in the IP header) and the ID of a PDU session of the WAB node. For example, the mapping configuration can indicate a mapping between (IP address in the IP header + TEID in the GTP-U header) and the ID of a PDU session of the WAB node. For example, the mapping configuration can indicate a mapping relation between the TEID in the GTP-U header

(or the IP address in the IP header) and the ID of a DRB between the WAB node and the parent node of the WAB node. For example, the mapping configuration can indicate a mapping between (IP address in the IP header + TEID in the GTP-U header) and the ID of a DRB between the WAB node and the parent node of the WAB node.

[0099] For example, the packet can be encapsulated by a GTP-U layer to include a GTP-U header. An example is shown in FIG. 5B. The GTP-U header may include a TEID. The mapping configuration may include a mapping between the TEID in the GTP-U header and at least one of a PDU session of the WAB node or a DRB between the WAB node and the parent node of the WAB node.

[00100] For example, the mapping configuration can indicate a mapping relation between the TEID in the GTP-U header and the ID of a PDU session of the WAB node. For example, the mapping configuration can indicate a mapping relation between the TEID in the GTP-U header and the ID of a DRB between the WAB node and the parent node of the WAB node.

[00101] The QFI(s) of the PDU session of the WAB node may be set in the same manner as described above or in other manners that can be conceived of by persons skilled in the art. For example, in some embodiments, the QFI of the UL traffic remains consistent between the first and second hops. In some embodiments, the QFI of the UL traffic in the second hop may be configured by, for example, a parent node of the WAB node, the WAB donor or the CN (e.g., an AMF).

[00102] The following embodiments illustrate the transmission of UL CP traffic at a WAB node.

[00103] Referring to any of FIGs. 2, 4A and 4B, the WAB node may generate UL CP signaling (denoted as "UL CP signaling #B1") and may map UL CP signaling #B1 to a PDU session of the WAB node (e.g., the MT part of the WAB node). As will be described in the following text, various methods can be employed to implement the mapping. For example, the above mapping may be based on a mapping configuration, which may be configured by a parent node of the WAB node, the WAB donor or the CN (e.g., an AMF). In the case of single hopping, the parent node of the WAB node is the WAB donor.

[00104] The PDU session of the WAB node is hereinafter denoted as PDU session #B1 for clarity. PDU session #B1 may refer to the PDU session between the MT of the WAB node and the MT-UPF and can be used for transporting UL traffic and DL traffic associated with the WAB node. PDU session #B1 may include a list of QoS flows (e.g., one or more QoS flows), each with a respective QFI. PDU session #B1 (i.e., QoS flows of PDU session #B1) can be mapped to a set of DRBs (e.g., one or more DRBs) between the WAB node (e.g., the MT of the WAB node) and the parent node of the WAB node. The relation between the QFIs and the DRBs can be configured by the parent node of the WAB node via RRC signaling or by other methods that are disclosed in the present disclosure or can be conceived of by persons skilled in the art.

[00105] In some embodiments, all UL CP signaling is mapped to a single PDU session of the WAB node. For example, regardless of the types of the UL CP signaling, all UL CP signaling is mapped to one PDU session (e.g., PDU session #B1) of the WAB node. For example, CP signaling such as non UE-associated NGAP signaling, UE-associated NGAP signaling and other non-NG message (e.g., SCTP association related message) are mapped to the same PDU session. The above listed UL CP signaling or message(s) may have the same or different QFIs.

[00106] In some embodiments, the mapping may be based on UL CP signaling types. The UL CP signaling types may include UE-associated NGAP signaling, non-UE-associated NGAP signaling, and other non-NG message. For example, UL CP signaling of a first CP signaling type may be mapped to a PDU session of the WAB node and another UL CP signaling of a second, a different CP signaling type may be mapped to another PDU session of the WAB node. For example, UE-associated NGAP signaling and non-UE-associated NGAP signaling may be mapped to a PDU session of the WAB node and another non-NG message may be mapped to another PDU session of the WAB node.

[00107] On the other hand, as mentioned before, the CP traffic may be encapsulated by the STCP/IP layer at the WAB node (e.g., see FIG. 4A). The mapping configuration may be based on the information in the header(s) of the encapsulated packet or the information for transmitting the encapsulated packet. For example, the

mapping configuration may include a mapping between the information in the header(s) of the encapsulated packet and at least one of a PDU session of the WAB node or a DRB between the WAB node and the parent node of the WAB node. For example, the mapping configuration may include a mapping between an IP port number for transmitting the encapsulated packet and at least one of a PDU session of the WAB node or a DRB between the WAB node and the parent node of the WAB node.

[00108] For example, the packet can be encapsulated by a STCP/IP layer to include an IP header. The IP header may include an IP address, a DSCP or a flow label. The mapping configuration may include a mapping between (a) at least one of the IP address, a DSCP or a flow label in the IP header or the IP port number for transmitting the encapsulated packet and (b) at least one of a PDU session of the WAB node or a DRB between the WAB node and the parent node of the WAB node. In some embodiments, the IP address may refer to the destination IP address.

[00109] The WAB node may transmit all the UL UP or UL CP traffic to the WAB donor via, for example, the DRB(s) over the Uu interface between the WAB node and the WAB donor. Then, the WAB donor may further transmit the received traffic to the MT-UPF over the NG interface between the WAB donor and the MT-UPF, based on, for example, the UL NG-U UP transport network layer (TNL) information configured for the corresponding PDU session for the WAB node (e.g., the MT of the WAB node) which is anchored at the MT-UPF. To a certain extent, an MT part of a WAB node functions like a normal UE of a WAB donor. Examples are shown in FIGs. 3A-4B.

[00110] The following embodiments illustrate how the MT-UPF handles the UL UP and CP traffic.

[00111] For example, the MT-UPF may receive UL traffic associated with the WAB node (e.g., UP traffic from a UE served by the WAB node or CP traffic from the WAB node) via a PDU session of the WAB node (e.g., the MT part of the WAB node). The MT-UPF may transmit the UL traffic to either an AMF entity for the CP traffic or another UPF for the UP traffic. The another UPF is the UE-UPF which establishes a PDU session with the UE served by the WAB node.

[00112] In some embodiments, the MT-UPF may transmit the UL traffic to either the AMF entity or the UE-UPF based on an IP address in an IP header of the UL traffic.

[00113] For example, the UL traffic (e.g., UL UP traffic) may be encapsulated by a GTP-U layer to include a GTP-U header and further encapsulated by a UDP/IP layer to include an IP header. An example is shown in FIGs. 3A and 5A. The MT-UPF may transmit the UL UP traffic to the UE-UPF based on an IP address in the IP header. For example, the MT-UPF may transmit the UL UP traffic to a UE-UPF based on the destination IP address in the IP header.

[00114] For example, the UL traffic (e.g., UL CP traffic) may be encapsulated by a STCP/IP layer to include an IP header. An example is shown in FIG. 4A. The MT-UPF may transmit the UL CP traffic to the AMF entity based on an IP address in the IP header. For example, the MT-UPF may transmit the UL CP traffic to an AMF based on the destination IP address in the IP header.

[00115] In some embodiments, the MT-UPF may transmit the UL traffic to either the AMF entity or the UE-UPF based on a mapping configuration. The mapping configuration may be configured by a CN entity (e.g., an AMF or a session management function (SMF)).

[00116] For example, the UL traffic (e.g., UL UP traffic) may be encapsulated by a GTP-U layer to include a GTP-U header, but not be further encapsulated by a UDP/IP layer. The MT-UPF may encapsulate the received UL traffic with an IP header based on the mapping configuration. An example is shown in FIGs. 3B and 5B. For example, the MT-UPF may transmit the UL UP traffic to the UE-UPF based on the destination IP address in the IP header.

[00117] For example, the UL traffic (e.g., UL CP traffic) may be UL NGAP signaling (not be encapsulated by a STCP/IP layer). The MT-UPF may encapsulate the received UL traffic with an IP header based on the mapping configuration. An example is shown in FIG. 4B. For example, the MT-UPF may transmit the UL CP traffic to the AMF based on the destination IP address in the IP header.

[00118] The mapping configuration may include one or more of the following: a

mapping between the PDU session of the WAB node (e.g., the MT part of the WAB node) and a CN entity (e.g., the destination CN entity such as the AMF or the UE-UPF); and a mapping between a TEID in the GTP-U header and a CN entity (e.g., the destination CN entity such as the UE-UPF). For example, the mapping configuration may include a mapping between a PDU session ID of the WAB node and an identifier of a CN entity. For example, the mapping configuration may include a mapping between a TEID in the GTP-U header in the UL UP traffic and an identifier of a CN entity.

[00119] In some embodiments, the MT-UPF and the UE-UPF are the same UPF and thus the transmission between the MT-UPF and the UE-UPF as described above can be omitted.

[00120] As described above, the DL UP traffic of a UE served by a WAB node is not delivered from the UE-UPF to the RAN directly, but is transferred by the UPF of the WAB node (e.g., the MT-UPF). To support the above feature or functionality, the UE-UPF needs to differentiate the DL UP traffic of a UE served by a WAB node from the DL UP traffic of a UE served by a normal BS (a BS not including an MT part) and then transmits the DL UP traffic of a UE served by a WAB node to the MT-UPF. Moreover, the MT-UPF needs to map the DL UP traffic to a corresponding PDU session. The transmission of DL CP traffic faces the same issues. Embodiments of the present disclosure provide solutions to solve the above issues. For example, the present disclosure provides solutions for handling DL transmission (e.g., CP and UP traffic) at entities in a WAB network, such as a UE-UPF and an MT-UPF. More details on the embodiments of the present disclosure will be illustrated in the following text in combination with the appended drawings.

[00121] Referring to FIG. 2, a PDU session (e.g., PDU session #A2 or PDU session #B1) may be established between the BH UPF (e.g., MT-UPF) and the WAB node (e.g., the MT part of the WAB node) for transporting UL traffic and DL traffic associated with the WAB node. The PDU session is also referred to a PDU session of the WAB node.

[00122] Referring to any of FIGs. 2, 4A and 4B, if the destination node of certain DL CP traffic is a WAB donor, the AMF may transmit the CP traffic to the WAB donor

via an NG-C (N2) interface. The AMF may transmit DL CP traffic associated with a WAB node to the MT-UPF first. The MT-UPF may then transmit the DL traffic received from the AMF to the WAB node over the PDU session of the WAB node via a WAB donor of the WAB node.

[00123] Referring to any of FIGs. 2, 3A and 3B, if the destination node of certain DL UP traffic is a UE served by a WAB donor, the UPF of this UE can transmit the UP traffic to the WAB donor via an NG-U interface. The UE-UPF may transmit DL UP traffic associated with a WAB node (e.g., DL data to a UE served by the WAB node) to the MT-UPF first. The MT-UPF may then transmit the DL traffic received from the UE-UPF to the WAB node over the PDU session of the WAB node via a WAB donor of the WAB node.

[00124] In some embodiments, the AMF may determine the entity to which certain DL CP traffic should be transmitted based on, for example, the destination node or destination IP address of this CP traffic. For example, the AMF may receive UL CP traffic with a source IP address (denoted as "IP addr#1") from an MT-UPF, and then for DL CP traffic with a target IP address the same as IP addr#1, the AMF can determine to transmit this DL CP traffic to the MT-UPF. For example, if the AMF intends to transmit DL CP traffic to a certain WAB node, the AMF can directly transmit this DL CP traffic to the UPF of the MT part of this WAB node. This is because the AMF knows a bundling relationship between the WAB node and its MT-UPF during, for example, the registration of the WAB node.

[00125] In some embodiments, the UE-UPF may determine the entity to which certain DL UP traffic should be transmitted based, for example, on a mapping configuration. The mapping configuration may be configured by a CN entity (e.g., an AMF or an SMF). For example, the mapping configuration may indicate a mapping between a destination IP address or a TEID of the DL UP traffic and an IP address of the MT-UPF.

[00126] For example, referring to FIG. 3A, the UDP/IP layer at the UE-UPF may encapsulate the DL UP traffic to be transmitted with an IP header. The mapping configuration may indicate a mapping between at least one of a destination IP address in the IP header or a TEID in the GTP-U header and an IP address of the MT-UPF.

For example, referring to FIG. 3B, the GTP-U layer at the UE-UPF may encapsulate the DL UP traffic to be transmitted with a GTP-U header. The mapping configuration may indicate a mapping between a TEID in the GTP-U header and an IP address of the MT-UPF.

[00127] In some embodiments, the MT-UPF and the UE-UPF are the same UPF and thus the transmission between the UE-UPF and the MT-UPF as described above can be omitted.

[00128] In response to receiving the DL traffic associated with the WAB node (e.g., DL CP traffic from the AMF or DL UP traffic from the UE-UPF), the MT-UPF may transmit the DL traffic to the WAB donor of the WAB node based on a mapping configuration. The mapping configuration may be configured by a CN entity (e.g., an AMF or an SMF).

[00129] For example, in some embodiments, the DL traffic associated with the WAB node received from the UE-UPF (i.e., DL UP traffic) may be encapsulated with an IP header and the IP header isn't removed by the MT-UPF. An example can be found in FIG. 3A. The mapping configuration may indicate a mapping between (c) at least one of a destination IP address in the IP header or a TEID of the NG-U tunnel between the WAB node and the UE-UPF and (d) at least one of a PDU session of the WAB node (e.g., a PDU session ID) or a TEID of a NG-U tunnel between the WAB donor and the MT-UPF.

[00130] For example, in some embodiments, the DL traffic associated with the WAB node received from the UE-UPF (i.e., DL UP traffic) may be encapsulated with a GTP-U header and an IP header, and the IP header is removed by the MT-UPF. An example can be found in FIG. 3B. The mapping configuration may indicate a mapping between (e) a TEID of the NG-U tunnel between the WAB node and the UE-UPF and (f) at least one of a PDU session of the WAB node (e.g., a PDU session ID) or a TEID of a NG-U tunnel between the WAB donor and the MT-UPF.

[00131] For example, in some embodiments, the DL traffic associated with the WAB node received from the AMF (i.e., DL CP traffic) may be encapsulated with an IP header and the IP header isn't removed by the MT-UPF. An example can be found

in FIG. 4A. The mapping configuration may indicate a mapping between (g) at least one of a destination IP address, a DSCP or a flow label in the IP header or an IP port number for transmitting the DL traffic and (h) at least one of a PDU session of the WAB node (e.g., a PDU session ID) or a TEID of a NG-U tunnel between the WAB donor and the MT-UPF.

[00132] For example, in some embodiments, the DL traffic associated with the WAB node received from the AMF (i.e., DL CP traffic) is encapsulated with an IP header and the IP header is removed by the MT-UPF. For example, the DL traffic is NGAP signaling. An example can be found in FIG. 4B. The mapping configuration may indicate a mapping between (i) at least one of a source or destination IP address for receiving the DL traffic and (j) at least one of a PDU session of the WAB node (e.g., a PDU session ID) or a TEID of a NG-U tunnel between the WAB donor and the MT-UPF.

[00133] The parameter (i) (i.e., the source or destination IP address for receiving the DL traffic) can be understood with reference to FIG. 4B. As shown in FIG. 4B, the AMF may encapsulate the DL traffic (e.g., the NGAP signaling) to be transmitted with an IP header. The IP header is used for transporting the DL traffic between the AMF and the MT-UPF. That is, from the perspective of the MT-UPF, the IP header is used for receiving the DL traffic from the AMF. The MT-UPF may remove the IP header before transmitting the DL traffic to the WAB donor. The IP header may indicate a source IP address (e.g., the IP address of the AMF) and a destination IP address (e.g., the IP address of the MT-UPF). The parameter (i) may refer to the source IP address or the destination IP in this IP header.

[00134] Based on the above mapping configuration, the MT-UPF can map the DL traffic (UP traffic or CP traffic) to the corresponding PDU session of the WAB node or the GTP-U tunnel between the MT-UPF and the WAB donor for transmission to the WAB donor.

[00135] In response to receiving the DL traffic associated with the WAB node from the MT-UPF (e.g., DL UP traffic or DL CP traffic), the WAB donor may transmit the DL traffic to the WAB node. For example, referring to FIGs. 3A and 3B, the WAB donor may transmit the DL UP traffic to the WAB node (e.g., the MT part of the WAB

node) via the Uu interface. The WAB node may transmit the DL UP traffic to the corresponding UE served by the WAB node via the Uu interface between the BS part of the WAB node and the UE. For example, referring to FIGs. 4A and 4B, the WAB donor may transmit the DL CP traffic to the WAB node (e.g., the MT part of the WAB node) via the Uu interface. The MT part of the WAB node may further transmit the DL CP traffic to the BS part of the WAB node via an internal interface.

[00136] FIG. 6 illustrates a flow chart of exemplary method 600 for wireless communications in accordance with some embodiments of the present disclosure. Details described in all of the foregoing embodiments of the present disclosure are applicable for the embodiments shown in FIG. 6. In some examples, method 600 may be performed by a NE such as a network node, a wireless network node or a WAB node. In some embodiments, the NE may execute a set of instructions to control the functional elements of the network node to perform the described functions or operations. For the sake of simplicity, the operations in method 600 are described as follows with respect to a wireless network node.

[00137] At 611, the wireless network node may receive UL UP traffic from a UE served by the wireless network node, or generate first UL CP signaling to a CN. The wireless network node may support a BS part and an MT part. The wireless network node may access the CN via a donor BS.

[00138] At 613, the wireless network node may map the UL UP traffic or the first UL CP signaling to a PDU session of the wireless network node based on a mapping configuration from the donor BS or the CN.

[00139] In some embodiments, the wireless network node may encapsulate the UL UP traffic into a first encapsulated UL UP traffic with a GTP-U header and map the first encapsulated UL UP traffic to the PDU session of the wireless network node. In some embodiments, the wireless network node may encapsulate the UL UP traffic into a second encapsulated UL UP traffic with a GTP-U header, a UDP header and an IP header and map the second encapsulated UL UP traffic to the PDU session of the wireless network node.

[00140] In some embodiments, the first UL CP signaling is UL NGAP signaling.

The wireless network node may map the UL NGAP signaling to the PDU session of the wireless network node. In some embodiments, the first UL CP signaling is UL NGAP signaling. The wireless network node may: encapsulate the UL NGAP signaling into an encapsulated UL NGAP signaling with a SCTP header and an IP header and map the encapsulated UL NGAP signaling to the PDU session of the wireless network node. In some embodiments, the first UL CP signaling is SCTP association related signaling or TNLA related signaling. The wireless network node may map the SCTP association related signaling or the TNLA related signaling to the PDU session of the wireless network node.

[00141] In some embodiments, the mapping configuration comprises one or more of the following: a mapping between a DRB between the UE and the wireless network node via which the UL UP traffic is received by the wireless network node and the PDU session of the wireless network node; a mapping between a DRB between the UE and the wireless network node via which the UL UP traffic is received and a first DRB between the wireless network node and a parent node of the wireless network node, wherein the PDU session of the wireless network node is mapped to a first set of DRBs between the wireless network node and the parent node of the wireless network node and the first set of DRBs comprises the first DRB; and a mapping between a PDU session of the UE and the PDU session of the wireless network node, wherein the PDU session of the UE is mapped to a second set of DRBs between the UE and the wireless network node and the second set of DRBs comprises the DRB via which the UL UP traffic is received by the wireless network node.

[00142] In some embodiments, an ID of a QoS flow used to indicate the UL UP traffic between the wireless network node and the parent node is the same as an ID of a QoS flow used to indicate the UL UP traffic from the UE. In some embodiments, the wireless network node may receive, from the CN, a message for configuring an ID of a QoS flow used to indicate the UL UP traffic between the wireless network node and the parent node.

[00143] In some embodiments, the mapping configuration may include one or more of the following: a mapping between at least one of an IP address in the IP header or a TEID in the GTP-U header and the PDU session of the wireless network node; and a

mapping between at least one of an IP address in the IP header or a TEID in the GTP-U header and a first DRB between the wireless network node and a parent node of the wireless network node. The PDU session of the wireless network node is mapped to a first set of DRBs between the wireless network node and the parent node of the wireless network node, and the first set of DRBs comprises the first DRB. In some embodiments, the IP address may be the destination IP address in the IP header.

[00144] In some embodiments, the wireless network node may map all UL CP signaling to a single PDU session of the wireless network node. In some embodiments, the wireless network node may map a second UL CP signaling to another PDU session of the wireless network node. The first UL CP signaling and the second UL CP signaling are of different UL CP signaling types. Such mapping may be configured by the donor BS or a CN entity (e.g., an AMF).

[00145] In some embodiments, the UL CP signaling types may include: UE-associated NGAP signaling, non-UE-associated NGAP signaling, and other non-NG message.

[00146] In some embodiments, the mapping configuration comprises one or more of the following: a mapping between at least one of an IP address, a DSCP or a flow label in the IP header or an IP port number for transmitting the encapsulated UL NGAP signaling and the PDU session of the wireless network node; and a mapping between at least one of an IP address, a DSCP or a flow label in the IP header or an IP port number for transmitting the encapsulated UL NGAP signaling and a first DRB between the wireless network node and a parent node of the wireless network node. The PDU session of the wireless network node is mapped to a first set of DRBs between the wireless network node and the parent node of the wireless network node and the first set of DRBs comprises the first DRB. In some embodiments, the IP address may be the destination IP address in the IP header.

[00147] It should be appreciated by persons skilled in the art that the sequence of the operations in exemplary method 600 may be changed and that some of the operations in exemplary method 600 may be eliminated or modified, without departing from the spirit and scope of the disclosure.

[00148] FIG. 7 illustrates a flow chart of exemplary method 700 for wireless communications in accordance with some embodiments of the present disclosure. Details described in all of the foregoing embodiments of the present disclosure are applicable for the embodiments shown in FIG. 7. In some examples, method 700 may be performed by a CN entity such as a UPF. In some embodiments, the CN entity may execute a set of instructions to control the functional elements of the CN entity to perform the described functions or operations. For the sake of simplicity, the operations in method 700 are described as follows with respect to a UPF.

[00149] At 711, a first UPF entity may establish a first PDU session for transporting UL traffic and DL traffic associated with a wireless network node. The first PDU session anchors at the first UPF entity. At 713, the first UPF entity may transmit the UL traffic associated with the wireless network node to either an AMF entity or a second UPF entity which establishes a second PDU session with a UE served by the wireless network node. At 715, the first UPF entity may transmit the DL traffic associated with the wireless network node to the wireless network node over the first PDU session via a donor BS of the wireless network node.

[00150] In some embodiments, the first UPF entity may receive the UL traffic associated with the wireless network node from the donor BS, wherein the received UL traffic is encapsulated with an IP header. The first UPF entity may transmit the UL traffic associated with the wireless network node to either the AMF entity or the second UPF entity based on a destination IP address in the IP header.

[00151] In some embodiments, the first UPF entity may receive the UL traffic associated with the wireless network node from the donor BS, wherein the received UL traffic is encapsulated with a GTP-U header or is a UL NGAP signaling. The first UPF entity may transmit the UL traffic associated with the wireless network node to either the AMF entity or the second UPF entity based on a mapping configuration.

[00152] In some embodiments, the first UPF entity may encapsulate the received UL traffic with an IP header based on the mapping configuration.

[00153] In some embodiments, the mapping configuration may include one or more of the following: a mapping between the first PDU session and a destination CN

entity; and a mapping between a TEID in the GTP-U header and a destination CN entity.

[00154] In some embodiments, the first UPF entity may receive the DL traffic associated with the wireless network node from the second UPF entity, wherein the received DL traffic is encapsulated with an IP header. The first UPF entity may transmit the DL traffic associated with the wireless network node based on a mapping between at least one of a destination IP address in the IP header or a TEID of an NG-U tunnel between the wireless network node and the second UPF entity and at least one of the first PDU session or a TEID of a NG-U tunnel between the donor BS of the wireless network node and the first UPF entity.

[00155] In some embodiments, the first UPF entity may receive the DL traffic associated with the wireless network node from the second UPF entity, wherein the received DL traffic is encapsulated with a GTP-U header. The first UPF entity may transmit the DL traffic associated with the wireless network node based on a mapping between a TEID of an NG-U tunnel between the wireless network node and the second UPF entity and at least one of the first PDU session or a TEID of a NG-U tunnel between the donor BS of the wireless network node and the first UPF entity.

[00156] In some embodiments, the first UPF entity may receive the DL traffic associated with the wireless network node from the AMF entity, wherein the received DL traffic is encapsulated with an IP header. The first UPF entity may transmit the DL traffic associated with the wireless network node based on a mapping between at least one of a destination IP address, a DSCP or a flow label in the IP header or an IP port number for transmitting the DL traffic and at least one of the first PDU session or a TEID of an NG-U tunnel between the donor BS of the wireless network node and the first UPF entity.

[00157] In some embodiments, the first UPF entity may receive the DL traffic associated with the wireless network node from the AMF entity, wherein the received DL traffic is NGAP signaling. The first UPF entity may transmit the DL traffic associated with the wireless network node based on a mapping between at least one of a source or destination IP address for receiving the DL traffic and at least one of the first PDU session or a TEID of an NG-U tunnel between the donor BS of the wireless

network node and the first UPF entity.

[00158] It should be appreciated by persons skilled in the art that the sequence of the operations in exemplary method 700 may be changed and that some of the operations in exemplary method 700 may be eliminated or modified, without departing from the spirit and scope of the disclosure.

[00159] FIG. 8 illustrates an example of an NE 800 in accordance with aspects of the present disclosure. NE 800 may be a network node, a wireless network node, a WAB node, a BS, a WAB donor, a CN entity, a UPF or an AMF. The NE 800 may include a processor 802, a memory 804, a controller 806, and a transceiver 808. The processor 802, the memory 804, the controller 806, or the transceiver 808, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[00160] The processor 802, the memory 804, the controller 806, or the transceiver 808, or various combinations or components thereof may be implemented in hardware (e.g., circuitry). The hardware may include a processor, a DSP, an ASIC, or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[00161] The processor 802 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, or any combination thereof). In some implementations, the processor 802 may be configured to operate the memory 804. In some other implementations, the memory 804 may be integrated into the processor 802. The processor 802 may be configured to execute computer-readable instructions stored in the memory 804 to cause the NE 800 to perform various functions of the present disclosure.

[00162] The memory 804 may include volatile or non-volatile memory. The memory 804 may store computer-readable, computer-executable code including instructions when executed by the processor 802 cause the NE 800 to perform various functions described herein. The code may be stored in a non-transitory

computer-readable medium such as the memory 804 or another type of memory. Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer.

[00163] In some implementations, the processor 802 and the memory 804 coupled with the processor 802 may be configured to cause the NE 800 to perform one or more of the functions described herein (e.g., executing, by the processor 802, instructions stored in the memory 804). For example, the processor 802 may support wireless communication at the NE 800 in accordance with examples as disclosed herein.

[00164] For example, the NE 800 may be configured to support means for performing the operations as described with respect to FIG. 6. For example, the NE 800 may support a BS part and an MT part and may be configured to support: a means for receiving UL UP traffic from a UE served by the NE 800, or generating first UL CP signaling to a CN, wherein the NE 800 accesses the CN via a donor BS; and a means for mapping the UL UP traffic or the first UL CP signaling to a PDU session of the NE 800 based on a mapping configuration from the donor BS or the CN.

[00165] For example, the NE 800 may be configured to support means for performing the operations as described with respect to FIG. 7. For example, the NE 800 may be configured to support: a means for establishing a first PDU session for transporting UL traffic and DL traffic associated with a wireless network node, wherein the first PDU session anchors at the NE 800; a means for transmitting the UL traffic associated with the wireless network node to either an AMF entity or a second UPF entity which establishes a second PDU session with a UE served by the wireless network node; and a means for transmitting the DL traffic associated with the wireless network node to the wireless network node over the first PDU session via a donor BS of the wireless network node.

[00166] The controller 806 may manage input and output signals for the NE 800. The controller 806 may also manage peripherals not integrated into the NE 800. In

some implementations, the controller 806 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 806 may be implemented as part of the processor 802.

[00167] In some implementations, the NE 800 may include at least one transceiver 808. In some other implementations, the NE 800 may have more than one transceiver 808. The transceiver 808 may represent a wireless transceiver. The transceiver 808 may include one or more receiver chains 810, one or more transmitter chains 812, or a combination thereof.

[00168] A receiver chain 810 may be configured to receive signals (e.g., control information, data, or packets) over a wireless medium. For example, the receiver chain 810 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 810 may include at least one amplifier (e.g., an LNA) configured to amplify the received signal. The receiver chain 810 may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receiver chain 810 may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[00169] A transmitter chain 812 may be configured to generate and transmit signals (e.g., control information, data, or packets). The transmitter chain 812 may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as AM, FM, or digital modulation schemes like PSK or QAM. The transmitter chain 812 may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 812 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[00170] It should be appreciated by persons skilled in the art that the components in exemplary NE 800 may be changed, for example, some of the components in exemplary NE 800 may be omitted or modified or a new component(s) may be added to exemplary NE 800, without departing from the spirit and scope of the disclosure.

For example, in some embodiments, the NE 800 may not include the controller 806.

[00171] FIG. 9 illustrates an example of a processor 900 in accordance with aspects of the present disclosure. The processor 900 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 900 may include a controller 902 configured to perform various operations in accordance with examples as described herein. The processor 900 may optionally include at least one memory 904, which may be, for example, an L1/L2/L3 cache. Additionally, or alternatively, the processor 900 may optionally include one or more arithmetic-logic units (ALUs) 906. One or more of these components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

[00172] The processor 900 may be a processor chipset and include a protocol stack (e.g., a software stack) executed by the processor chipset to perform various operations (e.g., receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) in accordance with examples as described herein. The processor chipset may include one or more cores, one or more caches (e.g., memory local to or included in the processor chipset (e.g., the processor 900) or other memory (e.g., random access memory (RAM), read-only memory (ROM), dynamic RAM (DRAM), synchronous dynamic RAM (SDRAM), static RAM (SRAM), ferroelectric RAM (FeRAM), magnetic RAM (MRAM), resistive RAM (RRAM), flash memory, phase change memory (PCM), and others).

[00173] The controller 902 may be configured to manage and coordinate various operations (e.g., signaling, receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) of the processor 900 to cause the processor 900 to support various operations in accordance with examples as described herein. For example, the controller 902 may operate as a control unit of the processor 900, generating control signals that manage the operation of various components of the processor 900. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[00174] The controller 902 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 904 and determine a subsequent instruction(s) to be executed to cause the processor 900 to support various operations in accordance with examples as described herein. The controller 902 may be configured to track memory address of instructions associated with the memory 904. The controller 902 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 902 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 900 to cause the processor 900 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 902 may be configured to manage flow of data within the processor 900. The controller 902 may be configured to control transfer of data between registers, ALUs, and other functional units of the processor 900.

[00175] The memory 904 may include one or more caches (e.g., memory local to or included in the processor 900 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementations, the memory 904 may reside within or on a processor chipset (e.g., local to the processor 900). In some other implementations, the memory 904 may reside external to the processor chipset (e.g., remote to the processor 900).

[00176] The memory 904 may store computer-readable, computer-executable code including instructions that, when executed by the processor 900, cause the processor 900 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. The controller 902 and/or the processor 900 may be configured to execute computer-readable instructions stored in the memory 904 to cause the processor 900 to perform various functions. For example, the processor 900 and/or the controller 902 may be coupled with or to the memory 904, the processor 900, the controller 902, and the memory 904 may be configured to perform various functions described herein. In some examples, the processor 900 may include multiple processors and the memory 904 may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions herein.

[00177] The one or more ALUs 906 may be configured to support various operations in accordance with examples as described herein. In some implementations, the one or more ALUs 906 may reside within or on a processor chipset (e.g., the processor 900). In some other implementations, the one or more ALUs 906 may reside external to the processor chipset (e.g., the processor 900). One or more ALUs 906 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 906 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 906 be configured with a variety of logical and arithmetic circuits, including adders, subtractors, shifters, and logic gates, to process and manipulate the data according to the operation. Additionally, or alternatively, the one or more ALUs 906 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 906 to handle conditional operations, comparisons, and bitwise operations.

[00178] The processor 900 may support wireless communication in accordance with examples as disclosed herein.

[00179] For example, the processor 900 may be configured to support means for performing the operations as described with respect to FIG. 6. For example, the processor 900 may be configured to or operable to support a BS part and an MT part of a wireless network node and support: a means for receiving UL UP traffic from a UE served by the wireless network node, or generating first UL CP signaling to a CN, wherein the wireless network node accesses the CN via a donor BS; and a means for mapping the UL UP traffic or the first UL CP signaling to a PDU session of the wireless network node based on a mapping configuration from the donor BS or the CN.

[00180] For example, the processor 900 may be configured to support means for performing the operations as described with respect to FIG. 7. For example, the processor 900 may be configured to support: a means for establishing a first PDU session for transporting UL traffic and DL traffic associated with a wireless network node, wherein the first PDU session anchors at a first UPF entity; a means for transmitting the UL traffic associated with the wireless network node to either an

AMF entity or a second UPF entity which establishes a second PDU session with a UE served by the wireless network node; and a means for transmitting the DL traffic associated with the wireless network node to the wireless network node over the first PDU session via a donor BS of the wireless network node.

[00181] It should be appreciated by persons skilled in the art that the components in exemplary processor 900 may be changed, for example, some of the components in exemplary processor 900 may be omitted or modified or a new component(s) may be added to exemplary processor 900, without departing from the spirit and scope of the disclosure. For example, in some embodiments, the processor 900 may not include the ALUs 906.

[00182] Those having ordinary skill in the art would understand that the operations or steps of the methods described in connection with the aspects disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module may reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, a hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. Additionally, in some aspects, the operations or steps of the methods may reside as one or any combination or set of codes and/or instructions on a non-transitory computer-readable medium, which may be incorporated into a computer program product.

[00183] While this disclosure has been described with specific embodiments thereof, it is evident that many alternatives, modifications, and variations may be apparent to those skilled in the art. The disclosure is not limited to the examples and designs described herein but is to be accorded with the broadest scope consistent with the principles and novel features disclosed herein. For example, various components of the embodiments may be interchanged, added, or substituted in other embodiments. Also, all of the elements of each figure are not necessary for the operation of the disclosed embodiments. For example, one of ordinary skill in the art of the disclosed embodiments would be enabled to make and use the teachings of the disclosure by simply employing the elements of the independent claims. Accordingly, embodiments of the disclosure as set forth herein are intended to be illustrative, not

limiting. Various changes may be made without departing from the spirit and scope of the disclosure.

[00184] In this document, the terms "comprises," "comprising," "includes," "including," or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that includes a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. The term "transport" may mean "receive" or "transmit" depending on the context. An element preceded by "a," "an," or the like does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that includes the element. Also, the term "another" is defined as at least a second or more. The term "having" or the like, as used herein, is defined as "including." Expressions such as "A and/or B" or "at least one of A and B" may include any and all combinations of words enumerated along with the expression. For instance, the expression "A and/or B" or "at least one of A and B" may include A, B, or both A and B. The wording "the first," "the second" or the like is only used to clearly illustrate the embodiments of the present disclosure, but is not used to limit the substance of the present disclosure.

WHAT IS CLAIMED:

1. A wireless network node, comprising:
 - at least one memory; and
 - at least one processor coupled with the at least one memory and configured to cause the wireless network node to:
 - support a base station (BS) part and a mobile terminal (MT) part;
 - receive uplink (UL) user plane (UP) traffic from a user equipment (UE) served by the wireless network node, or generate first UL control plane (CP) signaling to a core network (CN), wherein the wireless network node accesses the CN via a donor BS; and
 - map the UL UP traffic or the first UL CP signaling to a protocol data unit (PDU) session of the wireless network node based on a mapping configuration from the donor BS or the CN.
2. The wireless network node of Claim 1, wherein the at least one processor is further configured to cause the wireless network node to:
 - encapsulate the UL UP traffic into a first encapsulated UL UP traffic with a general packet radio service tunneling protocol user plane (GTP-U) header and map the first encapsulated UL UP traffic to the PDU session of the wireless network node;
 - or
 - encapsulate the UL UP traffic into a second encapsulated UL UP traffic with a GTP-U header, a user datagram protocol (UDP) header and an internet protocol (IP) header and map the second encapsulated UL UP traffic to the PDU session of the wireless network node.
3. The wireless network node of Claim 1, wherein the first UL CP signaling is UL next generation application protocol (NGAP) signaling, and the at least one

processor is further configured to cause the wireless network node to map the UL NGAP signaling to the PDU session of the wireless network node; or

wherein the first UL CP signaling is UL NGAP signaling, and the at least one processor is further configured to cause the wireless network node to: encapsulate the UL NGAP signaling into an encapsulated UL NGAP signaling with a stream control transport protocol (SCTP) header and an internet protocol (IP) header and map the encapsulated UL NGAP signaling to the PDU session of the wireless network node; or

wherein the first UL CP signaling is SCTP association related signaling or transport network layer association (TNLA) related signaling, and the at least one processor is further configured to cause the wireless network node to map the SCTP association related signaling or the TNLA related signaling to the PDU session of the wireless network node.

4. The wireless network node of Claim 1, wherein the mapping configuration comprises one or more of the following:

a mapping between a data radio bearer (DRB) between the UE and the wireless network node via which the UL UP traffic is received by the wireless network node and the PDU session of the wireless network node;

a mapping between a DRB between the UE and the wireless network node via which the UL UP traffic is received and a first DRB between the wireless network node and a parent node of the wireless network node, wherein the PDU session of the wireless network node is mapped to a first set of DRBs between the wireless network node and the parent node of the wireless network node and the first set of DRBs comprises the first DRB; and

a mapping between a PDU session of the UE and the PDU session of the wireless network node, wherein the PDU session of the UE is mapped to a second set of DRBs between the UE and the wireless network node and the second set of DRBs

comprises the DRB via which the UL UP traffic is received by the wireless network node.

5. The wireless network node of Claim 4, wherein an ID of a quality-of-service (QoS) flow used to indicate the UL UP traffic between the wireless network node and the parent node is the same as an ID of a QoS flow used to indicate the UL UP traffic from the UE; or

wherein the at least one processor is further configured to cause the wireless network node to receive, from the CN, a message for configuring an ID of a QoS flow used to indicate the UL UP traffic between the wireless network node and the parent node.

6. The wireless network node of Claim 2, wherein the mapping configuration comprises one or more of the following:

a mapping between at least one of an IP address in the IP header or a tunnel endpoint identifier (TEID) in the GTP-U header and the PDU session of the wireless network node; and

a mapping between at least one of an IP address in the IP header or a TEID in the GTP-U header and a first DRB between the wireless network node and a parent node of the wireless network node, wherein the PDU session of the wireless network node is mapped to a first set of DRBs between the wireless network node and the parent node of the wireless network node and the first set of DRBs comprises the first DRB.

7. The wireless network node of Claim 1, wherein the at least one processor is further configured to cause the wireless network node to:

map all UL CP signaling to a single PDU session of the wireless network node;
or

map a second UL CP signaling to another PDU session of the wireless network node, wherein the first UL CP signaling and the second UL CP signaling are of different UL CP signaling types.

8. The wireless network node of Claim 7, wherein the UL CP signaling types comprise: UE-associated next generation application protocol (NGAP) signaling, non-UE-associated NGAP signaling, and other non-next generation (NG) message.

9. The wireless network node of Claim 3, wherein the mapping configuration comprises one or more of the following:

a mapping between at least one of an IP address, a differentiated services code point (DSCP), or a flow label in the IP header or an IP port number for transmitting the encapsulated UL NGAP signaling and the PDU session of the wireless network node; and

a mapping between at least one of an IP address, a DSCP, or a flow label in the IP header or an IP port number for transmitting the encapsulated UL NGAP signaling and a first DRB between the wireless network node and a parent node of the wireless network node, wherein the PDU session of the wireless network node is mapped to a first set of DRBs between the wireless network node and the parent node of the wireless network node and the first set of DRBs comprises the first DRB.

10. A first user plane function (UPF) entity, comprising:

at least one memory; and

at least one processor coupled with the at least one memory and configured to cause the first UPF entity to:

establish a first protocol data unit (PDU) session for transporting uplink (UL) traffic and downlink (DL) traffic associated with a wireless network node, wherein the first PDU session anchors at the first UPF entity;

transmit the UL traffic associated with the wireless network node to either an access and mobility management function (AMF) entity or a second UPF entity which establishes a second PDU session with a user equipment (UE) served by the wireless network node; and

transmit the DL traffic associated with the wireless network node to the wireless network node over the first PDU session via a donor base station (BS) of the wireless network node.

11. The first UPF entity of Claim 10, wherein the at least one processor is further configured to cause the first UPF entity to:

receive the UL traffic associated with the wireless network node from the donor BS, wherein the received UL traffic is encapsulated with an internet protocol (IP) header; and

transmit the UL traffic associated with the wireless network node to either the AMF entity or the second UPF entity based on a destination IP address in the IP header.

12. The first UPF entity of Claim 10, wherein the at least one processor is further configured to cause the first UPF entity to:

receive the UL traffic associated with the wireless network node from the donor BS, wherein the received UL traffic is encapsulated with a general packet radio service tunneling protocol user plane (GTP-U) header or is a UL next generation application protocol (NGAP) signaling; and

transmit the UL traffic associated with the wireless network node to either the AMF entity or the second UPF entity based on a mapping configuration.

13. The first UPF entity of Claim 12, wherein the at least one processor is further configured to cause the first UPF entity to encapsulate the received UL traffic with an internet protocol (IP) header based on the mapping configuration.

14. The first UPF entity of Claim 12 or 13, wherein the mapping configuration comprises one or more of the following:

a mapping between the first PDU session and a destination core network (CN) entity; and

a mapping between a tunnel endpoint identifier (TEID) in the GTP-U header and a destination CN entity.

15. The first UPF entity of Claim 10, wherein the at least one processor is further configured to cause the first UPF entity to:

receive the DL traffic associated with the wireless network node from the second UPF entity, wherein the received DL traffic is encapsulated with an internet protocol (IP) header; and

transmit the DL traffic associated with the wireless network node based on a mapping between at least one of a destination IP address in the IP header or a tunnel endpoint identifier (TEID) of a next generation user plane (NG-U) tunnel between the wireless network node and the second UPF entity and at least one of the first PDU session or a TEID of a NG-U tunnel between the donor BS of the wireless network node and the first UPF entity.

16. The first UPF entity of Claim 10, wherein the at least one processor is further configured to cause the first UPF entity to:

receive the DL traffic associated with the wireless network node from the second UPF entity, wherein the received DL traffic is encapsulated with a general packet radio service tunneling protocol user plane (GTP-U) header; and

transmit the DL traffic associated with the wireless network node based on a mapping between a tunnel endpoint identifier (TEID) of a next generation user plane (NG-U) tunnel between the wireless network node and the second UPF entity and at least one of the first PDU session or a TEID of a NG-U tunnel between the donor BS of the wireless network node and the first UPF entity.

17. The first UPF entity of Claim 10, wherein the at least one processor is further configured to cause the first UPF entity to:

receive the DL traffic associated with the wireless network node from the AMF entity, wherein the received DL traffic is encapsulated with an internet protocol (IP) header; and

transmit the DL traffic associated with the wireless network node based on a mapping between at least one of a destination IP address, a differentiated services code point (DSCP), or a flow label in the IP header or an IP port number for transmitting the DL traffic and at least one of the first PDU session or a tunnel endpoint identifier (TEID) of a next generation user plane (NG-U) tunnel between the donor BS of the wireless network node and the first UPF entity.

18. The first UPF entity of Claim 10, wherein the at least one processor is further configured to cause the first UPF entity to:

receive the DL traffic associated with the wireless network node from the AMF entity, wherein the received DL traffic is next generation application protocol (NGAP) signaling; and

transmit the DL traffic associated with the wireless network node based on a mapping between at least one of a source or destination IP address for receiving the DL traffic and at least one of the first PDU session or a tunnel endpoint identifier (TEID) of a next generation user plane (NG-U) tunnel between the donor BS of the wireless network node and the first UPF entity.

19. A method for wireless communication, comprising:

receiving uplink (UL) user plane (UP) traffic from a user equipment (UE) served by a wireless network node, or generating first UL control plane (CP) signaling to a core network (CN), wherein the wireless network node supports a base station (BS) part and a mobile terminal (MT) part and accesses the CN via a donor BS; and

mapping the UL UP traffic or the first UL CP signaling to a protocol data unit (PDU) session of the wireless network node based on a mapping configuration from the donor BS or the CN.

20. A method for wireless communication

establishing a first protocol data unit (PDU) session for transporting uplink (UL) traffic and downlink (DL) traffic associated with a wireless network node, wherein the first PDU session anchors at a first user plane function (UPF) entity;

transmitting the UL traffic associated with the wireless network node to either an access and mobility management function (AMF) entity or a second UPF entity which establishes a second PDU session with a user equipment (UE) served by the wireless network node; and

transmitting the DL traffic associated with the wireless network node to the wireless network node over the first PDU session via a donor base station (BS) of the wireless network node.