

DEVICES AND METHODS FOR STORE AND FORWARD OPERATIONS

[0001] The present disclosure relates to wireless communications, and more specifically to store and forward operations.

BACKGROUND

[0002] A wireless communications system may include one or multiple network communication devices, such as base stations, which may be otherwise known as an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. Each network communication devices, such as a base station may support wireless communications for one or multiple user communication devices, which may be otherwise known as user equipment (UE), or other suitable terminology. The wireless communications system may support wireless communications 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). Additionally, the wireless communications system may support wireless communications across various radio access technologies including third generation (3G) radio access technology, fourth generation (4G) radio access technology, fifth generation (5G) radio access technology, among other suitable radio access technologies beyond 5G (e.g., sixth generation (6G)).

[0003] Non-terrestrial network (NTN) refers to a network, or segment of networks using radio frequency (RF) resources on board a satellite. The satellite in NTN can be a geostationary earth orbiting (GEO) satellite with fixed location to the earth, or a low earth orbiting (LEO) satellite orbiting around the earth. 3GPP Rel-17 specifications have provided basic support of NTN features and in Rel-18 further enhancements are being studied. For Rel-19 NTN enhancements, It has been proposed to support store and forward (S&F) operations in NTN for delay-tolerant, non-real-time services to be offered in areas visited by the satellites but with no need to have NTN gateway infrastructure. However, there are some issues for store and forward operations to be addressed.

SUMMARY

[0004] The present disclosure relates to methods, apparatuses, and systems that support store and forward operations.

[0005] Some implementations of the method and devices described herein include, receiving, via the transceiver and from a network device, a configuration for a store and forward operation; and determining to initiate the store and forward operation based on the configuration. In this way, the store and forward operation may be initiated at appropriate occasions.

[0006] Some implementations of the method and devices described herein may further include transmitting, to the network device, a request for the store and forward operation.

[0007] Some implementations of the method and devices described herein may further include receiving, via the transceiver and from the network device, the delivery status to indicate whether the service data transmitted based on the store and forward operation is successfully delivered in the case that the delivery status provisioning supported by the network device or the delivery status provisioning requested by the user equipment.

[0008] Some implementations of the method and devices described herein may further include indicating, from the AS functional entity to the NAS functional entity via an AS-NAS interaction, starting, stopping, or suspending data delivery in the NAS functional entity for the store and forward operation.

[0009] Some implementations of the method and devices described herein may further include transmitting, to the network device, the service data based on the store and forward operation.

[0010] Some implementations of the method and devices described herein may further include identifying the service data associated with the store and forward operation by one of the following: mapping an internet protocol (IP) flow of the service data associated with the store and forward operation to a QoS flow with the at least one QFI configured in the configuration; mapping an QoS flow of the service data associated with the store and forward operation to a DRB with the at least one DRB ID configured in the configuration; mapping an IP flow of the service data associated with the store and forward operation to a QoS flow dedicated for the store and forward operation; or

mapping a QoS flow of the service data associated with the store and forward to a DRB dedicated for the store and forward operation.

[0011] Some implementations of the method and devices described herein may further include transmitting, to the network device, assistance information comprising one of the following: at least one QFI for identifying the service data; at least one DRB ID for identifying the service data; or at least one ID of at least one target device for the store and forward operation.

[0012] In some implementations of the method and devices described herein, the configuration may comprise one of the following: a first explicit indication of supporting the store and forward operation; a first implicit indication of supporting the store and forward operation; delivery status for pervious service data transmitted based on the store and forward operation, wherein the delivery status indicates whether the pervious service data is successfully delivered; a quality of service (QoS) flow identifier (ID) or a data radio bearer (DRB) ID to identify service data associated with the store and forward operation; or at least one ID of at least one user equipment for the store and forward operation.

[0013] In some implementations of the method and devices described herein, the first explicit indication may be associated with one of the following: at least one ID of at least one cell; at least one satellite ephemeris; at least one tracking area (TA); at least one radio access network (RAN) notification area (RNA); at least one 5G QoS indicator (5QI); at least one QoS flow ID (QFI); at least one DRB ID; or at least one single network slice selection assistance information (S-NSSAI).

[0014] In some implementations of the method and devices described herein, the first implicit indication may comprise one of the following: delivery time for the store and forward operation provided by the network device; duration for the store and forward operation provided by the network device; a delivery area for the store and forward operation provided by the network device; a response to the request; delivery status provisioning supported by the network device; a data size for the store and forward operation supported by the network device; a cast type for the store and forward operation supported by the network device; a mode for the store and forward operation supported by the network device, wherein the mode is defined for an access network device; a target device type for the store and forward operation supported by the network device, wherein

the target device type comprises one of a network device or a user equipment; or a QoS configuration for the store and forward operation provided by the network device.

[0015] In some implementations of the method and devices described herein, the request may comprise one of the following: a second explicit indication of requesting support of the store and forward operation; or a second implicit indication of requesting support of the store and forward operation.

[0016] In some implementations of the method and devices described herein, the second explicit indication may be associated with one of the following: the user equipment; at least one 5G QoS indicator (5QI); at least one QoS flow ID (QFI); at least one DRB; or at least one single network slice selection assistance information (S-NSSAI).

[0017] In some implementations of the method and devices described herein, the second implicit indication may comprise one of the following: expected delivery time for the store and forward operation requested by the user equipment; expected duration for the store and forward operation requested by the user equipment; an expected delivery area for the store and forward operation requested by the user equipment; an expected target device type for the store and forward operation requested by the user equipment, wherein the expected target device type comprises one of a network device or a user equipment; an ID of an expected target device for the store and forward operation requested by the user equipment; an indication of delivery status provisioning requested by the user equipment; a data size for the store and forward operation requested by the user equipment; a cast type for the store and forward operation requested by the user equipment; user equipment mode for the store and forward operation requested by the user equipment, wherein the mode is defined for an access network device; or a QoS configuration for the store and forward operation requested by the user equipment.

[0018] In some implementations of the method and devices described herein, receiving the configuration may comprise: receiving, at a non-access-stratum (NAS) functional entity of the user equipment from the network device, the configuration via a NAS signalling; receiving, at the NAS functional entity of the user equipment from an access-stratum (AS) functional entity of the user equipment, the configuration via an AS-NAS interaction; or receiving, at the AS functional entity from the network device, the configuration via a AS signalling.

[0019] In some implementations of the method and devices described herein, the determination to initiate the store and forward operation may be based on at least one of the following conditions: the store and forward operation is supported by the network device; the delivery time provided by the network device fulfils at least one QoS requirement of a corresponding store and forward service; the duration provided by the network device fulfils at least one QoS requirement of a corresponding store and forward service; at least one target user equipment of a corresponding store and forward service is located in the delivery area provided by the network device; a data size of the corresponding store and forward service is smaller than the data size supported by the network device; the delivery status provisioning is supported by the network device; the cast type for the store and forward operation is supported by the network device; a mode for the store and forward operation is supported by the network device, wherein the mode is defined for an access network device; or receiving a delivery status indicating that service data transmitted based on the store and forward operation is not successfully delivered.

[0020] In some implementations of the method and devices described herein, the network device may comprise one of the following: an eNodeB, a gNodeB, an access and mobility management function (AMF) entity, or a session management function (SMF) entity.

[0021] Some implementations of the method and devices described herein include transmitting, via the transceiver and to a user equipment, a configuration for a store and forward operation; and receiving, from the user equipment, service data based on the store and forward operation. In this way, the store and forward operation may be initiated at appropriate occasions.

[0022] Some implementations of the method and devices described herein may further include receiving, from the user equipment, a request for the store and forward operation.

[0023] Some implementations of the method and devices described herein may further include transmitting, to the user equipment, the delivery status to indicate whether the service data transmitted based on the store and forward operation is successfully delivered in the case that the delivery status provisioning supported by the network device or the delivery status provisioning requested by the user equipment.

[0024] Some implementations of the method and devices described herein may further include receiving, from the user equipment, assistance information comprising one of the following: at least one QFI for identifying the service data; at least one DRB ID for identifying the service data; or at least one ID of at least one target device for the store and forward operation.

[0025] Some implementations of the method and devices described herein may further comprise at least one of the following: a eNodeB, a gNodeB, an access and mobility management function (AMF) entity, or a session management function (SMF) entity.

[0026] In some implementations of the method and devices described herein, the configuration may comprise one of the following: a first explicit indication of supporting the store and forward operation; a first implicit indication of supporting the store and forward operation; delivery status for pervious service data transmitted based on the store and forward operation, wherein the delivery status indicates whether the pervious service data is successfully delivered; a quality of service (QoS) flow identifier (ID) or a data radio bearer (DRB) ID to identify service data associated with the store and forward operation; or at least one ID of at least one user equipment for the store and forward operation.

[0027] In some implementations of the method and devices described herein, the first explicit indication may be associated with one of the following: at least one ID of at least one cell; at least one satellite ephemeris; at least one tracking area (TA); at least one radio access network (RAN) notification area (RNA); at least one 5G QoS indicator (5QI); at least one QoS flow ID (QFI); at least one DRB ID; or at least one single network slice selection assistance information (S-NSSAI).

[0028] In some implementations of the method and devices described herein, the first implicit indication may comprise at least one of the following: delivery time for the store and forward operation provided by the network device; duration for the store and forward operation provided by the network device; a delivery area for the store and forward operation provided by the network device; a response to the request; delivery status provisioning supported by the network device; a data size for the store and forward operation supported by the network device; a cast type for the store and forward operation supported by the network device; a mode for the store and forward operation supported

by the network device, wherein the mode is defined for an access network device; a target device type for the store and forward operation supported by the network device, wherein the target device type comprises one of a network device or a user equipment; or a QoS configuration for the store and forward operation provided by the network device.

[0029] In some implementations of the method and devices described herein, the request may comprise one of the following: a second explicit indication of requesting support of the store and forward operation; or a second implicit indication of requesting support of the store and forward operation.

[0030] In some implementations of the method and devices described herein, the second explicit indication may be associated with one of the following: the user equipment; at least one 5G QoS indicator (5QI); at least one QoS flow ID (QFI); at least one DRB; or at least one single network slice selection assistance information (S-NSSAI).

[0031] In some implementations of the method and devices described herein, the second implicit indication may comprise at least the following: expected delivery time for the store and forward operation requested by the user equipment; expected duration for the store and forward operation requested by the user equipment; an expected delivery area for the store and forward operation requested by the user equipment; an expected target device type for the store and forward operation requested by the user equipment, wherein the expected target device type comprises one of a network device or a user equipment; an ID of an expected target device for the store and forward operation requested by the user equipment; an indication of delivery status provisioning requested by the user equipment; a data size for the store and forward operation requested by the user equipment; a cast type for the store and forward operation requested by the user equipment; a mode for the store and forward operation requested by the user equipment, wherein the mode is defined for an access network device; or a QoS configuration for the store and forward operation requested by the user equipment.

[0032] In some implementations of the method and devices described herein, an internet protocol (IP) flow of the service data associated with the store and forward operation may be mapped to a QoS flow with the at least one QFI configured in the configuration; an QoS flow of the service data associated with the store and forward operation may be mapped to a DRB with the at least one DRB ID configured in the configuration; an IP flow of the service data associated with the store and forward

operation may be mapped to a QoS flow dedicated for the store and forward operation; or a QoS flow of the service data associated with the store and forward may be mapped to a DRB dedicated for the store and forward operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] FIG. 1A illustrates an example of a wireless communications system that supports store and forward operations in accordance with aspects of the present disclosure.

[0034] FIG. 1B illustrates an example of store and forward operations in NTN associated with aspects of the present disclosure.

[0035] FIG. 1C illustrates another example of store and forward operations in NTN associated with aspects of the present disclosure.

[0036] FIG. 2 illustrates an example signaling chart illustrating an example process in accordance with aspects of the present disclosure.

[0037] FIG. 3 illustrates an example of store and forward operations procedure in accordance with aspects of the present disclosure.

[0038] FIGS. 4 through 5 illustrate examples of devices that support sensing data exchange in accordance with aspects of the present disclosure.

[0039] FIGS. 6 through 7 illustrate examples of processors that support storing and forwarding operations in accordance with aspects of the present disclosure.

[0040] FIG. 8 illustrates a flowchart of a method that supports store and forward operations in accordance with aspects of the present disclosure.

[0041] FIG. 9 illustrates a flowchart of a method that supports store and forward operations in accordance with aspects of the present disclosure.

[0042] Throughout the drawings, the same or similar reference numerals represent the same or similar elements.

DETAILED DESCRIPTION

[0043] Principles of the present disclosure will now be described with reference to some embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement

the present disclosure, without suggesting any limitation as to the scope of the disclosure. The disclosure described herein may be implemented in various manners other than the ones described below.

[0044] In the following description and claims, unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

[0045] References in the present disclosure to “one embodiment,” “an example embodiment,” “an embodiment,” “some embodiments,” and the like indicate that the embodiment(s) described may include a particular feature, structure, or characteristic, but it is not necessary that every embodiment includes the particular feature, structure, or characteristic. Moreover, such phrases do not necessarily refer to the same embodiment(s). Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

[0046] It shall be understood that although the terms “first” and “second” or the like may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another element. For example, a first element could also be termed as a second element, and similarly, a second element could also be termed as a first element, without departing from the scope of embodiments. As used herein, the term “and/or” includes any and all combinations of one or more of the listed terms.

[0047] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of example embodiments. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises”, “comprising”, “has”, “having”, “includes” and/or “including”, when used herein, specify the presence of stated features, elements, and/or components etc., but do not preclude the presence or addition of one or more other features, elements, components and/ or combinations thereof.

[0048] As used herein, the term “communication network” refers to a network following any suitable communication standards, such as, 5G new radio (NR), Long Term

Evolution (LTE), LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), High-Speed Packet Access (HSPA), Narrow Band Internet of Things (NB-IoT), and so on. Further, the communications between a user equipment and a network device in the communication network may be performed according to any suitable generation communication protocols, including but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G) communication protocols, and/or any other protocols either currently known or to be developed in the future. Embodiments of the present disclosure may be applied in various communication systems. Given the rapid development in communications, there will also be future type communication technologies and systems in which the present disclosure may be embodied. It should not be seen as limiting the scope of the present disclosure to only the aforementioned systems.

[0049] As used herein, the term “network device” generally refers to a node in a communication network via which a user equipment can access the communication network and receive services therefrom. The network device may refer to a base station (BS) or an access point (AP), for example, a node B (NodeB or NB), a radio access network (RAN) node, an evolved NodeB (eNodeB or eNB), a NR NB (also referred to as a gNB), a Remote Radio Unit (RRU), a radio header (RH), an infrastructure device for a V2X (vehicle-to-everything) communication, a transmission and reception point (TRP), a reception point (RP), a remote radio head (RRH), a relay, an integrated access and backhaul (IAB) node, a low power node such as a femto BS, a pico BS, and so forth, depending on the applied terminology and technology. The network device may further refer to a network function (NF) in the core network, for example, a SMF, an AMF, a PCF, a UPF or devices with same function in future network architectures, and so forth.

[0050] As used herein, the term “user equipment (UE)” generally refers to any end device that may be capable of wireless communications. By way of example rather than a limitation, a user equipment may also be referred to as a communication device, a terminal device, an end user device, a subscriber station (SS), an unmanned aerial vehicle (UAV), a portable subscriber station, a mobile station (MS), or an access terminal (AT). The user equipment may include, but is not limited to, a mobile phone, a cellular phone, a smart phone, a voice over IP (VoIP) phone, a wireless local loop phone, a tablet, a wearable user equipment, a personal digital assistant (PDA), a portable computer, a desktop computer, an image capture user equipment such as a digital camera, a gaming

user equipment, a music storage and playback appliance, a vehicle-mounted wireless user equipment, a wireless endpoint, a mobile station, laptop-embedded equipment (LEE), laptop-mounted equipment (LME), a USB dongle, a smart device, wireless customer-premises equipment (CPE), an Internet of Things (IoT) device, a watch or other wearable, a head-mounted display (HMD), a vehicle, a drone, a medical device (for example, a remote surgery device), an industrial device (for example, a robot and/or other wireless devices operating in an industrial and/or an automated processing chain contexts), a consumer electronics device, a device operating on commercial and/or industrial wireless networks, and the like. In the following description, the terms: “user equipment,” “communication device,” “terminal,” “user equipment” and “UE,” may be used interchangeably.

[0051] As used herein, the term “NTN” refers to network, or segment of networks using radio frequency (RF) resources on board a satellite. The satellite in NTN can be a geostationary earth orbiting (GEO) satellite with fixed location to the earth, or a low earth orbiting (LEO) satellite orbiting around the earth.

[0052] FIG. 1A illustrates an example of a wireless communications system 100A that supports store and forward operations in accordance with aspects of the present disclosure. The wireless communications system 100A may include one or more network entities 102 (also referred to as network equipment (NE)), one or more UEs 104, a core network 106, and a packet data network 108. The wireless communications system 100A may support various radio access technologies. In some implementations, the wireless communications system 100A may be a 4G network, such as an LTE network or an LTE-Advanced (LTE-A) network. In some other implementations, the wireless communications system 100A may be a 5G network, such as an NR network. In other implementations, the wireless communications system 100A 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), IEEE 802.20. The wireless communications system 100A may support radio access technologies beyond 5G. Additionally, the wireless communications system 100A may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

[0053] The one or more network entities 102 may be dispersed throughout a geographic region to form the wireless communications system 100A. One or more of the network entities 102 described herein may be or include or may be referred to as a network node, a base station, a network element, a radio access network (RAN), a base transceiver station, an access point, a NodeB, an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. A network entity 102 and a UE 104 may communicate via a communication link 110, which may be a wireless or wired connection. For example, a network entity 102 and a UE 104 may perform wireless communication (e.g., receive signaling, transmit signaling) over a Uu interface.

[0054] A network entity 102 may provide a geographic coverage area 112 for which the network entity 102 may support services (e.g., voice, video, packet data, messaging, broadcast, etc.) for one or more UEs 104 within the geographic coverage area 112. For example, a network entity 102 and a UE 104 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, a network entity 102 may be moveable, for example, a satellite associated with a non-terrestrial network. In some implementations, different geographic coverage areas 112 associated with the same or different radio access technologies may overlap, but the different geographic coverage areas 112 may be associated with different network entities 102. Information and signals described herein may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[0055] The one or more UEs 104 may be dispersed throughout a geographic region of the wireless communications system 100A. A UE 104 may include or may be referred to as a mobile device, a wireless device, a remote device, a remote unit, a handheld device, or a subscriber device, or some other suitable terminology. In some implementations, the UE 104 may be referred to as a unit, a station, a terminal, or a client, among other examples. Additionally, or alternatively, the UE 104 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. In some implementations, a UE

104 may be stationary in the wireless communications system 100A. In some other implementations, a UE 104 may be mobile in the wireless communications system 100A.

[0056] The one or more UEs 104 may be devices in different forms or having different capabilities. Some examples of UEs 104 are illustrated in FIG. 1A. A UE 104 may be capable of communicating with various types of devices, such as the network entities 102, other UEs 104, or network equipment (e.g., the core network 106, the packet data network 108, a relay device, an integrated access and backhaul (IAB) node, or another network equipment), as shown in FIG. 1A. Additionally, or alternatively, a UE 104 may support communication with other network entities 102 or UEs 104, which may act as relays in the wireless communications system 100A.

[0057] A UE 104 may also be able to support wireless communication directly with other UEs 104 over a communication link 114. For example, a UE 104 may support wireless communication directly with another UE 104 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 114 may be referred to as a sidelink. For example, a UE 104 may support wireless communication directly with another UE 104 over a PC5 interface.

[0058] A network entity 102 may support communications with the core network 106, or with another network entity 102, or both. For example, a network entity 102 may interface with the core network 106 through one or more backhaul links 116 (e.g., via an S1, N2, N2, or another network interface). The network entities 102 may communicate with each other over the backhaul links 116 (e.g., via an X2, Xn, or another network interface). In some implementations, the network entities 102 may communicate with each other directly (e.g., between the network entities 102). In some other implementations, the network entities 102 may communicate with each other or indirectly (e.g., via the core network 106). In some implementations, one or more network entities 102 may include subcomponents, such as an access network entity, which may be an example of an access node controller (ANC). An ANC may communicate with the one or more UEs 104 through one or more other access network transmission entities, which may be referred to as a radio heads, smart radio heads, or transmission-reception points (TRPs). In an example, the network entity 102 may be the satellite, there may be full or part of a eNB/gNB on board. A communication link 110 between the satellite 102 and the

UE 104, a communication link 110 between the satellite 102 and a BS 102, and a communication link 116 between the BS 102 and core network 106 may be used for the NTN transparent mode. A communication link 110 between the satellite 102 and the UE 104, and a communication link 116 between the satellite 102 (with BS on board) and core network 106 may be used for the NTN regenerative mode.

[0059] In some implementations, a network entity 102 may be configured in a disaggregated architecture, which may be configured to utilize a protocol stack physically or logically distributed among two or more network entities 102, such as an integrated access backhaul (IAB) network, an open RAN (O-RAN) (e.g., a network configuration sponsored by the O-RAN Alliance), or a virtualized RAN (vRAN) (e.g., a cloud RAN (C-RAN)). For example, a network entity 102 may include one or more of a central unit (CU), a distributed unit (DU), a radio unit (RU), a RAN Intelligent Controller (RIC) (e.g., a Near-Real Time RIC (Near-RT RIC), a Non-Real Time RIC (Non-RT RIC)), a Service Management and Orchestration (SMO) system, or any combination thereof.

[0060] An RU may also be referred to as a radio head, a smart radio head, a remote radio head (RRH), a remote radio unit (RRU), or a transmission reception point (TRP). One or more components of the network entities 102 in a disaggregated RAN architecture may be co-located, or one or more components of the network entities 102 may be located in distributed locations (e.g., separate physical locations). In some implementations, one or more network entities 102 of a disaggregated RAN architecture may be implemented as virtual units (e.g., a virtual CU (VCU), a virtual DU (VDU), a virtual RU (VRU)).

[0061] Split of functionality between a CU, a DU, and an RU may be flexible and may support different functionalities depending upon which functions (e.g., network layer functions, protocol layer functions, baseband functions, radio frequency functions, and any combinations thereof) are performed at a CU, a DU, or an RU. For example, a functional split of a protocol stack may be employed between a CU and a DU such that the CU may support one or more layers of the protocol stack and the DU may support one or more different layers of the protocol stack. In some implementations, the CU may host upper protocol layer (e.g., a layer 3 (L3), a layer 2 (L2)) functionality and signaling (e.g., Radio Resource Control (RRC), service data adaptation protocol (SDAP), Packet Data Convergence Protocol (PDCP)). The CU may be connected to one or more DUs or RUs, and the one or more DUs or RUs may host lower protocol layers, such as a layer 1 (L1)

(e.g., physical (PHY) layer) or an L2 (e.g., radio link control (RLC) layer, medium access control (MAC) layer) functionality and signaling, and may each be at least partially controlled by the CU 160.

[0062] Additionally, or alternatively, a functional split of the protocol stack may be employed between a DU and an RU such that the DU may support one or more layers of the protocol stack and the RU may support one or more different layers of the protocol stack. The DU may support one or multiple different cells (e.g., via one or more RUs). In some implementations, a functional split between a CU and a DU, or between a DU and an RU may be within a protocol layer (e.g., some functions for a protocol layer may be performed by one of a CU, a DU, or an RU, while other functions of the protocol layer are performed by a different one of the CU, the DU, or the RU).

[0063] A CU may be functionally split further into CU control plane (CU-CP) and CU user plane (CU-UP) functions. A CU may be connected to one or more DUs via a midhaul communication link (e.g., F1, F1-c, F1-u), and a DU may be connected to one or more RUs via a fronthaul communication link (e.g., open fronthaul (FH) interface). In some implementations, a midhaul communication link or a fronthaul communication link may be implemented in accordance with an interface (e.g., a channel) between layers of a protocol stack supported by respective network entities 102 that are in communication via such communication links.

[0064] The core network 106 may support user authentication, access authorization, tracking, connectivity, and other access, routing, or mobility functions. The core network 106 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 the one or more UEs 104 served by the one or more network entities 102 associated with the core network 106.

[0065] The core network 106 may communicate with the packet data network 108 over one or more backhaul links 116 (e.g., via an S1, N2, N2, or another network

interface). The packet data network 108 may include an application server 118. In some implementations, one or more UEs 104 may communicate with the application server 118. A UE 104 may establish a session (e.g., a protocol data unit (PDU) session, or the like) with the core network 106 via a network entity 102. The core network 106 may route traffic (e.g., control information, data, and the like) between the UE 104 and the application server 118 using the established session (e.g., the established PDU session). The PDU session may be an example of a logical connection between the UE 104 and the core network 106 (e.g., one or more network functions of the core network 106).

[0066] In the wireless communications system 100A, the network entities 102 and the UEs 104 may use resources of the wireless communications system 100A (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 communications). In some implementations, the network entities 102 and the UEs 104 may support different resource structures. For example, the network entities 102 and the UEs 104 may support different frame structures. In some implementations, such as in 4G, the network entities 102 and the UEs 104 may support a single frame structure. In some other implementations, such as in 5G and among other suitable radio access technologies, the network entities 102 and the UEs 104 may support various frame structures (i.e., multiple frame structures). The network entities 102 and the UEs 104 may support various frame structures based on one or more numerologies.

[0067] One or more numerologies may be supported in the wireless communications system 100A, and a numerology may include a subcarrier spacing and a cyclic prefix. A first numerology (e.g., $\mu=0$) may be associated with a first subcarrier spacing (e.g., 15 kHz) and a normal cyclic prefix. In some implementations, the first numerology (e.g., $\mu=0$) associated with the first subcarrier spacing (e.g., 15 kHz) may utilize one slot per subframe. A second numerology (e.g., $\mu=1$) may be associated with a second subcarrier spacing (e.g., 30 kHz) and a normal cyclic prefix. A third numerology (e.g., $\mu=2$) may be associated with a third subcarrier spacing (e.g., 60 kHz) and a normal cyclic prefix or an extended cyclic prefix. A fourth numerology (e.g., $\mu=3$) may be associated with a fourth subcarrier spacing (e.g., 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g., $\mu=4$) may be associated with a fifth subcarrier spacing (e.g., 240 kHz) and a normal cyclic prefix.

[0068] A time interval of a resource (e.g., a communication resource) may be organized according to frames (also referred to as radio frames). Each frame may have a duration, for example, a 10 millisecond (ms) duration. In some implementations, each frame may include multiple subframes. For example, each frame may include 10 subframes, and each subframe may have a duration, for example, a 1 ms duration. In some implementations, each frame may have the same duration. In some implementations, each subframe of a frame may have the same duration.

[0069] Additionally or alternatively, a time interval of a resource (e.g., a communication resource) may be organized according to slots. For example, a subframe may include a number (e.g., quantity) of slots. The number of slots in each subframe may also depend on the one or more numerologies supported in the wireless communications system 100A. For instance, the first, second, third, fourth, and fifth numerologies (i.e., $\mu=0$, $\mu=1$, $\mu=2$, $\mu=3$, $\mu=4$) associated with respective subcarrier spacings of 15 kHz, 30 kHz, 60 kHz, 120 kHz, and 240 kHz may utilize a single slot per subframe, two slots per subframe, four slots per subframe, eight slots per subframe, and 16 slots per subframe, respectively. Each slot may include a number (e.g., quantity) of symbols (e.g., OFDM symbols). In some implementations, the number (e.g., quantity) of slots for a subframe may depend on a numerology. For a normal cyclic prefix, a slot may include 14 symbols. For an extended cyclic prefix (e.g., applicable for 60 kHz subcarrier spacing), a slot may include 12 symbols. The relationship between the number of symbols per slot, the number of slots per subframe, and the number of slots per frame for a normal cyclic prefix and an extended cyclic prefix may depend on a numerology. It should be understood that reference to a first numerology (e.g., $\mu=0$) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

[0070] In the wireless communications system 100A, an electromagnetic (EM) spectrum may be split, based on frequency or wavelength, into various classes, frequency bands, frequency channels, etc. By way of example, the wireless communications system 100A 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, the network entities 102 and the UEs 104 may perform wireless communications over one or more of the operating frequency bands. In some implementations, FR1 may be used by the network entities 102

and the UEs 104, among other equipment or devices for cellular communications traffic (e.g., control information, data). In some implementations, FR2 may be used by the network entities 102 and the UEs 104, among other equipment or devices for short-range, high data rate capabilities.

[0071] FR1 may be associated with one or multiple numerologies (e.g., at least three numerologies). For example, FR1 may be associated with a first numerology (e.g., $\mu=0$), which includes 15 kHz subcarrier spacing; a second numerology (e.g., $\mu=1$), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., $\mu=2$), which includes 60 kHz subcarrier spacing. FR2 may be associated with one or multiple numerologies (e.g., at least 2 numerologies). For example, FR2 may be associated with a third numerology (e.g., $\mu=2$), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., $\mu=3$), which includes 120 kHz subcarrier spacing.

[0072] 3GPP Rel-17 specifications have provided basic support of NTN features and in Rel-18 further enhancements are being studied. Both Rel-17 and Rel-18 NTN assumes immediate data delivery (from a source UE to a target UE) without a time duration of storing the data in network. For Rel-19 NTN enhancements, it has been proposed to support store and forward (S&F) satellite operations in NTN for delay-tolerant, non-real-time services to be offered in areas visited by the satellites but with no need to have NTN gateway infrastructure (e.g. mid-sea, remote areas), and it considered as a key to facilitate cost-effective deployment of NTN services with sparse satellite constellations and reduced ground segment infrastructure.

[0073] Support of S&F operation is currently the first-priority objective for Rel-19 IoT NTN according to offline discussions. Some potential Rel-19 IoT NTN objectives to support S&F operation are proposed in 3GPP RAN#101:

Define the necessary enhancements into RAN to support store and forward (S&F) operation for delay-tolerant services. Specific aspects at least to be considered if applicable:

- Capabilities for the RAN to inform UEs that the network operates in S&F mode.
- Capabilities for the RAN to handle signalling procedures under S&F operation (e.g. suspend / resume signalling procedures that cannot be normally completed because of the S&F operation).

- Capabilities for the RAN to handle data transmission under S&F operation (e.g. enforcement of specific S&F QoS requirements such as maximum message size and acknowledgement policy).

[0074] FIG. 1B illustrates an example of store and forward operations in NTN associated with aspects of the present disclosure. For satellite payload, it should be defined that at least regenerative payload is assumed as the service data, wherein the eNB/gNB is on-boarded with satellite. For transparent payload, the S&F operation is also possible only that the service data is stored in eNB/gNBs on the ground. For intra-inter-satellite, the service data could be at least stored in and forwarded by the same satellite (eNB/gNB), and the service data could be also transferred between satellites (eNB/gNBs) via inter satellite links (ISLs) or ground stations. In such case, additional information exchange is needed between these satellites (eNB/gNBs). For core network (CN) involvement, the S&F operations could be conducted with or without CN entity involved. If no CN entity is involved, the eNB/gNB may need new functionality to identify S&F service data and a target UE.

[0075] One scenario of S&F operation in NTN for UE to UE services is shown in FIG. 1B. At time T1, the satellite 120, which is example of network entities 102 and in a former of satellite, serves UE_1 130. UE_1 130 transmits data that is intended to UE_2 140 to the satellite 120 (eNB/gNB), and the satellite 120 (eNB/gNB) stores the data. At time T2, the satellite 120 serves UE_2 140. The satellite 120 (eNB/gNB) forwards the stored data to UE_2 140. At time T3, UE_2 140 transmits response data that is intended to UE_1 130 (if any) to the satellite 120 (eNB/gNB), and the satellite 120 (eNB/gNB) stores the response data. The satellite 120 (eNB/gNB) may also store information of delivery status (if any) generated by network. At time T4, the satellite 120 returns to serve UE_1 130. The satellite 120 (eNB/gNB) forwards the stored response data (if any) to UE_1 130. The satellite 120 (eNB/gNB) may also transmit information of delivery status generated by network (if any) to UE_1 130.

[0076] FIG. 1C illustrates another example of store and forward operations in NTN associated with aspects of the present disclosure. For satellite payload, it should be defined that at least regenerative payload is assumed as the service data, wherein the eNB/gNB is on-boarded with satellite. For intra-inter-satellite, the service data could be at least stored in and forwarded by the same satellite (eNB/gNB), and the service data

could be also transferred between satellites (eNB/gNBs) via ISLs or ground stations. In such case, additional information exchange is needed between these satellites (eNB/gNBs). For core network (CN) involvement, the S&F operations are conducted without connection to a CN entity (or data network) temporarily.

[0077] One scenario of S&F operation in NTN for UE to network services is shown in FIG. 1C. At time T1, the satellite 120 serves UE_1 130. UE_1 130 transmits data that is meant for a target network (core/data network) entity 150 to the satellite 120 (eNB/gNB), and the satellite 120 (eNB/gNB) stores the data. At time T2, the satellite 120 connects to the target network (core/data network) entity 150. The satellite 120 (eNB/gNB) forwards the stored data that is meant for network (core/data network) to the target network (core/data network) entity 150. At time T3, the target network (core/data network) entity 150 transmits response data that is meant for UE_1 130 (if any) to the satellite 120 (eNB/gNB), and the satellite 120 (eNB/gNB) stores the response data. The satellite 120 (eNB/gNB) may also store information of delivery status (if any) generated by RAN. At time T4, the satellite 120 returns to serve UE_1 130. The satellite 120 (eNB/gNB) forwards the stored response data (if any) that is meant for UE_1 130 to UE_1 130. The satellite 120 (eNB/gNB) may also transmit information of delivery status generated by network (if any) to UE_1 130.

[0078] There are some issues regarding the S&F operations to be solved. The services that can leverage S&F operations have some specific characteristics including delay-tolerant (could be hours) and remote (source or target could be reached only by limited satellite coverage), and as a result the source or target UE may need to be aware that the current cell supports S&F delivery or configuration, either for determination of initiating S&F data transmission or for configuration of transmitting/receiving S&F data/response with large delay.

[0079] Moreover, the UE may also need some availability information about the S&F operation supported by the network, e.g., for which area or for how long the data can be delivered, or some functional information about the S&F operation supported by the network, e.g., support of providing delivery status, support of cast types for delivery (unicast, multicast and broadcast), support of eNB/gNB-only S&F (i.e., no CN entity is involved during the S&F operation). Therefore, the issue of how does UE know that network supports S&F operation may need to be addressed.

[0080] On the other hand, network may also need to be aware that a UE supports S&F capability, e.g., to configure the UE for S&F data transmission/reception specifically. Network may also need to be aware of the UE requirements for S&F operation, e.g., to understand for which area or for how long the data shall be delivered, or whether providing delivery status is needed, or which cast types for delivery is expected. Therefore, the issue of how does network know that UE requires S&F operation may need to be addressed.

[0081] When both the network and the UE supports S&F operation, the UE may need to determine when an S&F operation service can be initiated e.g., whether a service can leverage S&F operation. The UE may also need to provide additional information for completing an S&F operation, e.g., where the service data shall be delivered to and for how long the service data can be considered as valid.

[0082] It should be specified that the AS-NAS functional split in UE for S&F, e.g., one stratum is responsible for the initiation and the other stratum can provide assistances. Moreover, AS-NAS interaction could be needed to ensure appropriate S&F initiation and data delivery, e.g., start or suspend S&F data delivery from NAS to AS when satellite coverage is valid or invalid to avoid congestion. Therefore, the issue of how does UE initiate an S&F operation or service may need to be addressed.

[0083] In the case of CN entity is involved, the eNB or gNB does not need to identify the service data leveraging S&F operations or find the target UE to be delivered, which are CN functionalities. In the case of no CN entity is involved for an S&F operation wherein the eNB or the gNB is the only node responsible for storing and forwarding, the eNB or the gNB has to identify the service data leveraging S&F operations to store it and even identify the target UE to deliver it. Therefore, the issue of how does gNB identify the service data leveraging S&F operations when no CN entity is involved may need to be addressed. In general, the present disclosure relates to developing the signaling and procedures to support S&F operation based on LTE protocols for NB-IoT and eMTC (and extending to NR as well).

[0084] In view of the above discussions, some embodiments of the present disclosure provide a solution for store and forward operations. In one aspect of the solution of the present disclosure, a user equipment receives a configuration for a store and forward operation from a network device. Based on the configuration, the user equipment

determines to initiate the store and forward operation. In this way, the store and forward operation may be initiated at appropriate occasions. Therefore, the performance of communication is improved. Principles and implementations of embodiments of the present disclosure will be described in detail below with reference to FIGS. 2-9.

[0085] FIG. 2 illustrates a signaling chart illustrating an example process 200 in accordance with aspects of the present disclosure. The process 200 may involve the user equipment 201 and the network device 202. The user equipment 201 in Fig. 2 may be an example of UE_1 130 in FIG. 1B or FIG. 1C. The network device 202 in Fig. 2 may be an example of the satellite 120 in FIG. 1B or FIG. 1C. It would be appreciated that although the process 200 is applied to in the communication environment 100A of FIG. 1A, this process may be likewise applied to other communication scenarios with similar issues.

[0086] In the process 200, the network device 202 transmits 210 a configuration for a store and forward operation 207 via the transceiver and to the user equipment 201. On another side of the communication, the user equipment 201 receives the configuration 207 from the network device 202. In other words, the network may indicate its capability of supporting the store and forward operation.

[0087] In some embodiments, the configuration may comprise a first explicit indication of supporting the store and forward operation, a first implicit indication of supporting the store and forward operation, delivery status for pervious service data transmitted based on the store and forward operation, wherein the delivery status indicates whether the pervious service data is successfully delivered, a quality of service (QoS) flow identifier (ID) or a data radio bearer (DRB) ID to identify service data associated with the store and forward operation, at least one ID of at least one user equipment for the store and forward operation, or any combination of two or more of the above-mentioned items.

[0088] Alternatively or additionally, the first explicit indication may be associated with at least one ID of at least one cell, at least one satellite ephemeris, at least one tracking area (TA), at least one radio access network (RAN) notification area (RNA), at least one 5G QoS indicator (5QI), at least one QoS flow ID (QFI), at least one DRB ID, at least one single network slice selection assistance information (S-NSSAI), or any combination of two or more of the above-mentioned items. For example, the first explicit

indication may be 1-bit indicating support of the store and forward operation, and the first explicit indication could be per cell (associated with cell ID), per satellite or eNB/gNB (associated with satellite ephemeris), per area (associated with TA/RNA), per service (associated with 5QI, QFI or DRB) or per slice (associated with NSSAI).

[0089] Additionally, the first implicit indication may comprise delivery time for the store and forward operation provided by the network device, duration for the store and forward operation provided by the network device, a delivery area for the store and forward operation provided by the network device, a response to the request, delivery status provisioning supported by the network device, a data size for the store and forward operation supported by the network device, a cast type for the store and forward operation supported by the network device, a mode for the store and forward operation supported by the network device, and the mode is defined for an access network device, a target device type for the store and forward operation supported by the network device, and the target device type comprises one of a network device or a user equipment, a QoS configuration for the store and forward operation provided by the network device, or any combination of two or more of the above-mentioned items.

[0090] For example, the first implicit indication may be the information or configuration specific for the store and forward operation, and the first implicit indication may include S&F availability, S&F functions, S&F QoS configurations. The S&F availability may indicate the expected or limited delivery time, duration, the expected delivery area, or confirmation to UE's request. The S&F functions may indicate supported functions of the network, e.g., delivery status provisioning, S&F data size limit, S&F cast type, eNB/gNB-only mode, scenario of store and forward operations, i.e. delivering user data to network or a target UE. The S&F QoS may indicate the QoS or SDAP layer configurations for the S&F operation provided by the network e.g., DRB mapping rules for S&F QoS flows in the case of new 5QI introduced.

[0091] Alternatively or additionally, the user equipment 201 may further transmit a request for the store and forward operation to the network device 202. In other words, the UE may indicate its requirement of S&F operation. Correspondingly, the network device 202 may receive the request from the user equipment 201.

[0092] Additionally, the request may comprise a second explicit indication of requesting support of the store and forward operation, or a second implicit indication of

requesting support of the store and forward operation. Additionally, the second explicit indication may be associated with the user equipment, at least one 5G QoS indicator (5QI), at least one QoS flow ID (QFI), at least one DRB, at least one single network slice selection assistance information (S-NSSAI), or any combination of two or more of the above-mentioned items. For example, the second explicit indication may be 1-bit indicating requiring for the store and forward operation capability, and the second explicit indication could be per UE, per service (associated with 5QI, QFI or DRB) or per slice (associated with NSSAI).

[0093] In addition, the second implicit indication may comprise expected delivery time for the store and forward operation requested by the user equipment, expected duration for the store and forward operation requested by the user equipment, an expected delivery area for the store and forward operation requested by the user equipment, an expected target device type for the store and forward operation requested by the user equipment, and the expected target device type comprises one of a network device or a user equipment, an ID of an expected target device for the store and forward operation requested by the user equipment, an indication of delivery status provisioning requested by the user equipment, a data size for the store and forward operation requested by the user equipment, a cast type for the store and forward operation requested by the user equipment, a mode for the store and forward operation requested by the user equipment, and the mode is defined for an access network device, or a QoS configuration for the store and forward operation requested by the user equipment.

[0094] For example, the second implicit indication may be the requirement information specific for the store and forward operation, and the second implicit indication may include required S&F availability, required S&F functions, required S&F QoS information. The S&F availability may indicate expected delivery time or duration for the S&F operation requested by the UE, the expected delivery area for the S&F operation requested by the UE, and an expected target device for delivery requested by the UE, e.g., an expected target type of store and forward operation: to network or to at least one other UE. The S&F functions may indicate required functions e.g., delivery status provisioning, S&F data size, S&F cast type. The S&F QoS information may indicate the QoS or SDAP layer configurations for the S&F operation requested by the UE, e.g., DRB mapping rules for S&F QoS flows. The mode for the store and forward operation may comprise the eNB-only mode or the gNB-only mode.

[0095] In some embodiments, if the delivery status provisioning supported by the network device or the delivery status provisioning requested by the user equipment, the network device 202 may transmit the delivery status to the user equipment 201 to indicate whether the service data transmitted based on the store and forward operation is successfully delivered.

[0096] Correspondingly, if the delivery status provisioning supported by the network device or the delivery status provisioning requested by the user equipment, the user equipment 201 may further receive the delivery status via the transceiver and from the network device 202 to indicate whether the service data transmitted based on the store and forward operation is successfully delivered.

[0097] In an example, if network indicates support of S&F delivery status provisioning or source UE requests for S&F delivery status provisioning, the network may send a delivery status indication to source UE to indicate whether the corresponding service data using S&F operation is successfully delivered.

[0098] Alternatively or additionally, the user equipment 201 may receive the configuration via a NAS signalling at a non-access-stratum (NAS) functional entity of the user equipment from the network device. In some embodiments, the user equipment 201 may receive the configuration via an AS-NAS interaction at the NAS functional entity of the user equipment from an access-stratum (AS) functional entity of the user equipment. In some embodiments, the user equipment 201 may receive receiving the configuration via a AS signalling at the AS functional entity from the network device. In an example, if the initiation stratum is the NAS stratum, the S&F configurations are received in NAS signalling in containers or AS signalling with AS-NAS interaction in UE. In another example, if the initiation stratum is the AS stratum, the S&F configurations are received in AS signalling. AS-NAS interaction could be needed to initiate S&F data delivery in NAS stratum, and the S&F configurations may be forwarded to UE NAS stratum via UE AS-NAS interaction.

[0099] Continuing with reference to FIG. 2, the user equipment 201 determines 215 to initiate the store and forward operation based on the configuration. In some embodiments, the determination to initiate the store and forward operation may be based on the store and forward operation is supported by the network device, the delivery time provided by the network device fulfils at least one QoS requirement of a corresponding

store and forward service, the duration provided by the network device fulfils at least one QoS requirement of a corresponding store and forward service, at least one target user equipment of a corresponding store and forward service is located in the delivery area provided by the network device, a data size of the corresponding store and forward service is smaller than the data size supported by the network device, the delivery status provisioning is supported by the network device, the cast type for the store and forward operation is supported by the network device, a mode for the store and forward operation is supported by the network device, and the mode is defined for an access network device, receiving a delivery status indicating that service data transmitted based on the store and forward operation is not successfully delivered, or any combination of two or more of the above-mentioned items.

[0100] In an example, if a condition of initiation is fulfilled, the user equipment 201 may initiate the S&F operation. The conditions of initiation may comprise: the network supports S&F operation, network delivery time or duration fulfils QoS requirement of the corresponding S&F service, a target UE of the corresponding S&F service is possibly located in the network delivery area, a data size of the corresponding S&F service is smaller than the network S&F data size limit. The conditions of initiation may further comprise other functional fulfilment, e.g., delivery status provisioning, S&F cast type, etc. The conditions of initiation may further comprise UE receives a delivery status indicating a corresponding service data using S&F operation is not successfully delivered.

[0101] Alternatively or additionally, the user equipment 201 may further indicate, from the AS functional entity to the NAS functional entity via an AS-NAS interaction, starting, stopping, or suspending data delivery in the NAS functional entity for the store and forward operation.

[0102] For instance, the determination of initiating an S&F operation may up to one of UE NAS functions or the UE AS functions. The S&F-related indication/information/configuration may be received via NAS signalling or received via AS signalling and forwarded to UE NAS layer via UE AS-NAS interaction. The S&F-related indication/information/configuration is received via AS signalling. UE may indicate UE NAS via UE AS-NAS interaction to start/stop/suspend data delivery in UE NAS for the corresponding S&F operation. The AS stratum may indicate NAS that

initiation conditions are fulfilled (NAS initiation) or that S&F operation is initiated (AS initiation) for S&F data delivery.

[0103] Continuing with reference to FIG. 2, the user equipment 201 may further transmit 220 the service data based on the store and forward operation 223 to the network device 202. On the other side of the communication, the network device 202 receives 225 the service data based on the store and forward operation 223 from the user equipment 201.

[0104] In some embodiments, in order to identify the service data associated with the store and forward operation, the user equipment 201 may map an internet protocol (IP) flow of the service data associated with the store and forward operation to a QoS flow with the at least one QFI configured in the configuration. In some embodiments, in order to identify the service data associated with the store and forward operation, the user equipment 201 may map an QoS flow of the service data associated with the store and forward operation to a DRB with the at least one DRB ID configured in the configuration. In some embodiments, in order to identify the service data associated with the store and forward operation, the user equipment 201 may map an IP flow of the service data associated with the store and forward operation to a QoS flow dedicated for the store and forward operation. In some embodiments, in order to identify the service data associated with the store and forward operation, the user equipment 201 may map a QoS flow of the service data associated with the store and forward to a DRB dedicated for the store and forward operation, or any combination of two or more of the above-mentioned items.

[0105] For example, if no CN entity is involved (i.e., eNB/gNB-only mode), S&F service data may be marked and UE identification may be transmitted to the network. There are multiple options for the S&F service data marking. In one option, the S&F service data is marked at SDAP layer per QoS flow or per DRB in SDAP configuration. In another option, the S&F service data is transmitted or received via dedicated QoS flow or DRB specified in specifications. An AS-level UE identity is introduced for S&F target UE identification, and the AS-level UE identity is configured by eNB/gNB.

[0106] Alternatively or additionally, the user equipment 201 may further transmit assistance information to the network device 202. The assistance information may comprise at least one QFI for identifying the service data, at least one DRB ID for

identifying the service data, at least one ID of at least one target device for the store and forward operation, or any combination of two or more of the above-mentioned items.

[0107] In an example, the assistant information may comprise a time stamp to indicate when the S&F data is generated or transmitted or a validity duration to indicate for how long the S&F data is valid. The assistant information may further comprise a target UE or area to indicate the UE or the area to which the S&F data is to be delivered. The assistant information may further comprise an expected target identity of store and forward operation, for example, a network entity identity or a UE identity.

[0108] In some embodiments, the network device 202 may further receive assistance information from the user equipment. The assistance information may comprise at least one QFI for identifying the service data, at least one DRB ID for identifying the service data, at least one ID of at least one target device for the store and forward operation, or any combination of two or more of the above-mentioned items. In some embodiments, the network device 202 may comprise a eNodeB, a gNodeB, an access and mobility management function (AMF) entity, a session management function (SMF) entity, or any combination of two or more of the above-mentioned items.

[0109] In addition, the network device 202 may comprise an eNodeB, a gNodeB, an access and mobility management function (AMF) entity, a session management function (SMF) entity, or any combination of two or more of the above-mentioned items.

[0110] In general, the potential issues of supporting store & forward operations for service data delivery in NTN scenarios is solved, and the initiation of an S&F operation based on the AS/NAS signalling of essential capability and necessary function between network and UE. The AS-NAS functional split and interaction in UE for S&F operation are designed as well. Moreover, S&F operation with eNB/gNB-only mode (without CN entity involved) is also considered.

[0111] FIG. 3 illustrates a signaling chart illustrating an example process 300 according to some embodiments of the present disclosure. The process 300 may involve a UE 301, a eNB/gNB 302 and a core network 303. The UE 301 in Fig. 3 may be an example of UE_1 130 in FIG. 1B or FIG. 1C. The eNB/gNB 302 or the core network 303 in Fig. 3 may be an example of the satellite 120 in FIG. 1B or FIG. 1C. It is understood that the process 300 can be considered as a more specific example of the process 200 in FIG. 2.

[0112] In the process 300, before or after receiving a first configuration for S&F operation, the UE 301 may transmit a first request for S&F operation. the first request includes an explicit indication of requesting support of S&F operation, an implicitly indicates UE's request of supporting S&F operation, a reported target UE ID for S&F (only for eNB/gNB), or any combination of two or more of the above-mentioned items. At 305, the first request is transmitted to the eNB/gNB 302 via AS signalling. At 310, the first request is transmitted to the core network 303 via NAS signalling.

[0113] The network entity (eNB/gNB or AMF/SMF) generates a first configuration for S&F operation and indicates to UE. The first configuration for S&F operation includes: an explicit indication of supporting S&F operation, an implicitly indicates network supports S&F operation, delivery status for a previous service data using S&F, a QoS flow ID or DRB ID to mark service data using S&F (only for eNB/gNB), a UE ID for S&F (only for eNB/gNB), or any combination of two or more of the above-mentioned items.

[0114] At 315, the first configuration is transmitted by the eNB/gNB 302 via AS signalling. At 320, the first configuration is transmitted by the core network 303 via NAS signalling.

[0115] Based on the first configuration, the UE 301 determines to initiate an S&F operation. The S&F operation interaction may be up to NAS initiation or AS initiation and AS-NAS interaction. The S&F operation interaction may be further up to conditions of initiation.

[0116] At 330, the UE 301 may transmit a service data using an S&F operation to the network entity. At 335, the UE 301 may also transmit a first assistance information for service data using S&F to the network entity (eNB/gNB or AMF/SMF) when transmits the service data using an S&F operation. The first assistance information includes a QoS flow ID or a DRB ID used to mark service data using S&F or a target UE ID for S&F.

[0117] In an example, the network configures the UE 301 with the QoS flow ID or DRB ID to mark the service data using S&F operation, and the UE 301 may map the IP flow of the service data using S&F operation to the configured QoS flow or map the QoS flow of the service data using S&F operation to the configured DRB. In addition, UE may map the IP flow of the service data using S&F operation to the QoS flow specified to be dedicated for S&F operation, or map the QoS flow of the service data using S&F

operation to the DRB specified to be dedicated for S&F operation. Then first assistance information may include the QoS flow ID or the DRB ID used to mark service data.

[0118] In another example, the eNB/gNB 302 distributes IDs for S&F operation with eNB/gNB-only mode to UEs served by it. The UE 301 that initiates an S&F operation reports at least one ID of at least one target UE for S&F operation with eNB/gNB-only mode. Then first assistance information may include the target UE ID for S&F. The eNB/gNB 302 delivers the service data using the corresponding S&F operation to the at least one target UE based on the at least one reported ID.

[0119] FIG. 4 illustrates an example of a device 400 that supports store and forward operations in accordance with aspects of the present disclosure. The device 400 may be an example of a UE 104 as described herein. The device 400 may support wireless communication with one or more network entities 102, UEs 104, or any combination thereof. The device 400 may include components for bi-directional communications including components for transmitting and receiving communications, such as a processor 402, a memory 404, a transceiver 406, and, optionally, an I/O controller 408. 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).

[0120] The processor 402, the memory 404, the transceiver 406, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. For example, the processor 402, the memory 404, the transceiver 406, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

[0121] In some implementations, the processor 402, the memory 404, the transceiver 406, or various combinations or components thereof may be implemented in hardware (e.g., in communications management circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA) or other programmable logic device, a discrete gate or transistor logic, discrete hardware components, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure. In some implementations, the processor 402 and the memory 404 coupled with

the processor 402 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 402, instructions stored in the memory 404).

[0122] For example, the processor 402 may support wireless communication at the device 400 in accordance with examples as disclosed herein. The processor 402 may be configured to operable to support a means for receiving, via the transceiver and from a network device, a configuration for a store and forward operation; and a means for determining to initiate the store and forward operation based on the configuration.

[0123] The processor 402 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, a microcontroller, an ASIC, an FPGA, a programmable logic device, a discrete gate or transistor logic component, a discrete hardware component, or any combination thereof). In some implementations, the processor 402 may be configured to operate a memory array using a memory controller. In some other implementations, a memory controller may be integrated into the processor 402. The processor 402 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 404) to cause the device 400 to perform various functions of the present disclosure.

[0124] The memory 404 may include random access memory (RAM) and read-only memory (ROM). The memory 404 may store computer-readable, computer-executable code including instructions that, when executed by the processor 402 cause the device 400 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. In some implementations, the code may not be directly executable by the processor 402 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 404 may include, among other things, a basic I/O system (BIOS) which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[0125] The I/O controller 408 may manage input and output signals for the device 400. The I/O controller 408 may also manage peripherals not integrated into the device 400. In some implementations, the I/O controller 408 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 408 may utilize an operating system such as iOS®, ANDROID®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system. In some

implementations, the I/O controller 408 may be implemented as part of a processor, such as the processor 406. In some implementations, a user may interact with the device 400 via the I/O controller 408 or via hardware components controlled by the I/O controller 408.

[0126] In some implementations, the device 400 may include a single antenna 410. However, in some other implementations, the device 400 may have more than one antenna 410 (i.e., multiple antennas), including multiple antenna panels or antenna arrays, which may be capable of concurrently transmitting or receiving multiple wireless transmissions. The transceiver 406 may communicate bi-directionally, via the one or more antennas 410, wired, or wireless links as described herein. For example, the transceiver 406 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 406 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 410 for transmission, and to demodulate packets received from the one or more antennas 410. The transceiver 406 may include one or more transmit chains, one or more receive chains, or a combination thereof.

[0127] A transmit chain may be configured to generate and transmit signals (e.g., control information, data, packets). The transmit chain 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 amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmit chain 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 transmit chain may also include one or more antennas 410 for transmitting the amplified signal into the air or wireless medium.

[0128] A receive chain may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receive chain may include one or more antennas 410 for receive the signal over the air or wireless medium. The receive chain may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receive chain 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 receive chain may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[0129] FIG. 5 illustrates an example of a device 500 that supports store and forward operations in accordance with aspects of the present disclosure. The device 500 may be an example of a network entity 102 or a core network 106 as described herein. The device 500 may support wireless communication with one or more network entities 102, UEs 104, or any combination thereof. The device 500 may include components for bi-directional communications including components for transmitting and receiving communications, such as a processor 502, a memory 504, a transceiver 506, and, optionally, an I/O controller 508. 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).

[0130] The processor 502, the memory 504, the transceiver 506, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. For example, the processor 502, the memory 504, the transceiver 506, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

[0131] In some implementations, the processor 502, the memory 504, the transceiver 506, or various combinations or components thereof may be implemented in hardware (e.g., in communications management circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA) or other programmable logic device, a discrete gate or transistor logic, discrete hardware components, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure. In some implementations, the processor 502 and the memory 504 coupled with the processor 502 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 502, instructions stored in the memory 504).

[0132] For example, the processor 502 may support wireless communication at the device 500 in accordance with examples as disclosed herein. The processor 502 may be configured to operable to support a means for transmitting, via the transceiver and to a

user equipment, a configuration for a store and forward operation; and a means for receiving, from the user equipment, service data based on the store and forward operation.

[0133] The processor 502 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, a microcontroller, an ASIC, an FPGA, a programmable logic device, a discrete gate or transistor logic component, a discrete hardware component, or any combination thereof). In some implementations, the processor 502 may be configured to operate a memory array using a memory controller. In some other implementations, a memory controller may be integrated into the processor 502. The processor 502 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 504) to cause the device 500 to perform various functions of the present disclosure.

[0134] The memory 504 may include random access memory (RAM) and read-only memory (ROM). The memory 504 may store computer-readable, computer-executable code including instructions that, when executed by the processor 502 cause the device 500 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. In some implementations, the code may not be directly executable by the processor 502 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 504 may include, among other things, a basic I/O system (BIOS) which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[0135] The I/O controller 508 may manage input and output signals for the device 500. The I/O controller 508 may also manage peripherals not integrated into the device 500. In some implementations, the I/O controller 508 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 508 may utilize an operating system such as iOS®, ANDROID®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system. In some implementations, the I/O controller 508 may be implemented as part of a processor, such as the processor 506. In some implementations, a user may interact with the device 500 via the I/O controller 508 or via hardware components controlled by the I/O controller 508.

[0136] In some implementations, the device 500 may include a single antenna 510. However, in some other implementations, the device 500 may have more than one antenna 510 (i.e., multiple antennas), including multiple antenna panels or antenna arrays, which may be capable of concurrently transmitting or receiving multiple wireless transmissions. The transceiver 506 may communicate bi-directionally, via the one or more antennas 510, wired, or wireless links as described herein. For example, the transceiver 506 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 506 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 510 for transmission, and to demodulate packets received from the one or more antennas 510. The transceiver 506 may include one or more transmit chains, one or more receive chains, or a combination thereof.

[0137] A transmit chain may be configured to generate and transmit signals (e.g., control information, data, packets). The transmit chain 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 amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmit chain 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 transmit chain may also include one or more antennas 510 for transmitting the amplified signal into the air or wireless medium.

[0138] A receive chain may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receive chain may include one or more antennas 510 for receive the signal over the air or wireless medium. The receive chain may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receive chain 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 receive chain may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[0139] FIG. 6 illustrates an example of a processor 600 that supports store and forward operations in accordance with aspects of the present disclosure. The processor 600 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 600 may include a controller 602 configured to perform various operations in accordance with examples as described herein. The processor 600 may optionally include at least one memory 604. Additionally, or alternatively, the processor 600 may optionally include one or more arithmetic-logic units (ALUs) 600. 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).

[0140] The processor 600 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 600) 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).

[0141] The controller 602 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 600 to cause the processor 600 to support various operations in accordance with examples as described herein. For example, the controller 602 may operate as a control unit of the processor 600, generating control signals that manage the operation of various components of the processor 600. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0142] The controller 602 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 604 and determine subsequent instruction(s) to be executed to cause the processor 600 to support various operations in accordance with examples as

described herein. The controller 602 may be configured to track memory address of instructions associated with the memory 604. The controller 602 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 602 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 600 to cause the processor 600 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 602 may be configured to manage flow of data within the processor 600. The controller 602 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 600.

[0143] The memory 604 may include one or more caches (e.g., memory local to or included in the processor 600 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementation, the memory 604 may reside within or on a processor chipset (e.g., local to the processor 600). In some other implementations, the memory 604 may reside external to the processor chipset (e.g., remote to the processor 600).

[0144] The memory 604 may store computer-readable, computer-executable code including instructions that, when executed by the processor 600, cause the processor 600 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 602 and/or the processor 600 may be configured to execute computer-readable instructions stored in the memory 604 to cause the processor 600 to perform various functions (e.g., functions or tasks supporting transmit power prioritization). For example, the processor 600 and/or the controller 602 may be coupled with or to the memory 604, the processor 600, the controller 602, and the memory 604 may be configured to perform various functions described herein. In some examples, the processor 600 may include multiple processors and the memory 604 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.

[0145] The one or more ALUs 600 may be configured to support various operations in accordance with examples as described herein. In some implementation, the one or

more ALUs 600 may reside within or on a processor chipset (e.g., the processor 600). In some other implementations, the one or more ALUs 600 may reside external to the processor chipset (e.g., the processor 600). One or more ALUs 600 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 600 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 600 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 600 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 600 to handle conditional operations, comparisons, and bitwise operations.

[0146] The processor 600 may support wireless communication in accordance with examples as disclosed herein. The processor 602 may be configured to or operable to support a means for transmitting, via the transceiver and to a user equipment, a configuration for a store and forward operation; and a means for receiving, from the user equipment, service data based on the store and forward operation.

[0147] FIG. 7 illustrates an example of a processor 700 that supports store and forward operations in accordance with aspects of the present disclosure. The processor 700 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 700 may include a controller 702 configured to perform various operations in accordance with examples as described herein. The processor 700 may optionally include at least one memory 704. Additionally, or alternatively, the processor 700 may optionally include one or more arithmetic-logic units (ALUs) 700. 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).

[0148] The processor 700 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 700)

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).

[0149] The controller 702 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 700 to cause the processor 700 to support various operations in accordance with examples as described herein. For example, the controller 702 may operate as a control unit of the processor 700, generating control signals that manage the operation of various components of the processor 700. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0150] The controller 702 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 704 and determine subsequent instruction(s) to be executed to cause the processor 700 to support various operations in accordance with examples as described herein. The controller 702 may be configured to track memory address of instructions associated with the memory 704. The controller 702 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 702 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 700 to cause the processor 700 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 702 may be configured to manage flow of data within the processor 700. The controller 702 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 700.

[0151] The memory 704 may include one or more caches (e.g., memory local to or included in the processor 700 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementation, the memory 704 may reside within or on a processor chipset (e.g., local to the processor 700). In some other implementations, the memory 704 may reside external to the processor chipset (e.g., remote to the processor 700).

[0152] The memory 704 may store computer-readable, computer-executable code including instructions that, when executed by the processor 700, cause the processor 700 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 702 and/or the processor 700 may be configured to execute computer-readable instructions stored in the memory 704 to cause the processor 700 to perform various functions (e.g., functions or tasks supporting transmit power prioritization). For example, the processor 700 and/or the controller 702 may be coupled with or to the memory 704, the processor 700, the controller 702, and the memory 704 may be configured to perform various functions described herein. In some examples, the processor 700 may include multiple processors and the memory 704 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.

[0153] The one or more ALUs 700 may be configured to support various operations in accordance with examples as described herein. In some implementation, the one or more ALUs 700 may reside within or on a processor chipset (e.g., the processor 700). In some other implementations, the one or more ALUs 700 may reside external to the processor chipset (e.g., the processor 700). One or more ALUs 700 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 700 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 700 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 700 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 700 to handle conditional operations, comparisons, and bitwise operations.

[0154] The processor 700 may support wireless communication in accordance with examples as disclosed herein. The processor 702 may be configured to or operable to support a means for transmitting, via the transceiver and to a user equipment, a configuration for a store and forward operation; and a means for receiving, from the user equipment, service data based on the store and forward operation.

[0155] FIG. 8 illustrates a flowchart of a method 800 that supports store and forward operations in accordance with aspects of the present disclosure. The operations of the method 800 may be implemented by a device or its components as described herein. For example, the operations of the method 800 may be performed by a UE 104 as described herein. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[0156] At 805, the method includes receiving, via the transceiver and from a network device, a configuration for a store and forward operation. The operations of 805 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 805 may be performed by a device as described with reference to FIG. 1A.

[0157] At 810, the method includes determining to initiate the store and forward operation based on the configuration. The operations of 810 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 810 may be performed by a device as described with reference to FIG. 1A.

[0158] In some embodiment, the method may further include transmitting, to the network device, a request for the store and forward operation. In some embodiment, the configuration may comprise one of the following: a first explicit indication of supporting the store and forward operation; a first implicit indication of supporting the store and forward operation; delivery status for pervious service data transmitted based on the store and forward operation, wherein the delivery status indicates whether the pervious service data is successfully delivered; a quality of service (QoS) flow identifier (ID) or a data radio bearer (DRB) ID to identify service data associated with the store and forward operation; or at least one ID of at least one user equipment for the store and forward operation.

[0159] In some embodiment, the first explicit indication may be associated with one of the following: at least one ID of at least one cell; at least one satellite ephemeris; at least one tracking area (TA); at least one radio access network (RAN) notification area (RNA); at least one 5G QoS indicator (5QI); at least one QoS flow ID (QFI); at least one DRB ID; or at least one single network slice selection assistance information (S-NSSAI).

[0160] In some embodiment, the first implicit indication may comprise one of the following: delivery time for the store and forward operation provided by the network device; duration for the store and forward operation provided by the network device; a delivery area for the store and forward operation provided by the network device; a response to the request; delivery status provisioning supported by the network device; a data size for the store and forward operation supported by the network device; a cast type for the store and forward operation supported by the network device; a mode for the store and forward operation supported by the network device, wherein the mode is defined for an access network device; a target device type for the store and forward operation supported by the network device, wherein the target device type comprises one of a network device or a user equipment; or a QoS configuration for the store and forward operation provided by the network device.

[0161] In some embodiment, the request may comprise one of the following: a second explicit indication of requesting support of the store and forward operation; or a second implicit indication of requesting support of the store and forward operation.

[0162] In some embodiment, the second explicit indication may be associated with one of the following: the user equipment; at least one 5G QoS indicator (5QI); at least one QoS flow ID (QFI); at least one DRB; or at least one single network slice selection assistance information (S-NSSAI).

[0163] In some embodiment, the second implicit indication may comprise one of the following: expected delivery time for the store and forward operation requested by the user equipment; expected duration for the store and forward operation requested by the user equipment; an expected delivery area for the store and forward operation requested by the user equipment; an expected target device type for the store and forward operation requested by the user equipment, wherein the expected target device type comprises one of a network device or a user equipment; an ID of an expected target device for the store and forward operation requested by the user equipment; an indication of delivery status provisioning requested by the user equipment; a data size for the store and forward operation requested by the user equipment; a cast type for the store and forward operation requested by the user equipment; a mode for the store and forward operation requested by the user equipment, wherein the mode is defined for an access network device; or a QoS configuration for the store and forward operation requested by the user equipment.

[0164] In some embodiment, the method may further include receiving, via the transceiver and from the network device, the delivery status to indicate whether the service data transmitted based on the store and forward operation is successfully delivered in the case that the delivery status provisioning supported by the network device or the delivery status provisioning requested by the user equipment.

[0165] In some embodiment, receiving the configuration may comprise: receiving, at a non-access-stratum (NAS) functional entity of the user equipment from the network device, the configuration via a NAS signalling; receiving, at the NAS functional entity of the user equipment from an access-stratum (AS) functional entity of the user equipment, the configuration via an AS-NAS interaction; or receiving, at the AS functional entity from the network device, the configuration via a AS signalling.

[0166] In some embodiment, the method may further include indicating, from the AS functional entity to the NAS functional entity via an AS-NAS interaction, starting, stopping, or suspending data delivery in the NAS functional entity for the store and forward operation.

[0167] In some embodiment, the determination to initiate the store and forward operation may be based on at least one of the following conditions: the store and forward operation is supported by the network device; the delivery time provided by the network device fulfils at least one QoS requirement of a corresponding store and forward service; the duration provided by the network device fulfils at least one QoS requirement of a corresponding store and forward service; at least one target user equipment of a corresponding store and forward service is located in the delivery area provided by the network device; a data size of the corresponding store and forward service is smaller than the data size supported by the network device; the delivery status provisioning is supported by the network device; the cast type for the store and forward operation is supported by the network device; a mode for the store and forward operation is supported by the network device, wherein the mode is defined for an access network device; or receiving a delivery status indicating that service data transmitted based on the store and forward operation is not successfully delivered.

[0168] In some embodiment, the method may further include transmitting, to the network device, the service data based on the store and forward operation. In some embodiment, the method may further include identifying the service data associated with

the store and forward operation by one of the following: mapping an internet protocol (IP) flow of the service data associated with the store and forward operation to a QoS flow with the at least one QFI configured in the configuration; mapping an QoS flow of the service data associated with the store and forward operation to a DRB with the at least one DRB ID configured in the configuration; mapping an IP flow of the service data associated with the store and forward operation to a QoS flow dedicated for the store and forward operation; or mapping a QoS flow of the service data associated with the store and forward to a DRB dedicated for the store and forward operation.

[0169] In some embodiment, the method may further include transmitting, to the network device, assistance information comprising one of the following: at least one QFI for identifying the service data; at least one DRB ID for identifying the service data; or at least one ID of at least one target device for the store and forward operation.

[0170] In some embodiment, the network device may comprise one of the following: an eNodeB, a gNodeB, an access and mobility management function (AMF) entity, or a session management function (SMF) entity.

[0171] FIG. 9 illustrates a flowchart of a method 900 that supports store and forward operations in accordance with aspects of the present disclosure. The operations of the method 900 may be implemented by a device or its components as described herein. For example, the operations of the method 900 may be performed by a network entity 102 or a core network 106 as described herein. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[0172] At 905, the method includes transmitting, via the transceiver and to a user equipment, a configuration for a store and forward operation. The operations of 905 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 905 may be performed by a device as described with reference to FIG. 1A.

[0173] At 910, the method includes receiving, from the user equipment, service data based on the store and forward operation. The operations of 910 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 910 may be performed by a device as described with reference to FIG. 1A.

[0174] In some embodiment, the method may further includes receiving, from the user equipment, a request for the store and forward operation. In some embodiment, the first implicit indication may comprise at least one of the following: delivery time for the store and forward operation provided by the network device; duration for the store and forward operation provided by the network device; a delivery area for the store and forward operation provided by the network device; a response to the request; delivery status provisioning supported by the network device; a data size for the store and forward operation supported by the network device; a cast type for the store and forward operation supported by the network device; a mode for the store and forward operation supported by the network device, wherein the mode is defined for an access network device; a target device type for the store and forward operation supported by the network device, wherein the target device type comprises one of a network device or a user equipment; or a QoS configuration for the store and forward operation provided by the network device.

[0175] In some embodiment, the request may comprise one of the following: a second explicit indication of requesting support of the store and forward operation; or a second implicit indication of requesting support of the store and forward operation.

[0176] In some embodiment, the second explicit indication may be associated with one of the following: the user equipment; at least one 5G QoS indicator (5QI); at least one QoS flow ID (QFI); at least one DRB; or at least one single network slice selection assistance information (S-NSSAI).

[0177] In some embodiment, the second implicit indication may comprise at least the following: expected delivery time for the store and forward operation requested by the user equipment; expected duration for the store and forward operation requested by the user equipment; an expected delivery area for the store and forward operation requested by the user equipment; an expected target device type for the store and forward operation requested by the user equipment, wherein the expected target device type comprises one of a network device or a user equipment; an ID of an expected target device for the store and forward operation requested by the user equipment; an indication of delivery status provisioning requested by the user equipment; a data size for the store and forward operation requested by the user equipment; a cast type for the store and forward operation requested by the user equipment; a mode for the store and forward operation requested

by the user equipment, wherein the mode is defined for an access network device; or a QoS configuration for the store and forward operation requested by the user equipment.

[0178] In some embodiment, the method may further include transmitting, to the user equipment, the delivery status to indicate whether the service data transmitted based on the store and forward operation is successfully delivered in the case that the delivery status provisioning supported by the network device or the delivery status provisioning requested by the user equipment.

[0179] In some embodiment, an internet protocol (IP) flow of the service data associated with the store and forward operation may be mapped to a QoS flow with the at least one QFI configured in the configuration; an QoS flow of the service data associated with the store and forward operation may be mapped to a DRB with the at least one DRB ID configured in the configuration; an IP flow of the service data associated with the store and forward operation may be mapped to a QoS flow dedicated for the store and forward operation; or a QoS flow of the service data associated with the store and forward may be mapped to a DRB dedicated for the store and forward operation.

[0180] In some embodiment, the method may further include receiving, from the user equipment, assistance information comprising one of the following: at least one QFI for identifying the service data; at least one DRB ID for identifying the service data; or at least one ID of at least one target user equipment for the store and forward operation. In some embodiment, the network device may comprise at least one of the following: a eNodeB, a gNodeB, an access and mobility management function (AMF) entity, or a session management function (SMF) entity.

[0181] It should be noted that the methods described herein describes possible implementations, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible. Further, aspects from two or more of the methods may be combined.

[0182] The various illustrative blocks and components described in connection with the disclosure herein may be implemented or performed with a general-purpose processor, a DSP, an ASIC, a CPU, an FPGA or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any processor, controller,

microcontroller, or state machine. A processor may also be implemented as a combination of computing devices (e.g., a combination of a DSP and a microprocessor, multiple microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration).

[0183] The functions described herein may be implemented in hardware, software executed by a processor, firmware, or any combination thereof. If implemented in software executed by a processor, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Other examples and implementations are within the scope of the disclosure and appended claims. For example, due to the nature of software, functions described herein may be implemented using software executed by a processor, hardware, firmware, hardwiring, or combinations of any of these. Features implementing functions may also be physically located at various positions, including being distributed such that portions of functions are implemented at different physical locations.

[0184] 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. By way of example, non-transitory computer-readable media may include RAM, ROM, electrically erasable programmable ROM (EEPROM), flash memory, compact disk (CD) ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other non-transitory medium that may be used to carry or store desired program code means in the form of instructions or data structures and that may be accessed by a general-purpose or special-purpose computer, or a general-purpose or special-purpose processor.

[0185] As used herein, including in the claims, 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.

[0186] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

CLAIMS

What is claimed is:

1. A user equipment comprising:
a processor; and
a transceiver coupled to the processor,
wherein the processor is configured to:
receive, via the transceiver and from a network device, a configuration
for a store and forward operation; and
determine to initiate the store and forward operation based on the
configuration.
2. The user equipment of claim 1, wherein the processor is further
configured to:
transmit, to the network device, a request for the store and forward operation.
3. The user equipment of claim 1, wherein the configuration comprises one
of the following:
a first explicit indication of supporting the store and forward operation;
a first implicit indication of supporting the store and forward operation;
delivery status for pervious service data transmitted based on the store and
forward operation, wherein the delivery status indicates whether the pervious service
data is successfully delivered;
a quality of service (QoS) flow identifier (ID) or a data radio bearer (DRB) ID to
identify service data associated with the store and forward operation; or
at least one ID of at least one user equipment for the store and forward
operation.
4. The user equipment of claim 3, wherein the first explicit indication is
associated with one of the following:
at least one ID of at least one cell;
at least one satellite ephemeris;
at least one tracking area (TA);

- at least one radio access network (RAN) notification area (RNA);
- at least one 5G QoS indicator (5QI);
- at least one QoS flow ID (QFI);
- at least one DRB ID; or
- at least one single network slice selection assistance information (S-NSSAI).

5. The user equipment of claim 3, wherein the first implicit indication comprises one of the following:

- delivery time for the store and forward operation provided by the network device;
- duration for the store and forward operation provided by the network device;
- a delivery area for the store and forward operation provided by the network device;
- a response to the request;
- delivery status provisioning supported by the network device;
- a data size for the store and forward operation supported by the network device;
- a cast type for the store and forward operation supported by the network device;
- a mode for the store and forward operation supported by the network device, wherein the mode is defined for an access network device;
- a target device type for the store and forward operation supported by the network device, wherein the target device type comprises one of a network device or a user equipment; or
- a QoS configuration for the store and forward operation provided by the network device.

6. The user equipment of claim 2, wherein the request comprises one of the following:

- a second explicit indication of requesting support of the store and forward operation; or
- a second implicit indication of requesting support of the store and forward operation.

7. The user equipment of claim 6, wherein the second implicit indication comprises one of the following:

- expected delivery time for the store and forward operation requested by the user equipment;
- expected duration for the store and forward operation requested by the user equipment;
- an expected delivery area for the store and forward operation requested by the user equipment;
- an expected target device type for the store and forward operation requested by the user equipment, wherein the expected target device type comprises one of a network device or a user equipment;
- an ID of an expected target device for the store and forward operation requested by the user equipment;
- an indication of delivery status provisioning requested by the user equipment;
- a data size for the store and forward operation requested by the user equipment;
- a cast type for the store and forward operation requested by the user equipment;
- a user equipment mode for the store and forward operation requested by the user equipment, wherein the mode is defined for an access network device; or
- a QoS configuration for the store and forward operation requested by the user equipment.

8. The user equipment of claim 5, wherein the processor is further configured to:

- receive, via the transceiver and from the network device, the delivery status to indicate whether the service data transmitted based on the store and forward operation is successfully delivered in the case that the delivery status provisioning supported by the network device or the delivery status provisioning requested by the user equipment.

9. The user equipment of claim 1, wherein receive the configuration comprises:

- receiving, at a non-access-stratum (NAS) functional entity of the user equipment from the network device, the configuration via a NAS signalling;

receiving, at the NAS functional entity of the user equipment from an access-stratum (AS) functional entity of the user equipment, the configuration via an AS-NAS interaction; or

receiving, at the AS functional entity from the network device, the configuration via a AS signalling.

10. The user equipment of claim 1, wherein the processor is further configured to:

indicate, from the AS functional entity to the NAS functional entity via an AS-NAS interaction, starting, stopping, or suspending data delivery in the NAS functional entity for the store and forward operation.

11. The user equipment of claim 1, wherein the determination to initiate the store and forward operation is based on at least one of the following conditions:

the store and forward operation is supported by the network device;

the delivery time provided by the network device fulfils at least one QoS requirement of a corresponding store and forward service;

the duration provided by the network device fulfils at least one QoS requirement of a corresponding store and forward service;

at least one target user equipment of a corresponding store and forward service is located in the delivery area provided by the network device;

a data size of the corresponding store and forward service is smaller than the data size supported by the network device;

the delivery status provisioning is supported by the network device;

the cast type for the store and forward operation is supported by the network device;

a mode for the store and forward operation is supported by the network device, wherein the mode is defined for an access network device; or

receiving a delivery status indicating that service data transmitted based on the store and forward operation is not successfully delivered.

12. The user equipment of claim 1, wherein the processor is further configured to identify the service data associated with the store and forward operation by one of the following:

mapping an internet protocol (IP) flow of the service data associated with the store and forward operation to a QoS flow with the at least one QFI configured in the configuration;

mapping an QoS flow of the service data associated with the store and forward operation to a DRB with the at least one DRB ID configured in the configuration;

mapping an IP flow of the service data associated with the store and forward operation to a QoS flow dedicated for the store and forward operation; or

mapping a QoS flow of the service data associated with the store and forward to a DRB dedicated for the store and forward operation.

13. A network device comprising:

a processor; and

a transceiver coupled to the processor,

wherein the processor is configured to:

transmit, via the transceiver and to a user equipment, a configuration for a store and forward operation; and

receive, from the user equipment, service data based on the store and forward operation.

14. The network device of claim 13, wherein the configuration comprises one of the following:

a first explicit indication of supporting the store and forward operation;

a first implicit indication of supporting the store and forward operation;

delivery status for pervious service data transmitted based on the store and forward operation, wherein the delivery status indicates whether the pervious service data is successfully delivered;

a quality of service (QoS) flow identifier (ID) or a data radio bearer (DRB) ID to identify service data associated with the store and forward operation; or

at least one ID of at least one user equipment for the store and forward operation.

15. The network device of claim 14, wherein the first explicit indication is associated with one of the following:

- at least one ID of at least one cell;
- at least one satellite ephemeris;
- at least one tracking area (TA)
- at least one radio access network (RAN) notification area (RNA);
- at least one 5G QoS indicator (5QI);
- at least one QoS flow ID (QFI);
- at least one DRB ID; or
- at least one single network slice selection assistance information (S-NSSAI).

16. The network device of claim 14, wherein the first implicit indication comprises at least one of the following:

- delivery time for the store and forward operation provided by the network device;
- duration for the store and forward operation provided by the network device;
- a delivery area for the store and forward operation provided by the network device;
- a response to the request;
- delivery status provisioning supported by the network device;
- a data size for the store and forward operation supported by the network device;
- a cast type for the store and forward operation supported by the network device;
- a mode for the store and forward operation supported by the network device, wherein the mode is defined for an access network device;
- a target device type for the store and forward operation supported by the network device, wherein the target device type comprises one of a network device or a user equipment; or
- a QoS configuration for the store and forward operation provided by the network device.

17. The network device of claim 16, wherein the processor is further configured to:

transmit, to the user equipment, the delivery status to indicate whether the service data transmitted based on the store and forward operation is successfully delivered in the case that the delivery status provisioning supported by the network device or the delivery status provisioning requested by the user equipment.

18. The network device of claim 13, wherein one of the following:
- an internet protocol (IP) flow of the service data associated with the store and forward operation is mapped to a QoS flow with the at least one QFI configured in the configuration;
 - an QoS flow of the service data associated with the store and forward operation is mapped to a DRB with the at least one DRB ID configured in the configuration;
 - an IP flow of the service data associated with the store and forward operation is mapped to a QoS flow dedicated for the store and forward operation; or
 - a QoS flow of the service data associated with the store and forward is mapped to a DRB dedicated for the store and forward operation.

19. A method performed by a user equipment, comprising:
- receiving, via the transceiver and from a network device, a configuration for a store and forward operation; and
 - determining to initiate the store and forward operation based on the configuration.

20. A method performed by a network device, comprising:
- transmitting, via the transceiver and to a user equipment, a configuration for a store and forward operation; and
 - receiving, from the user equipment, service data based on the store and forward operation.