

METHOD FOR REQUESTING DOWNLINK SIGNAL

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to a user equipment (UE), a network entity, a processor for wireless communication, methods, and a computer readable medium for requesting a downlink (DL) signal.

BACKGROUND

[0002] A wireless communication 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] For network energy saving (NES), it is possible that network (NW) configures UEs with simplified or less SSB for measurement according to the Rel-19 NES work item description (WID). Then it can be deduced that the measurement could be configured with relatively long reporting period. Some methods are listed in WID to support on-demand synchronization signal/PBCH block (SSB) secondary cell (SCell) operation for UEs in connected mode configured with carrier aggregation (CA), for both intra-/inter-band CA. However, further issues regarding this matter need to be studied.

SUMMARY

[0004] The present disclosure relates to a UE, a network entity, a processor for wireless communication, methods, and a computer readable medium to for requesting a downlink (DL) signal.

[0005] In a first aspect, there is provided a UE. The UE comprises a processor; and a transceiver coupled to the processor, wherein the processor is configured to: determine whether at least one trigger condition of a request for a downlink (DL) signal is fulfilled; and transmit, via the transceiver and to a network entity, the request for the DL signal based on determining that the at least one trigger condition is fulfilled.

[0006] In a second aspect, there is provided a network entity, comprising: a processor; and a transceiver coupled to the processor, wherein the processor is configured to: receive, via the transceiver and from a user equipment (UE), a request for a DL signal, wherein the request for the DL signal is transmitted based on at least one trigger condition being fulfilled at the UE.

[0007] In a third aspect, there is provided a processor for wireless communication. The a processor comprise at least one memory; and a controller coupled with the at least one memory and configured to cause the controller to: determine whether at least one trigger condition of a request for a downlink (DL) signal is fulfilled; transmit, to a network entity, the request for the DL signal based on determining that the at least one trigger condition is fulfilled.

[0008] In a fourth aspect, there is provided method performed by a user equipment (UE), the method comprising: determining whether at least one trigger condition of a request for a downlink (DL) signal is fulfilled; and transmitting, to a network entity, the request for the DL signal based on determining that the at least one trigger condition is fulfilled.

[0009] In a fifth aspect, there is provided method performed by a network entity, the method comprising: receiving, from a user equipment (UE), a request for a DL signal, wherein the request for the DL signal is transmitted based on at least one trigger condition being fulfilled at the UE.

[0010] In a sixth aspect, there is provided a computer readable medium having instructions stored thereon, the instructions, when executed by a processor of an apparatus,

causing the apparatus to perform the method according to the fourth or the fifth aspect of the disclosure.

[0011] In some implementations of the methods, the UE and the network entity, the UE may receive, from the network entity, a configuration of allowing or not allowing to trigger the request for the DL signal.

[0012] In some implementations of the methods, the UE and the network entity, the at least one trigger condition comprise one or more of: a first one trigger condition that the UE has low beam quality; a second trigger condition that a timer has expired, where the timer restarts when a request for the DL signal is transmitted; a third trigger condition that a number or frequency of uplink (UL) or DL traffic arrival within a configured time window is equal to or larger than a first threshold; a fourth trigger condition that there is no buffered data of a logic channel; a fifth trigger condition that a volume of buffered data or remaining buffered data of a logic channel for UL transmission is larger than a second threshold or less than a third threshold, the third threshold being less than the second threshold; a sixth trigger condition that a remaining packet delay budget (PDB) of a logic channel or each packet associated with the logic channel is larger than a fifth threshold or less than a sixth threshold, the sixth threshold being less than the fifth threshold; a seventh trigger condition that the UE performs bandwidth parts (BWP) switching to a BWP associated with the DL signal; or an eighth trigger condition that the UE performs BWP switching from a dormant BWP to a BWP which is not a dormant BWP.

[0013] In some implementations of the methods, the UE and the network entity, the UE may determine that the first trigger condition is fulfilled if one of the following is fulfilled: quality of the best beam among configured beams is less than a first configured threshold; a number of beams with quality less than a second configured threshold, among configured beams, is higher than a first configured number; or a number of beams with quality higher than a third configured threshold, among configured beams, is less than a second configured number.

[0014] In some implementations of the methods, the UE and the network entity, the request for the DL signal may be used to request one of: transmission or stopping transmission of an on-demand synchronization signal/PBCH block (SSB) for a secondary cell (SCell); triggering activation or deactivation of the SCell; or activation or deactivation of the SCell.

[0015] In some implementations of the methods, the UE and the network entity, the on-demand SSB may comprise one of: a configured SSB; a non-configured SSB; or a configured SSB and a non-configured SSB.

[0016] In some implementations of the methods, the UE and the network entity, the request for which on-demand SSB may be indicated by a sequence of the request or included in a medium access control-information element (MAC CE) or a radio resource control (RRC) message.

[0017] In some implementations of the methods, the UE and the network entity, the request for the DL signal may indicate at least one SCell for which the DL signal is requested.

[0018] In some implementations of the methods, the UE and the network entity, the request for the DL signal may indicate an identifier (ID) of the at least one SCell.

[0019] In some implementations of the methods, the UE and the network entity, the request for the DL signal may further indicates a cell group which the at least one SCell belongs to.

[0020] In some implementations of the methods, the UE and the network entity, the request for the DL signal may comprise a bitmap indicating the at least one SCell from a set of cells configured for the UE.

[0021] In some implementations of the methods, the UE and the network entity, the SCell may be a default SCell configured to the UE.

[0022] In some implementations of the methods, the UE and the network entity, the UE may receive, after transmitting the request, an indication indicative of a SCell for which the DL signal is transmitted; and receive the DL signal based on the received indication.

[0023] In some implementations of the methods, the UE and the network entity, the SCell is a cell provided by the network entity or a neighbor cell of the cell.

[0024] In some implementations of the methods, the UE and the network entity, the indication is further indicative of time-frequency resources for the DL signal and transmission pattern of the DL signal.

[0025] In some implementations of the methods, the UE and the network entity, the transmitted DL signal may comprise at least one of SSB or system information block (SIB).

[0026] In some implementations of the methods, the UE and the network entity, the request for the DL signal may be transmitted via an uplink signal, a wake up signal (WUS) or a random access channel (RACH).

[0027] In some implementations of the methods, the UE and the network entity, the network entity may transmit, to the UE, a configuration of allowing or not allowing to trigger the request for the DL signal.

[0028] In some implementations of the methods, the UE and the network entity, the network entity may transmit, after reception of the request, an indication indicative of a SCell for which the DL signal is transmitted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] FIG. 1 illustrates an example of a wireless communications system in which some embodiments of the present disclosure can be implemented.

[0030] FIG. 2 illustrates an example of a process flow for requesting a downlink signal in accordance with some example embodiments of the present disclosure.

[0031] FIG. 3 illustrates an example of a device that is suitable for implementing some embodiments of the present disclosure.

[0032] FIG. 4 illustrates an example of a processor that is suitable for implementing some embodiments of the present disclosure.

[0033] FIG. 5 illustrates a flowchart of a method that performed by a user equipment in accordance with aspects of the present disclosure.

[0034] FIG. 6 illustrates a flowchart of a method that performed by a network entity in accordance with aspects of the present disclosure.

[0035] Throughout the drawings, the same or similar reference numerals represent the same or similar elements.

DETAILED DESCRIPTION

[0036] 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 can be implemented in various manners other than the ones described below. 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.

[0037] 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.

[0038] 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. In some examples, values, procedures, or apparatuses are referred to as “best,” “lowest,” “highest,” “minimum,” “maximum,” or the like. It will be appreciated that such descriptions are intended to indicate that a selection among many used functional alternatives can be made, and such selections need not be better, smaller, higher, or otherwise preferable to other selections.

[0039] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of 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, components and/or the like, but do not preclude the presence or addition of one or more other features, elements, components and/or combinations thereof. For example, the term “includes” and its variants are to be read as open terms that mean “includes, but is not limited to.” The term “based on” is to be read as “based at least in part on.” The term “one embodiment” and “an embodiment” are to be read as “at least one embodiment.” The term “another embodiment” is to be read as “at least one other embodiment.” The use of an expression such as “A and/or B” can mean either “only A” or “only B” or “both A and B.” Other definitions, explicit and implicit, may be included below.

[0040] Aspects of the present disclosure are described in the context of a wireless communications system. FIG. 1 illustrates an example of a wireless communications system 100 in which some embodiments of the present disclosure can be implemented. The wireless communications system 100 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 100 may support various radio access technologies. In some implementations, the wireless communications system 100 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 100 may be a 5G network, such as an NR network. In other implementations, the wireless communications system 100 may be a combination of a 4G network and a 5G network, or other suitable radio access technology including Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20. The wireless communications system 100 may support radio access technologies beyond 5G. Additionally, the wireless communications system 100 may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

[0041] The one or more network entities 102 may be dispersed throughout a geographic region to form the wireless communications system 100. 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. In a 3GPP non-terrestrial network (NTN), a network entity 102 in form of a satellite can directly communicate to UE 104 using NR/LTE Uu interface. The satellite may be a transparent satellite or a regenerative satellite. For NTN with a transparent satellite, a base station on earth may communicate with a UE via the satellite. For NTN with a regenerative satellite, the base station may be on board and directly communicate with the UE.

[0042] 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.

[0043] The one or more UEs 104 may be dispersed throughout a geographic region of the wireless communications system 100. 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 100. In some other implementations, a UE 104 may be mobile in the wireless communications system 100.

In some other implementations, a UE 104 may be a UAV UE and may communicate with one or more network entities 102 while flying.

[0044] 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. 1. 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. 1. 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 100.

[0045] 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.

[0046] 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).

[0047] 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.

[0048] 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)).

[0049] 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.

[0050] 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).

[0051] 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.

[0052] 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.

[0053] 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).

[0054] In the wireless communications system 100, the network entities 102 and the UEs 104 may use resources of the wireless communications system 100 (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers)) to perform various operations (e.g., wireless 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.

[0055] One or more numerologies may be supported in the wireless communications system 100, 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.

[0056] 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.

[0057] 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 100. 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.

[0058] In the wireless communications system 100, an electromagnetic (EM) spectrum may be split, based on frequency or wavelength, into various classes, frequency bands, frequency channels, etc. By way of example, the wireless communications system 100 may support one or multiple operating frequency bands, such as frequency range designations FR1 (410 MHz – 7.125 GHz), FR2 (24.25 GHz – 52.6 GHz), FR3 (7.125 GHz – 24.25 GHz), FR4 (52.6 GHz – 114.25 GHz), FR4a or FR4-1 (52.6 GHz – 71 GHz), and FR5 (114.25 GHz – 300 GHz). In some implementations, 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.

[0059] 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.

[0060] FIG. 2 illustrates an example of a process flow for requesting a downlink (DL) signal in accordance with some example embodiments of the present disclosure. The process flow 200 may involve a UE 201 and a network entity (e.g. a base station) 202. The process flow 200 may be applied to the wireless communications system 100 with reference to FIG. 1, for example, the UE 201 may be any of UEs 104, and the network entity 202 may be any of the network entities 102. It would be appreciated that the process flow 200 may be applied to other communication scenarios.

[0061] At 210, the network entity 202 may optionally transmit, to the UE 201, a configuration 215 of allowing or not allowing to trigger the request for the DL signal. Accordingly, at 220, the UE 201 receives the configuration 215. By doing this, NW may configure the UE 201 with enabling or disabling the trigger request for the activation or deactivation of a secondary cell (SCell), or NW may configure the UE 201 with enabling or disabling to activate or deactivate the SCell. For example, the configuration 215 may be setup or release the request for on-demand SSB; or if the *onDemandSSB-Request* field is present, the UE 201 is allowed to request the SSB(s) on-demand e.g. transmission from the SCell while in RRC_CONNECTED.

[0062] At 230, the UE 201 determines whether at least one trigger condition of a request for the DL signal is fulfilled. The trigger condition may comprise one or more of: a beam quality based trigger condition, a timer based trigger condition, a traffic based trigger condition, a data volume based trigger condition, a remaining packet delay budget (PDB) based trigger condition, bandwidth parts (BWP) switching based trigger condition, or any combination thereof.

[0063] At 240, the UE 201 transmits, to the network entity 202, the request 245 for the DL signal based on determining that the at least one trigger condition is fulfilled. Accordingly, at 250, the network entity 202 receives the request 245 for the DL signal from the UE 201.

[0064] In some embodiments, the UE 201 may transmit the request 245 for the DL signal via an uplink signal, a wake up signal (WUS) or a random access channel (RACH). The request 245 for DL signal may be used to request transmission or stopping transmission of an on-demand synchronization signal/PBCH block (SSB) for one or more SCells. Additionally or alternatively, the request 245 may be used to request triggering activation or deactivation of the SCell(s). Additionally or alternatively, the request 245 may be used to request activation or deactivation of the SCell(s).

[0065] In some embodiments, the requested on-demand SSB may comprise the currently configured SSB(s), other SSB(s) not configured, or both of configured and non-configured SSB(s). In some embodiments, the request for which on-demand SSB may be indicated by a sequence of the request or included in a medium access control-information element (MAC CE) or a radio resource control (RRC) message. The request for on-demand SSB may be used to activate the SCell(s), or may be used to request a normal SSB (including more beams), or may be used to request more SSB transmission (more frequent transmission).

[0066] In this way, the UE 201 can request the DL signal in on-demand manner, and thus the DL signal can be transmitted or stopped from transmission according to UE's request. As such, network energy saving is achieved.

[0067] The trigger condition(s) may comprise a beam quality based trigger condition. According to the beam quality based trigger condition, if the UE 201 determines that it has low beam quality, it may request the DL signal from NW. Some criteria may be calculated to determine whether the UE 201 is in a low beam quality state.

[0068] In some embodiments, if the quality of the best beam among the configured beam(s) (one specific beam or multiple beams), e.g. reference signal received powers (RSRP) of the SSB, is lower than a configured threshold, the UE may determine it has low beam quality. Additionally or alternatively, the UE may be configured with a number, and if the number of bad beam (e.g. the quality of SSB is lower than a configured threshold), among configured beams, is larger than the configured number, the UE may

determine it has low beam quality and the request for on-demand SSB may be triggered. Additionally or alternatively, another number k may be configured to the UE; if there is only m (which is less than k) good beam(s) e.g. RSRP of the SSB is higher than a configured threshold measured by the UE, the UE may determine it has low beam quality and the request for on-demand SSB may be triggered.

[0069] Further, the request may be for the currently configured SSB or for other SSB or for more SSB including configured and not configured. The request may also be the transmission period for an on-demand SSB. In some embodiments, the request is for which SSB may be represented by a sequence of the request or included a medium access control-information element (MAC CE) or a radio resource control (RRC) message.

[0070] Regarding the timer based trigger condition, a timer/time windows/time duration may be configured to the UE. A request for on-demand SSB may be triggered, transmitted, or indicated to lower layer when the timer expires. Alternatively, a request for on-demand SSB is or can be triggered or transmitted or indicated to the lower layer when the timer expires and when the other trigger condition(s) in the disclosure is fulfilled.

[0071] In some embodiments, the timer may be used as a prohibit timer to avoid frequent request; if the timer is running, the UE is not allowed to trigger the request. Additionally or alternatively, the timer may be used as a trigger timer to avoid no request for a long period; for example, once the time expires, the UE triggers the request for DL signal. More than one timers are also possible, including the prohibit timer and the trigger timer.

[0072] The UE may start or restart the timer when a request for on-demand SSB is triggered, transmitted, or indicated to the lower layer. For example, if the timer is managed or configured by MAC layer and the request is sent by PHY layer, the request triggered by MAC layer and MAC layer may indicate the lower layer, e.g., PHY layer to send the request. As another example, if the timer is managed or configured by PHY layer and the request is sent by PHY layer, the request is triggered and/or transmitted by PHY layer directly.

[0073] The trigger condition may further be based on traffic arrival at the UE. In some embodiments, a request for on-demand SSB may be triggered, transmitted, or indicated to the lower layer if the number or frequency of UL/DL(e.g. paging for the UE is received)

traffic arrival is equal to or larger than a configured threshold within a configured timer or time window or time duration.

[0074] Regarding traffic based trigger condition, one or more specific traffic(s) logic channel(s) may be configured to the UE. If there is no more buffered data of the specific traffic(s) or logic channel(s), which means the demand for UL transmission is small, the UE may request to stop the SSB transmission of the SCell(s) or the UE may stop receiving the SSB; or alternatively, the UE may request to deactivate the SCell(s) or UE deactivates the SCell(s) autonomously.

[0075] Regarding data volume based trigger condition, one or more thresholds for data volume may be configured to the UE. The threshold(s) may be configured for the buffered data volume or the buffered remaining data volume. If the buffered data volume or the buffered remaining data volume is larger than the threshold, which means the demand for UL transmission is large, the request for on-demand SSB may be triggered, or the activation of the SCell(s) is triggered, or the SCell(s) is activated.

[0076] Regarding remaining PDB based trigger condition, one or more threshold(s) for remaining PDB may be configured to logical channel(s). If the remaining PDB of the logical channel or each packet associated with the logical channel is less than the threshold, which means there is time pressure for UL transmission and more resources are needed for transmission, the request for on-demand SSB may be triggered, or the request for activation of the SCell(s) may be triggered, or the SCell(s) may be activated.

[0077] Correspondingly, if the remaining PDB of the logical channel or each packet associated with the logical channel is larger than the threshold or larger than another threshold, which means there is no time pressure for UL transmission, the UE may request to stop the SSB transmission of the SCell(s), or UE may stop receiving the SSB(s); or alternatively, the UE may request to deactivate the SCell(s) or the UE may deactivate the SCell(s) autonomously.

[0078] Considering the potential BWP switching and the SSB configuration, it is possible that the UE performs BWP switching e.g. from the BWP associated with the SSB to the BWP not associated with the SSB to transmit different traffics. Regarding BWP based trigger condition, if the UE performs BWP switching to a BWP associated with the SSB, the request for on-demand SSB is triggered. Additionally or alternatively,

if UE performs BWP switching from a dormant BWP to a BWP which is not a dormant BWP, the request for on-demand SSB is triggered.

[0079] In some embodiments, if the UE performs BWP switching to the BWP associated with the SSB and one or more other trigger condition(s) described above is/are fulfilled, the request for on-demand SSB is triggered. Additionally or alternatively, if the UE performs BWP switching to the BWP associated with the SSB and the UE identifies its position changes, the request for on-demand SSB is triggered.

[0080] The UE may indicate the request is for which SCell(s), which may be SCell(s) of main cell group (MCG) or secondary cell group (SCG). In some embodiments, the request for the DL signal indicates at least one SCell for which the DL signal is requested. For example, the request for the DL signal may indicate an identifier(s) (ID) of the at least one SCell. The ID may be an index or PHY ID of the SCell(s).

[0081] If the index of the SCell(s) is repetitive across cell groups (CGs), the indication to which CG(s) the SCell(s) belongs may need to be identified. To this end, the request for the DL signal may further indicate a cell group which the at least one SCell belongs to using an additional indicator. In some embodiments, a binary value may be used to indicate the CG is MCG or SCG, for example, 0 means MCG and 1 means SCG. Further, the UE may indicate with 1 bit if there is only one on-demand SSB SCell is configured to the UE per CG (e.g. one SCell for MCG and/or one SCell for SCG).

[0082] In some embodiments, ID(s) may be included via a RACH or a message that is used to request the on-demand SSB. For example, the request for on-demand SSB MAC CE of flexible length may be identified by a MAC subheader with LCID. The SCell ID/index may be included in the MAC CE to indicate the request is for which SCell(s).

[0083] Additionally or alternatively, the request for the DL signal may comprise a bitmap indicating SCell(s) for which the DL signal is requested from a set of cells configured for the UE. As an example, the request for on-demand SSB MAC CE of one octet may be identified by a MAC subheader with logic cell ID (LCID). It has a fixed size and consists of a single octet containing seven C-fields and one R-field. The C-field (Ci) may be used to indicate the request is for which SCell(s). As another example, the request for on-demand SSB MAC CE of four octets may be identified by a MAC subheader with LCID. It has a fixed size and consists of four octets containing 31 C-fields and one R-field. The C-field (Ci) may be used to indicate the request is for which SCell(s).

[0084] In some embodiments, a default or specific cell may be configured to the UE, which is a SCell. The request for on-demand SSB means the UE requests the SSB transmission from the default cell. The UE does not need to indicate the SCell(s) in the request.

[0085] After the request for DL signal is transmitted, the UE may monitor or receive the potential DL transmission from NW, for example the UE monitors the SSB transmission, immediately. In some embodiments, the UE may further receive, after transmitting the request, an indication from NW and may monitor or receive the potential DL transmission according to the indication. The transmitted DL signal from NW may comprise at least one of SSB or system information block (SIB).

[0086] The indication may be indicative of one or more SCells for which the DL signal is transmitted. The SCell(s) may be a cell provided by a base station which receives the request, or a neighbor cell of that cell. Additionally, the indication may include time-frequency resources for the DL signal and the transmission pattern of the DL signal. The resources may be represented by at least one of the starting point or starting time, the period and/or offset of the DL signal, the transmission occasion of the DL signal, and others.

[0087] The DL transmission related indication may be configured or transmitted, e.g., in a predefined, preconfigured or common channel, search space, or resource, or by a system information from the SCell or a neighbour cell of the SCell e.g. another SCell(s) or PCell. The indication may be transmitted via a dedicated signaling/information element (IE), or the configuration is predefined.

[0088] FIG. 3 illustrates an example of a device that is suitable for implementing some embodiments of the present disclosure. The device 300 may be an example of a UE 104 or network entity 102 as described herein. The device 300 may support wireless communication with one or more network entities 102, UEs 104, or any combination thereof. The device 300 may include components for bi-directional communications including components for transmitting and receiving communications, such as a processor 302, a memory 304, a transceiver 306, and, optionally, an I/O controller 308. 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).

[0089] The processor 302, the memory 304, the transceiver 306, 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 302, the memory 304, the transceiver 306, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

[0090] In some implementations, the processor 302, the memory 304, the transceiver 306, 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 302 and the memory 304 coupled with the processor 302 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 302, instructions stored in the memory 304).

[0091] For example, the processor 302 may support wireless communication at the device 300 in accordance with examples as disclosed herein. The device 300 may be an example of a UE 104. In this case, the processor 302 may be configured to operable to support means for determining whether at least one trigger condition of a request for a downlink (DL) signal is fulfilled; and means for transmitting, to a network entity, the request for the DL signal based on determining that the at least one trigger condition is fulfilled.

[0092] The device 300 may be an example of a network entity 102, e.g. a network entity. In this case, the processor 302 may be configured to operable to support means for receiving, via the transceiver and from a user equipment (UE), a request for a DL signal, wherein the request for the DL signal is transmitted based on at least one trigger condition being fulfilled at the UE.

[0093] The processor 302 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 302 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 302. The processor 302 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 304) to cause the device 300 to perform various functions of the present disclosure.

[0094] The memory 304 may include random access memory (RAM) and read-only memory (ROM). The memory 304 may store computer-readable, computer-executable code including instructions that, when executed by the processor 302 cause the device 300 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 302 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 304 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.

[0095] The I/O controller 308 may manage input and output signals for the device 300. The I/O controller 308 may also manage peripherals not integrated into the device 300. In some implementations, the I/O controller 308 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 308 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 308 may be implemented as part of a processor, such as the processor 302. In some implementations, a user may interact with the device 300 via the I/O controller 308 or via hardware components controlled by the I/O controller 308.

[0096] In some implementations, the device 300 may include a single antenna 310. However, in some other implementations, the device 300 may have more than one antenna 310 (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 306 may communicate bi-directionally, via the one or more antennas 310, wired, or wireless links as described herein. For example, the transceiver 306 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 306 may also include a

modem to modulate the packets, to provide the modulated packets to one or more antennas 310 for transmission, and to demodulate packets received from the one or more antennas 310. The transceiver 306 may include one or more transmit chains, one or more receive chains, or a combination thereof.

[0097] 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 310 for transmitting the amplified signal into the air or wireless medium.

[0098] 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 310 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.

[0099] FIG. 4 illustrates an example of a processor 400 is suitable for implementing some embodiments of the present disclosure. The processor 400 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 400 may include a controller 402 configured to perform various operations in accordance with examples as described herein. The processor 400 may optionally include at least one memory 404. Additionally, or alternatively, the processor 400 may optionally include one or more arithmetic-logic units (ALUs) 406. 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).

[0100] The processor 400 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 400) 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).

[0101] The controller 402 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 400 to cause the processor 400 to support various operations in accordance with examples as described herein. For example, the controller 402 may operate as a control unit of the processor 400, generating control signals that manage the operation of various components of the processor 400. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0102] The controller 402 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 404 and determine subsequent instruction(s) to be executed to cause the processor 400 to support various operations in accordance with examples as described herein. The controller 402 may be configured to track memory address of instructions associated with the memory 404. The controller 402 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 402 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 400 to cause the processor 400 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 402 may be configured to manage flow of data within the processor 400. The controller 402 may be configured to control

transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 400.

[0103] The memory 404 may include one or more caches (e.g., memory local to or included in the processor 400 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementation, the memory 404 may reside within or on a processor chipset (e.g., local to the processor 400). In some other implementations, the memory 404 may reside external to the processor chipset (e.g., remote to the processor 400).

[0104] The memory 404 may store computer-readable, computer-executable code including instructions that, when executed by the processor 400, cause the processor 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. The controller 402 and/or the processor 400 may be configured to execute computer-readable instructions stored in the memory 404 to cause the processor 400 to perform various functions. For example, the processor 400 and/or the controller 402 may be coupled with or to the memory 404, the processor 400, the controller 402, and the memory 404 may be configured to perform various functions described herein. In some examples, the processor 400 may include multiple processors and the memory 404 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.

[0105] The one or more ALUs 406 may be configured to support various operations in accordance with examples as described herein. In some implementation, the one or more ALUs 406 may reside within or on a processor chipset (e.g., the processor 400). In some other implementations, the one or more ALUs 406 may reside external to the processor chipset (e.g., the processor 400). One or more ALUs 406 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 406 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 406 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 406 may support logical operations such as AND,

OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 406 to handle conditional operations, comparisons, and bitwise operations.

[0106] The processor 400 may support wireless communication in accordance with examples as disclosed herein. The processor 400 may implemented at a UE 104. In this case, the processor 400 may be configured to operable to support means for determining whether at least one trigger condition of a request for a downlink (DL) signal is fulfilled; and means for transmitting, to a network entity, the request for the DL signal based on determining that the at least one trigger condition is fulfilled.

[0107] The processor 400 may implemented at a network entity 102, e.g. a base station. In this case, the processor 400 may be configured to operable to support means for receiving, from a user equipment (UE), a request for a DL signal, wherein the request for the DL signal is transmitted based on at least one trigger condition being fulfilled at the UE.

[0108] FIG. 5 illustrates a flowchart of a method 500 performed by a UE in accordance with aspects of the present disclosure. The operations of the method 500 may be implemented by a device or its components as described herein. For example, the operations of the method 500 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.

[0109] At 510, the method may include determining whether at least one trigger condition of a request for a downlink (DL) signal is fulfilled. The operations of 510 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 510 may be performed by a UE 104 as described with reference to FIG. 1.

[0110] At 520, the method may include transmitting, to a network entity, the request for the DL signal based on determining that the at least one trigger condition is fulfilled. The operations of 520 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 520 may be performed by a UE 104 as described with reference to FIG. 1.

[0111] FIG. 6 illustrates a flowchart of a method 600 performed by a network entity in accordance with aspects of the present disclosure. The operations of the method 600 may be implemented by a device or its components as described herein. For example, the operations of the method 600 may be performed by a network entity 102 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.

[0112] At 610, the method may include receiving, from a user equipment (UE), a request for a DL signal, wherein the request for the DL signal is transmitted based on at least one trigger condition being fulfilled at the UE. The operations of 610 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 610 may be performed by a network entity 102 as described with reference to FIG. 1.

[0113] 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.

[0114] 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).

[0115] 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.

[0116] 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.

[0117] 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.

[0118] 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

1. A user equipment (UE) comprising:
 - a processor; and
 - a transceiver coupled to the processor,wherein the processor is configured to:
 - determine whether at least one trigger condition of a request for a downlink (DL) signal is fulfilled; and
 - transmit, via the transceiver and to a network entity, the request for the DL signal based on determining that the at least one trigger condition is fulfilled.
2. The UE of claim 1, wherein the processor is further configured to:
 - receive, from the network entity, a configuration of allowing or not allowing to trigger the request for the DL signal.
3. The UE of claim 1, wherein the at least one trigger condition comprise one or more of:
 - a first trigger condition that the UE has low beam quality;
 - a second trigger condition that a timer has expired, where the timer restarts when a request for the DL signal is transmitted;
 - a third trigger condition that a number or frequency of uplink (UL) or DL traffic arrival within a configured time window is equal to or larger than a first threshold;
 - a fourth trigger condition that there is no buffered data of a logic channel;
 - a fifth trigger condition that a volume of buffered data or remaining buffered data of a logic channel for UL transmission is larger than a second threshold or less than a third threshold, the third threshold being less than the second threshold;
 - a sixth trigger condition that a remaining packet delay budget (PDB) of a logic channel or each packet associated with the logic channel is larger than a fifth threshold or less than a sixth threshold, the sixth threshold being less than the fifth threshold;
 - a seventh trigger condition that the UE performs bandwidth parts (BWP) switching to a BWP associated with the DL signal; or
 - an eighth trigger condition that the UE performs BWP switching from a dormant BWP to a BWP which is not a dormant BWP.

4. The UE of claim 3, wherein the processor is further configured to:
determine that the first trigger condition is fulfilled if one of the following is fulfilled:

quality of the best beam among configured beams is less than a first configured threshold;

a number of beams with quality less than a second configured threshold, among configured beams, is higher than a first configured number; or

a number of beams with quality higher than a third configured threshold, among configured beams, is less than a second configured number.

5. The UE of claim 1, wherein the request for the DL signal is used to request one of:

transmission or stopping transmission of an on-demand synchronization signal/PBCH block (SSB) for a secondary cell (SCell);

triggering activation or deactivation of the SCell; or

activation or deactivation of the SCell.

6. The UE of claim 5, wherein the on-demand SSB comprises one of:

a configured SSB;

a non-configured SSB; or

a configured SSB and a non-configured SSB.

7. The UE of claim 6, wherein the request for which on-demand SSB is indicated by a sequence of the request or included in a medium access control-information element (MAC CE) or a radio resource control (RRC) message.

8. The UE of claim 1, wherein the request for the DL signal indicates at least one SCell for which the DL signal is requested.

9. The UE of claim 8, wherein the request for the DL signal indicates an identifier (ID) of the at least one SCell.

10. The UE of claim 8, wherein the request for the DL signal further indicates a cell group which the at least one SCell belongs to.

11. The UE of claim 8, wherein the request for the DL signal comprises a bitmap indicating the at least one SCell from a set of cells configured for the UE.

12. The UE of claim 5, wherein the SCell is a default SCell configured to the UE.

13. The UE of claim 1, wherein the processor is further configured to:
receive, after transmitting the request, an indication indicative of a SCell for which the DL signal is transmitted; and
receive the DL signal based on the received indication.

14. The UE of claim 13, wherein the SCell is a cell provided by the network entity or a neighbor cell of the cell.

15. The UE of claim 13, wherein the indication is further indicative of time-frequency resources for the DL signal and transmission pattern of the DL signal.

16. The UE of claim 13, wherein the transmitted DL signal comprises at least one of SSB or system information block (SIB).

17. The UE of claim 1, wherein the request for the DL signal is transmitted via an uplink signal, a wake up signal (WUS) or a random access channel (RACH).

18. A network entity comprising:
a processor; and
a transceiver coupled to the processor,
wherein the processor is configured to:
receive, via the transceiver and from a user equipment (UE), a request for a DL signal,
wherein the request for the DL signal is transmitted based on at least one trigger condition being fulfilled at the UE.

19. The network entity of claim 18, wherein the processor is further configured to:
transmit, to the UE, a configuration of allowing or not allowing to trigger the

request for the DL signal.

20. The network entity of claim 18, wherein the processor is further configured to:
transmit, after reception of the request, an indication indicative of a SCell for
which the DL signal is transmitted.