

SSB TRANSMISSION

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to a user equipment (UE), a base station, processors for wireless communication, methods, and non-transitory computer readable media for synchronization signal and physical broadcast channel (PBCH) block (SSB) transmissions.

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] In the wireless communications system, when a UE is accessing the network, the UE searches for synchronization signal and physical broadcast channel (PBCH) blocks (SSBs) to obtain a physical cell identification (ID), fulfil downlink (DL) synchronization, and obtain master information block (MIB). The SSBs are also used by the UEs for channel quality measurements. The UE may obtain configurations for detection of system information block type 1 (SIB1) based on the MIB in the SSB. Then, the UE may detect SIB1 based on the configurations to obtain the remaining system information. To meet the various improvements and requirements that accompany the

development of wireless communication technology, further study on SSB transmissions is still needed.

SUMMARY

[0004] The present disclosure relates to methods, apparatuses, and systems that support SSB transmissions. By monitoring a set of SSBs of a secondary cell or a subset of a set of SSBs of the secondary cell after receiving an indication of activating the secondary cell or an indication of activating SSB transmissions in the secondary cell, a scheme for on-demand SSB transmissions for UEs with carrier aggregation may be designed, and the power consumption for SSB transmissions may thus be reduced.

[0005] In a first aspect of the solution, a UE receives, from a base station, an indication of activating a secondary cell or an indication of activating synchronization signal and physical broadcast channel (PBCH) block (SSB) transmissions in a secondary cell. The UE monitors a set of SSBs of the secondary cell or a subset of a set of SSBs of the secondary cell. In this way, a scheme for on-demand SSB transmissions for UEs with carrier aggregation may be designed, and the power consumption for SSB transmissions may thus be reduced.

[0006] In some implementations of the methods and apparatuses described herein, the subset of the set of SSBs of the secondary cell is associated with a first SSB among a first plurality of SSBs of a primary cell based on an association between the first plurality of SSBs and a second plurality of SSBs of the secondary cell.

[0007] In some implementations of the methods and apparatuses described herein, the first plurality of SSBs may include one of the following: a maximum number of SSBs in the primary cell; or a set of SSBs of the primary cell indicated by a *ssb-PositionsInBurst* for the primary cell. The set of SSBs of the secondary cell is indicated by a *ssb-PositionsInBurst* for the secondary cell. The second plurality of SSBs may include one of the following: a maximum number of SSBs in the secondary cell; or the set of SSBs of the secondary cell.

[0008] Some implementations of the method and apparatuses described herein may further include: monitoring a configuration for the association. Monitoring the set of SSBs of the secondary cell or the subset of the set of SSBs of the secondary cell may include: monitoring the set of SSBs of the secondary cell in the absence of the

configuration; and monitoring the subset of the set of SSBs of the secondary cell in the case that the configuration is received.

[0009] In some implementations of the methods and apparatuses described herein, the configuration may include: an index of at least one SSB among the second plurality of SSBs associated with a SSB of the primary cell.

[0010] In some implementations of the methods and apparatuses described herein, the configuration may include at least one of the following: an offset between a first-indexed SSB of the primary cell and one of at least one SSB among the second plurality of SSBs associated with the first-indexed SSB of the primary cell; or a number of SSBs among the second plurality of SSBs associated with a same SSB of the primary cell. The subset of the set of SSBs of the secondary cell is based on an index of the first SSB of the primary cell associated with the subset and the configuration.

[0011] In some implementations of the methods and apparatuses described herein, the subset of the set of SSBs of the secondary cell is further based on: a number of SSBs in the first plurality of SSBs of the primary cell; and a number of SSBs in the second plurality of SSBs of the secondary cell.

[0012] Some implementations of the method and apparatuses described herein may further include: receiving, from the base station, an indication that the set of SSBs is to be transmitted in the secondary cell or an indication that the subset of the set of SSBs is to be transmitted in the secondary cell.

[0013] In some implementations of the methods and apparatuses described herein, the second plurality of SSBs of the secondary cell may include a plurality of SSB groups each associated with a corresponding SSB in the first plurality of SSBs of the primary cell. The subset of the set of SSBs may include one of the plurality of SSB groups associated with the first SSB of the primary cell.

[0014] In some implementations of the methods and apparatuses described herein, the association is based on: a number of SSBs in the first plurality of SSBs of the primary cell; and a number of SSBs in the second plurality of SSBs of the secondary cell.

[0015] Some implementations of the method and apparatuses described herein may further include: determining a time point for activating the SSB transmissions in the

secondary cell based on the reception of the indication of activating the secondary cell or the indication of activating the SSB transmissions in the secondary cell.

[0016] In some implementations of the methods and apparatuses described herein, monitoring the set of SSBs of the secondary cell may include: monitoring N sets of SSBs of the secondary cell after the time point before performing communication with the base station, wherein N is a positive integer. Some implementations of the method and apparatuses described herein may further include: receiving, from the base station, an indication of N .

[0017] In some implementations of the methods and apparatuses described herein, a first set of SSBs of the secondary cell is not included in the N sets of SSBs in the case that the time point is during a duration for transmissions of the first set of SSBs of the secondary cell.

[0018] In some implementations of the methods and apparatuses described herein, monitoring the subset of the set of SSBs of the secondary cell may include: monitoring M subsets of M sets of SSBs of the secondary cell after the time point before performing communication with the base station, wherein M is a positive integer. Some implementations of the method and apparatuses described herein may further include: receiving, from the base station, an indication of M .

[0019] In some implementations of the methods and apparatuses described herein, a first subset of a first set of SSBs of the secondary cell is not included in the M subsets of the M sets of SSBs in the case that the time point is during a duration for transmissions of the first subset of the first set of SSBs.

[0020] In some implementations of the methods and apparatuses described herein, a first subset of a first set of SSBs of the secondary cell is included in the M subsets of the M sets of SSBs in the case that the time point is during a duration for transmissions of the first set of SSBs and prior to a duration for transmissions of the first subset of the first set of SSBs.

[0021] In some implementations of the methods and apparatuses described herein, the indication of activating the secondary cell is carried in a medium access control (MAC) control element (CE) signaling.

[0022] In some implementations of the methods and apparatuses described herein, the indication of activating the SSB transmissions in the secondary cell is carried in a MAC CE signaling or in a downlink control information (DCI) signaling for the UE.

[0023] In some implementations of the methods and apparatuses described herein, the secondary cell is activated after the indication of activating the SSB transmissions is received.

[0024] In some implementations of the methods and apparatuses described herein, the indication of activating the SSB transmissions in the secondary cell is received. Some implementations of the method and apparatuses described herein may further include: monitoring an indication of activating the secondary cell in a time window after the reception of the indication of activating the SSB transmissions.

[0025] In some implementations of the methods and apparatuses described herein, a duration length of the time window is predefined or is configured by the base station.

[0026] In some implementations of the methods and apparatuses described herein, the indication of activating the SSB transmissions in the secondary cell is carried in a DCI signaling for a group of UEs comprising the UE.

[0027] Some implementations of the method and apparatuses described herein may further include: receiving, from the base station, an indication of deactivating the secondary cell; and continuing monitoring or skip monitoring SSB transmissions in the secondary cell based on a configuration from the base station.

[0028] Some implementations of the method and apparatuses described herein may further include: receiving, from the base station, an indication of deactivating the secondary cell; continuing monitoring SSB transmissions in the secondary cell in the absence of an indication of deactivating the SSB transmissions in the secondary cell; receiving, from the base station, an indication of deactivating the SSB transmissions in the secondary cell; and skipping monitoring SSB transmissions in the secondary cell.

[0029] Some implementations of the method and apparatuses described herein may further include: receiving, from the base station, an indication of deactivating the SSB transmissions in the secondary cell; and skipping monitoring SSB transmissions in the secondary cell, wherein the secondary cell is deactivated based on the indication of deactivating the SSB transmissions in the secondary cell.

[0030] In a second aspect of the solution, a base station transmits, to a UE, an indication of activating a secondary cell or an indication of activating synchronization signal and physical broadcast channel (PBCH) block (SSB) transmissions in a secondary cell. The base station transmits, to the UE, a set of SSBs of the secondary cell or a subset of a set of SSBs of the secondary cell. By transmitting a set of SSBs of a secondary cell or a subset of a set of SSBs of the secondary cell after transmitting an indication of activating the secondary cell or an indication of activating SSB transmissions in the secondary cell, a scheme for on-demand SSB transmissions for UEs with carrier aggregation may be designed, and the power consumption for SSB transmissions may thus be reduced in the base station.

[0031] In some implementations of the methods and apparatuses described herein, the subset of the set of SSBs of the secondary cell is associated with a first SSB among a first plurality of SSBs of a primary cell based on an association between the first plurality of SSBs and a second plurality of SSBs of the secondary cell.

[0032] In some implementations of the methods and apparatuses described herein, the first plurality of SSBs may include one of the following: a maximum number of SSBs in the primary cell; or a set of SSBs of the primary cell indicated by a `ssb-PositionsInBurst` for the primary cell. The set of SSBs of the secondary cell is indicated by a `ssb-PositionsInBurst` for the secondary cell. The second plurality of SSBs may include one of the following a maximum number of SSBs in the secondary cell; or the set of SSBs of the secondary cell.

[0033] In some implementations of the methods and apparatuses described herein, transmitting the set of SSBs of the secondary cell or the subset of the set of SSBs of the secondary cell may include: transmitting, to the UE, the set of SSBs of the secondary cell in the absence of transmitting a configuration for the association to the UE.

[0034] Some implementations of the method and apparatuses described herein may further include: transmitting, to the UE, a configuration for the association. Transmitting the set of SSBs of the secondary cell or the subset of the set of SSBs of the secondary cell may include: transmitting, to the UE, the subset of the set of SSBs of the secondary cell in the case that the configuration is transmitted.

[0035] In some implementations of the methods and apparatuses described herein, the configuration may include: an index of at least one SSB among the second plurality of SSBs associated with a first SSB of the primary cell.

[0036] In some implementations of the methods and apparatuses described herein, the configuration may include at least one of the following: an offset between a first-indexed SSB of the primary cell and one of at least one SSB among the second plurality of SSBs associated with the first-indexed SSB of the primary cell; or a number of SSBs among the second plurality of SSBs associated with a same SSB of the primary cell. The subset of the set of SSBs of the secondary cell is based on an index of the first SSB of the primary cell associated with the subset and the configuration.

[0037] In some implementations of the methods and apparatuses described herein, the subset of the set of SSBs of the secondary cell is further based on: a number of SSBs in the first plurality of SSBs of the primary cell; and a number of SSBs in the second plurality of SSBs of the secondary cell.

[0038] Some implementations of the method and apparatuses described herein may further include: transmitting, to the UE, an indication that the set of SSBs is to be transmitted in the secondary cell or an indication that the subset of the set of SSBs is to be transmitted in the secondary cell.

[0039] In some implementations of the methods and apparatuses described herein, the second plurality of SSBs of the secondary cell may include a plurality of SSB groups each associated with a corresponding SSB in the first plurality of SSBs of the primary cell. The subset of the set of SSBs may include one of the plurality of SSB groups associated with the first SSB of the primary cell.

[0040] In some implementations of the methods and apparatuses described herein, the association is based on: a number of SSBs in the first plurality of SSBs of the primary cell; and a number of SSBs in the second plurality of SSBs of the secondary cell.

[0041] Some implementations of the method and apparatuses described herein may further include: determining a time point for activating the SSB transmissions in the secondary cell based on the transmission of the indication of activating the secondary cell or the indication of activating the SSB transmissions in the secondary cell.

[0042] In some implementations of the methods and apparatuses described herein, transmitting the set of SSBs of the secondary cell may include: transmitting, to the UE, N sets of SSBs of the secondary cell after the time point before performing communication with the UE, wherein N is a positive integer. Some implementations of the method and apparatuses described herein may further include: transmitting, to the UE, an indication of N.

[0043] In some implementations of the methods and apparatuses described herein, a first set of SSBs of the secondary cell is not included in the N sets of SSBs in the case that the time point is during a duration for transmissions of the first set of SSBs of the secondary cell.

[0044] In some implementations of the methods and apparatuses described herein, transmitting the subset of the set of SSBs of the secondary cell may include: transmitting, to the UE, M subsets of M sets of SSBs of the secondary cell after the time point before performing communication with the UE, wherein M is a positive integer. Some implementations of the method and apparatuses described herein may further include: transmitting, to the UE, an indication of M.

[0045] In some implementations of the methods and apparatuses described herein, a first subset of a first set of SSBs of the secondary cell is not included in the M subsets of the M sets of SSBs in the case that the time point is during a duration for transmissions of the first subset of the first set of SSBs.

[0046] In some implementations of the methods and apparatuses described herein, a first subset of a first set of SSBs of the secondary cell is included in the M subsets of the M sets of SSBs in the case that the time point is during a duration for transmissions of the first set of SSBs and prior to a duration for transmissions of the first subset of the first set of SSBs.

[0047] In some implementations of the methods and apparatuses described herein, the indication of activating the secondary cell is carried in a medium access control (MAC) control element (CE) signaling.

[0048] In some implementations of the methods and apparatuses described herein, the indication of activating the SSB transmissions in the secondary cell is carried in a MAC CE signaling or in a downlink control information (DCI) signaling for the base station.

[0049] In some implementations of the methods and apparatuses described herein, the secondary cell is activated after the indication of activating the SSB transmissions is transmitted.

[0050] In some implementations of the methods and apparatuses described herein, the indication of activating the SSB transmissions in the secondary cell is transmitted, and Some implementations of the method and apparatuses described herein may further include: transmitting, to the UE, an indication of activating the secondary cell in a time window after the transmission of the indication of activating the SSB transmissions.

[0051] In some implementations of the methods and apparatuses described herein, a duration length of the time window is predefined or associated with a configuration transmitted to the UE.

[0052] In some implementations of the methods and apparatuses described herein, the indication of activating the SSB transmissions in the secondary cell is carried in a DCI signaling for a group of UEs comprising the UE.

[0053] Some implementations of the method and apparatuses described herein may further include: transmitting, to the UE, a configuration of continuing monitoring or skipping monitoring SSB transmissions in the secondary cell after receiving an indication of deactivating the secondary cell.

BRIEF DESCRIPTION OF THE DRAWINGS

[0054] FIG. 1A illustrates an example of a wireless communications system that supports SSB transmissions in accordance with aspects of the present disclosure.

[0055] FIG. 1B illustrates an example structure of a SSB in time domain and frequency domain in related solutions.

[0056] FIG. 1C illustrates an example diagram of a full set of SSBs that is periodically transmitted in related solutions.

[0057] FIG. 1D illustrates an example diagram of SSB transmissions in a secondary cell (SCell) in related solutions.

[0058] FIG. 2 illustrates an example signaling chart of an example process that supports SSB transmissions in accordance with aspects of the present disclosure.

[0059] FIG. 3 illustrates an example diagram of a SSB association between a primary cell (PCell) and an SCell in accordance with aspects of the present disclosure.

[0060] FIG. 4A illustrates an example diagram of a case where the full set of SSBs in an SCell is monitored after the SCell is activated in accordance with aspects of the present disclosure.

[0061] FIG. 4B illustrates an example diagram of a case where an associated part of the full set of SSBs in an SCell is monitored after the SCell is activated in accordance with aspects of the present disclosure.

[0062] FIG. 5A illustrates an example diagram of a case where the SSB transmission is activated by a group common DCI in accordance with aspects of the present disclosure.

[0063] FIG. 5B illustrates an example diagram of a case where the SSB transmission is activated by a UE specific signaling in accordance with aspects of the present disclosure.

[0064] FIG. 6 illustrates an example of a device that supports SSB transmissions in accordance with aspects of the present disclosure.

[0065] FIG. 7 illustrates an example of a processor that supports SSB transmissions in accordance with aspects of the present disclosure.

[0066] FIGS. 8 through 11 illustrate flowcharts of methods that support SSB transmissions in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

[0067] 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.

[0068] 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.

[0069] 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.

[0070] 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.

[0071] 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. 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.

[0072] As used herein, the term “communication network” refers to a network following any suitable communication standards, such as, 5G 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 terminal device 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.

[0073] As used herein, the term “network device” generally refers to a node in a communication network via which a terminal device 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), an 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.

[0074] As used herein, the term “terminal device” generally refers to any end device that may be capable of wireless communications. By way of example rather than a limitation, a terminal device may also be referred to as a communication device, to a user equipment (UE), 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 terminal device 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 terminal device, a personal digital assistant (PDA), a portable computer, a desktop computer, an image capture terminal device such as a digital camera, a gaming terminal device, a music storage and playback appliance, a vehicle-mounted wireless

terminal device, 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: “terminal device,” “communication device,” “terminal,” “user equipment” and “UE,” may be used interchangeably.

[0075] As mentioned above, in a NR initial access procedure, a SSB is used in NR for radio resource control (RRC) idle/inactive UEs to synchronize to the cell, get the cell ID and obtain the necessary information for accessing the cell. A SSB is also used by in NR RRC connected UEs to maintain the synchronization to the network and to obtain the channel status and so on. The SSBs are transmitted periodically in a beam sweeping way. In current NR, for a UE that is configured with multiple carriers, in which one carrier is a PCell and other carriers are SCells, the UE assumes that SSBs are always transmitted in an SCell even when the SCell is deactivated. In other words, the UE always synchronizes to the SCell and is always ready to receive/transmit data signal when the SCell is activated. However, this is a burden for the base station since power should be consumed for SSB transmissions in the SCell even when the SCell is not used for data transmission. Techniques of on-demand SSB for SCell can be used to reduce the power consumption of the base station. The base station does not need to transmit SSBs in the SCell unless it is needed to do so. Enhancements on on-demand SSB transmissions for SCell need to be further studied.

[0076] Aspects of the present disclosure are described in the context of a wireless communications system. FIG. 1A illustrates an example of a wireless communications system 100 that supports SSB transmissions in accordance with aspects of the present disclosure. 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.

[0077] 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.

[0078] 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.

[0079] 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.

[0080] 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 100.

[0081] 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.

[0082] 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).

[0083] 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.

[0084] 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)).

[0085] 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.

[0086] 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).

[0087] 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.

[0088] 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.

[0089] 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).

[0090] 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.

[0091] 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.

[0092] 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.

[0093] 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.

[0094] 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.

[0095] 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., =0), which includes 15 kHz subcarrier spacing; a second numerology (e.g., =1), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., =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., =2), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., =3), which includes 120 kHz subcarrier spacing.

[0096] For the purpose of illustration without suggesting any limitations, some embodiments of the present disclosure will be described with reference to the scenario that a UE 104 monitors SSB transmissions from a network entity 102. It is to be understood that the disclosure described herein may be implemented in various manners other than the ones described below.

[0097] FIG. 1B illustrates an example structure of a SSB in time domain and frequency domain in related solutions. A SSB occupies 4 consecutive OFDM symbols in time domain and 20 resource blocks (RBs) (totally 240 subcarriers) in frequency domain. consists of primary synchronization signal (PSS), secondary synchronization signal (SSS) and physical broadcast channel (PBCH), which carries MIB. The PSS/SSS occupies 12 RBs (including the guard REs) and the PBCH occupies the whole 20 RBs.

[0098] FIG. 1C illustrates an example diagram of a full set of SSBs that is periodically transmitted in related solutions. The network device may transmit a full set of SSBs in a beam sweeping way, where each SSB is transmitted by a specific beam. As shown in FIG. 1C, a full set of SSBs 120 may comprise six SSBs, namely, SSB#0 120-1, SSB#1

120-2, SSB#2 120-3, SSB#3 120-4, SSB#4 120-5 and SSB#5 120-6. By applying beamforming for the SSBs, the coverage of the SSB transmissions is enhanced. The SSBs are transmitted in a time domain multiplexing fashion. The full set of SSBs 120 are always confined to a half frame, i.e., 5ms, either in the first or the second half of a 10ms frame. The half frames containing the transmitted SSBs occur every $N (=20/40/80\dots)$ ms. In the following description, the terms: “a full set of SSBs,” “a set of SSBs” and “a SSB burst set” may be used interchangeably.

[0099] The number of SSBs in the full set of SSBs in FIG. 1C is merely for illustration. The full set of SSBs may comprise various number of SSBs transmitted periodically in a beam sweeping way. The set of SSBs that are transmitted using different beams are indexed. According to 3GPP specification, the maximum number of SSB indexes (denoted as $L_{\max}$) is different for different frequency bands. For example, for frequency bands below 3GHz, $L_{\max} = 4$; for frequency bands between 3GHz and 6GHz, $L_{\max} = 8$, etc. In practice, the network device can freely choose which SSBs out of the $L_{\max}$ SSBs are actually to be transmitted. The actual transmitted SSBs are indicated to the UE through a configuration `ssb-PositionsInBurst`, which is contained either in SIB1 (for PCell) or in a UE specific RRC signalling (`ServingCellConfigCommon` in `cellGroupConfig`). As defined in TS38.331, for operations in licensed spectrum, `ssb-PositionsInBurst` indicates the time domain positions of the transmitted SS-blocks in a half frame with SS/PBCH blocks as defined in TS 38.213, clause 4.1. The first/leftmost bit of `ssb-PositionsInBurst` corresponds to SS/PBCH block index 0, the second bit of `ssb-PositionsInBurst` corresponds to SS/PBCH block index 1, and so on. Value 0 in the bitmap indicates that the corresponding SS/PBCH block is not transmitted while value 1 indicates that the corresponding SS/PBCH block is transmitted.

[0100] In current NR, for a UE that is configured with multiple carriers including one PCell and at least one SCell, the UE assumes that SSBs are always transmitted in an SCell even when the SCell is deactivated. In other words, the UE always synchronizes to the SCell and is always ready to receive/transmit data signal when the SCell is activated. However, this is a burden for the network device since power should be consumed for SSB transmissions in the SCell even when the SCell is not used for data transmission.

[0101] FIG. 1D illustrates an example diagram of SSB transmissions in an SCell in related solutions. As shown in FIG. 1D, in a legacy SCell, a full set of SSBs (e.g., eight

indexed SSBs) are always transmitted even when the SCell is not used for data transmission. In a network energy saving (NES) SCell, SSBs are not transmitted before the network device transmits a SSB triggering signaling. However, further research is needed on solutions for on-demand SSB transmissions for SCell to reduce the power consumption of the network device for SSB transmissions.

[0102] In view of the above and other aspects, embodiments of the present disclosure provide solutions for SSB transmissions. In one solution, a UE receives, from a base station, an indication of activating a secondary cell or an indication of activating SSB transmissions in a secondary cell. The UE monitors a set of SSBs of the secondary cell or a subset of a set of SSBs of the secondary cell. By monitoring a set of SSBs of a secondary cell or a subset of a set of SSBs of the secondary cell after receiving an indication of activating the secondary cell or an indication of activating SSB transmissions in the secondary cell, a scheme for on-demand SSB transmissions for UEs with carrier aggregation may be designed, and the power consumption for SSB transmissions may thus be reduced.

[0103] FIG. 2 illustrates an example signaling chart of an example process 200 that supports SSB transmissions in accordance with aspects of the present disclosure. For the purpose of discussion, the process 200 will be described with reference to FIG. 1A, and the process 200 may involve a UE 104 and a network entity 102 as shown in FIG. 1A. The network entity 102 may be also referred to as the base station 102. It is to be understood that the steps and the order of the steps in FIG. 2 are merely for illustration, and not for limitation. It is to be understood that process 200 may further include additional blocks not shown and/or omit some shown blocks, and the scope of the present disclosure is not limited in this regard.

[0104] As shown in FIG. 2, the base station 102 transmits 202 an indication 204 of activating a secondary cell or an indication 206 of activating SSB transmissions in a secondary cell to the UE 104. Accordingly, the UE 104 receives the indication 204 of activating the secondary cell or the indication 206 of activating SSB transmissions in the secondary cell. For example, assuming that an RRC connected UE is configured with multiple carriers, one carrier is configured as the PCell and other carriers are SCells. An SCell is deactivated and SSBs are not transmitted in the deactivated SCell. In some cases, an indication of activating the SCell may be transmitted to activate the SSB transmission

in the SCell. In other words, the SSBs may be triggered to be transmitted once the UE 104 receives an SCell activation command. In some cases, an indication of activating SSB transmissions in the SCell may be transmitted to activate the SSB transmission in the SCell. In other words, the SSBs may be triggered to be transmitted once the UE 104 receives a dedicated signaling for the SSB transmission activation.

[0105] The base station 102 transmits 210 a set of SSBs 212 of the secondary cell or a subset 214 of a set of SSBs of the secondary cell. The UE 104 monitors 216 the set of SSBs 212 of the secondary cell or the subset 214 of the set of SSBs of the secondary cell. In the following description, the terms: “a subset of a full set of SSBs,” “a subset of a set of SSBs,” “a subset of SSBs” and “part of SSBs” may be used interchangeably.

[0106] In some cases, when the SCell is to be activated for data transmission/reception, the base station 102 may transmit a full set of SSBs (i.e., SSBs configured in `ssb-PositionsInBurst`) of the SCell.

[0107] In some cases, when the SCell is to be activated for data transmission/reception, the base station 102 may transmit only part of SSBs among the full set of SSBs of the SCell. Correspondingly, when the UE 104 receives a signaling to trigger SSB transmission, the UE 104 may only need to monitor the part of SSBs among the full set of SSBs of the SCell. In this way, the energy in both base station side and UE side on SSB transmission and reception is reduced compared with transmission/reception of full set of SSBs in `ssb-PositionsInBurst`.

[0108] In some cases, when the SCell is to be activated for data transmission/reception, the base station 102 may transmit either a full set of SSBs of the SCell or only part of SSBs among the full set of SSBs of the SCell. Correspondingly, when the UE 104 receives a signaling to trigger SSB transmission, the UE 104 may monitor either the full set of SSBs or the part of SSBs, e.g., based on a configuration or an indication from the base station 102.

[0109] Some implementations of the on-demand SSB transmissions for SCell will be described in regard to various specific aspects. A first specific aspect relates to reducing the number of SSBs transmission and further reducing the power consumption of base station.

[0110] In some embodiments, the subset 214 of the set of SSBs of the secondary cell may be associated with a first SSB among a first plurality of SSBs of a primary cell based on an association between the first plurality of SSBs and a second plurality of SSBs of the secondary cell. In other words, to determine the part of SSBs transmitted for the UE, an association may be established between the SSBs that are transmitted in the PCell and the SSBs transmitted in the SCell. The association may be defined such that the coverage of the part of SSBs in the SCell is similar with (or containing) the coverage of the associated SSB in the PCell. By monitoring the subset of SSBs, the power consumption of base station may be further reduced.

[0111] In a more specific example, if in a PCell, a specific SSB corresponds to the best channel status for the UE, then in a SCell, one SSB in the part of SSBs associated with the specific SSB of the PCell will correspond to the best channel status in the SCell as well. In other words, the UE 104 could always find the best SSB from the associated part of SSBs of the SCell.

[0112] In some embodiments, the subset of the set of SSBs of the secondary cell may be indicated by a UE specific signaling, such as a RRC signaling, a MAC signaling or a physical signaling.

[0113] In some embodiments, the first plurality of SSBs may include a maximum number of SSBs in the primary cell. In some other embodiments, the first plurality of SSBs may include a set of SSBs of the primary cell indicated by a `ssb-PositionsInBurst` for the primary cell.

[0114] The set of SSBs 212 of the secondary cell is indicated by a `ssb-PositionsInBurst` for the secondary cell. In some embodiments, the second plurality of SSBs may include a maximum number of SSBs in the secondary cell. In some embodiments, the second plurality of SSBs may include a set of SSBs of the secondary cell indicated by a `ssb-PositionsInBurst` for the secondary cell, i.e., the set of SSBs of the secondary cell.

[0115] In other words, the SSB association between the PCell and the SCell may be based on one of the SSB set 1 and the SSB set 2 and one of the SSB set 3 and the SSB set 4. The SSB set 1 contains the maximum number of SSBs supported by the PCell, i.e., $L_{\max}$ SSBs of the PCell. The SSB set 2 contains the SSBs defined in `ssb-`

PositionsInBurst of the PCell, i.e., the full set of SSBs of the PCell. The SSB set 3 contains the maximum number of SSBs supported by the SCell, i.e., $L_{\max}$ SSBs of the SCell. The SSB set 4 contains the SSBs defined in `ssb-PositionsInBurst` of the SCell, i.e., the full set of SSBs of the SCell.

[0116] In some embodiments, the UE 104 may further monitor a configuration for the association. The UE 104 may determine to monitor the set of SSBs 212 of the secondary cell or to monitor the subset 214 of the set of SSBs of the secondary cell based on whether the configuration for the association is received. For example, the UE 104 may monitor the set of SSBs 212 of the secondary cell in the absence of the configuration for the association. The UE 104 may monitor the subset 214 of the set of SSBs of the secondary cell in the case that the configuration for the association is received.

[0117] In other words, from UE side, whether to monitor the full set of SSBs or the part of SSBs may be based on a configuration for an SSB association. For example, the SSB association may be established in base station side based on the factors such as cell and beam planning. The base station 102 may transmit a configuration that is related with the SSB association through either system information signaling, UE specific RRC signaling, or MAC signaling or PHY signaling. Based on the configuration, the UE 104 could determine the SSB association and then the base station 102 and the UE 104 may have the same understanding on the SSB association.

[0118] In some embodiments, the configuration for the association may include an index of at least one SSB among the second plurality of SSBs associated with a SSB of the primary cell. In other words, the base station 102 may transmit a configuration explicitly indicating the SSB(s) of the SCell associated with each SSB of the PCell. For example, for each SSB of SSB set 2 in the PCell, the configuration explicitly indicates the associated SSB(s) of the SCell. For example, a SSB k of PCell (e.g., in SSB set 2) might be configured to be associated with a subset of SSBs in SSB set 4 of SCell, where the indexes of the subset of SSBs are indicated in the configuration.

[0119] In some embodiments, the configuration may include an offset between a first-indexed SSB of the primary cell and one of at least one SSB among the second plurality of SSBs associated with the first-indexed SSB of the primary cell. The SSB index offset may be used to determine the first-indexed SSB of the SCell that is associated with a SSB in the PCell. The subset 214 of the set of SSBs of the secondary cell may be based on an

index of the first SSB of the primary cell associated with the subset and the configuration. For example, assuming the SSB offset is N_offset , then the first-indexed SSB of SCell that is associated with SSB 0 of PCell would be SSB $0+N_offset$. In some further embodiments, the subset 214 of the set of SSBs of the secondary cell may be further based on a number of SSBs in the first plurality of SSBs of the primary cell and a number of SSBs in the second plurality of SSBs of the secondary cell. For example, assuming the SSB offset is N_offset , the first SSB of SCell that is associated with SSB m of PCell is SSB $m*K + N_offset$, where K is equal to the number of SSBs in SSB set 3 (or SSB set 4) of the SCell divided by the number of SSBs in SSB set 1 (or SSB set 2) of the PCell.

[0120] In some embodiments, the configuration may include a number of SSBs among the second plurality of SSBs associated with a same SSB of the primary cell. The subset 214 of the set of SSBs of the secondary cell may be based on an index of the first SSB of the primary cell associated with the subset and the configuration. In some further embodiments, the subset 214 of the set of SSBs of the secondary cell may be further based on a number of SSBs in the first plurality of SSBs of the primary cell and a number of SSBs in the second plurality of SSBs of the secondary cell. For example, the first SSB of SCell that is associated with SSB m of PCell is SSB $m*K$ and the last SSB of SCell that is associated with SSB m of PCell is SSB $m*K + nAssociatedSSB$, where K is equal to the number of SSBs in SSB set 3 (or SSB set 4) of the SCell divided by the number of SSBs in SSB set 1 (or SSB set 2) of the PCell, and where $nAssociatedSSB$ is the number of SSBs in the part of SSBs of the SCell associated with a SSB of the PCell, which is configured by the base station 102. If $nAssociatedSSB$ is larger than K , then the two subsets of SSBs associated with two neighboring SSBs of the PCell is overlapped.

[0121] FIG. 3 illustrates an example diagram of a SSB association between a PCell and an SCell in accordance with aspects of the present disclosure. Assuming $L_{max} = 8$ in PCell and $L_{max} = 64$ in SCell. In other words, SSB set 1 in PCell contains 8 SSBs and SSB set 3 in SCell contains 64 SSBs. In the example shown in FIG. 3, the SSB set 2 of the PCell includes SSB $\{0,1,3,4,6,7\}$ and the SSB set 4 of the SCell includes SSB $\{0,1,2,4,6,7,8,9,11,12,13,14,16,17,18, \dots, 56,58,59,61,62,63\}$. The SSB association may be established such that each SSB in the SSB set 1 of the PCell is associated with 12 SSBs in the SSB set 3 of SCell. In other words, $nAssociatedSSB = 12$. For example, SSB 0 of the PCell is associated with SSB #0~#11 of the SCell, SSB 1 of PCell is associated with

SSB #8~#19 of the SCell, and so on. There are four overlapped SSBs between two parts of SSBs that are associated with two consecutive SSBs in the PCell.

[0122] Turning back to FIG. 2, in some embodiments, the configuration may include: an offset between a first-indexed SSB of the primary cell and one of at least one SSB among the second plurality of SSBs associated with the first-indexed SSB of the primary cell; and a number of SSBs among the second plurality of SSBs associated with a same SSB of the primary cell. The subset 214 of the set of SSBs of the secondary cell is based on an index of the first SSB of the primary cell associated with the subset and the configuration. In some further embodiments, the subset 214 of the set of SSBs of the secondary cell may be further based on a number of SSBs in the first plurality of SSBs of the primary cell and a number of SSBs in the second plurality of SSBs of the secondary cell. The SSB index offset is used to determine the first-indexed SSB of the SCell that is associated with a SSB in the PCell. For example, the first SSB of SCell that is associated with SSB m of PCell is $\text{SSB } m * K + N_{\text{offset}}$ and the last SSB of SCell that is associated with SSB m of PCell is $\text{SSB } m * K + N_{\text{offset}} + n_{\text{AssociatedSSB}}$, where K is equal to the number of SSBs in SSB set 3 (or SSB set 4) of SCell divided by the number of SSBs in SSB set 1 (or SSB set 2) in PCell, and where $n_{\text{AssociatedSSB}}$ is the number of SSBs in the part of SSBs of the SCell associated with a SSB of the PCell, which is configured by the base station 102.

[0123] As another example, assuming the SSB offset is N_{offset} , then the first SSB of SCell that is associated with SSB 0 of PCell would be $\text{SSB } 0 + N_{\text{offset}}$ and the first SSB of SCell that is associated with SSB k of PCell is $\text{SSB } k * n_{\text{AssociatedSSB}} + N_{\text{offset}}$, where $n_{\text{AssociatedSSB}}$ is the number of SSBs in the part of SSBs of the SCell associated with a SSB of the PCell, which is either implicitly determined or is configured by the base station 102.

[0124] In some embodiments, the UE 104 may further receive, from the base station 102, an indication that the set of SSBs 212 is to be transmitted in the secondary cell or an indication that the subset 214 of the set of SSBs is to be transmitted in the secondary cell. In other words, from UE side, whether to monitor the full set of SSBs or the part of SSBs may be based on an indication. For example, the base station 102 may transmit a 1-bit indication to the UE 104. If the 1-bit indication is “1”, the UE 104 assumes part of SSBs will be transmitted by the base station 102. If the 1-bit indication is “0”, the UE 104

assumes the full set of SSBs will be transmitted by the base station 102. The association of the SSBs between the PCell and the SCell may be established based on a predefined rule.

[0125] In some embodiments, the second plurality of SSBs of the secondary cell may include a plurality of SSB groups each associated with a corresponding SSB in the first plurality of SSBs of the primary cell. The subset 214 of the set of SSBs may include one of the plurality of SSB groups associated with the first SSB of the primary cell. For example, the SSB association may be based on SSB grouping in the SCell. For example, the SSBs in either SSB set 3 or SSB set 4 of the SCell may be divided to be groups and each SSB (e.g., in SSB set 2) in the PCell is associated with a SSB group of the SCell.

[0126] In some further embodiments, the association may be based on a number of SSBs in the first plurality of SSBs of the primary cell and a number of SSBs in the second plurality of SSBs of the secondary cell. For example, the number of SSB groups of the SCell is same with the number of SSBs in the SSB set 1 or SSB set 2 of the PCell. Each SSB group contains K SSBs, where K is equal to the number of SSBs in SSB set 3 (or SSB set 4) of the SCell divided by the number of SSBs in SSB set 1 (or SSB set 2) of the PCell.

[0127] A second specific aspect relates to the procedures of interaction of SSB activation/deactivation and SCell activation/deactivation. In some embodiments, the SSBs (either the full set of SSBs or the part of SSBs) may be triggered to be transmitted once the UE 104 receives the indication 204 of activating the secondary cell (i.e., an SCell activation command). In other embodiments, the SSBs (either the full set of SSBs or the part of SSBs) may be triggered to be transmitted once the UE 104 receives the indication 206 of activating SSB transmissions in the secondary cell (i.e., a dedicated signaling for the SSB transmission activation).

[0128] In some embodiments, the indication 204 of activating the secondary cell may be carried in a medium access control (MAC) control element (CE) signaling. In some embodiments, the indication 206 of activating the SSB transmissions in the secondary cell may be carried in a MAC CE signaling or in a downlink control information (DCI) signaling for the UE 104 or in a DCI signaling for a group of UEs comprising the UE 104. In other words, the dedicated signaling for the SSB transmission activation could

either be MAC signaling or UE specific DCI signaling (i.e., dedicated to the UE 104) or group UE specific DCI signaling (i.e., the DCI is dedicated for a group of UEs).

[0129] In some embodiments, the UE 104 may further determine a time point for activating the SSB transmissions in the secondary cell based on the reception of the indication 204 of activating the secondary cell or the indication 206 of activating the SSB transmissions in the secondary cell. For example, upon detecting an SCell activation command or a DCI or MAC CE for triggering SSB transmissions, the UE 104 may assume that the SSB transmissions are activated after a predefined or configured timing. For ease of illustration, the time point where the SSBs are activated may be referred to as an SSB activation time point.

[0130] In some embodiments, when monitoring the set of SSBs 212 of the secondary cell, the UE 104 may monitor N sets of SSBs of the secondary cell after the time point before performing channel/signal transmission and reception with the base station 102, wherein N is a positive integer. In some embodiments, an indication of N may be received by the UE 104 from the base station 102. In this way, the power consumption for SSB transmissions is reduced with a limited latency for channel/signal transmission. In some embodiments, the UE may assume the SCell is not activated before monitoring N set of SSBs.

[0131] For example, when the SCell is activated or when the UE 104 receives a dedicated signaling for the SSB transmission activation, the UE 104 shall firstly monitor SSBs in a time period before performing channel/signal transmission and reception in the SCell. The time period may contain N SSB burst sets for the UE 104 to synchronize to the SCell. The value N may depend on the channel status and thus can be up to the configuration from the base station 102. Typically the better the channel status, the smaller N value can be configured.

[0132] In some embodiments, a first set of SSBs of the secondary cell may be not included in the N sets of SSBs if the time point is during a duration for transmissions of the first set of SSBs of the secondary cell. In an example, implementation, depending on when the base station 102 transmits a SSB triggering signaling (e.g., the SCell activation signaling or the dedicated signaling for the SSB transmission activation), the SSB activation time point may or may not be within the duration where an SSB burst set of the SCell is transmitted. For the case that the UE 104 monitors a full set of SSBs after

receiving the SSB triggering signaling, if the SSB activation time point is within the duration of an SSB burst set, the UE 104 does not assume that the SSB burst set will be transmitted by the base station 102. That is to say, this SSB burst set is not counted in the N SSB burst sets for the UE 104 to synchronize to the SCell. The rationale behind it is that it is not sure if the SSBs that are transmitted after the SSB activation time point and are within the SSB burst set could correspond to a good channel status of the UE.

[0133] In some embodiments, when monitoring the subset 214 of the set of SSBs of the secondary cell, the UE 104 may monitor M subsets of M sets of SSBs of the secondary cell after the time point before performing communication with the base station 102, wherein M is a positive integer. In some embodiments, an indication of M may be received by the UE 104 from the base station 102. In this way, the power consumption for SSB transmissions is reduced with a limited latency for channel/signal transmission.

[0134] For example, when the SCell is activated or when the UE 104 receives dedicated signaling for the SSB transmission activation, the UE 104 shall firstly monitor SSBs in a time period before performing channel/signal transmission and reception in the SCell. The time period may contain M subsets of SSBs for the UE 104 to synchronize to the SCell. The value M may depend on the channel status and thus can be up to the configuration from the base station 102. Typically the better the channel status, the smaller M value can be configured.

[0135] In some embodiments, a first subset of a first set of SSBs of the secondary cell may be not included in the M subsets of the M sets of SSBs if the time point is during a duration for transmissions of the first subset of the first set of SSBs. In some embodiments, a first subset of a first set of SSBs of the secondary cell is included in the M subsets of the M sets of SSBs if the time point is during a duration for transmissions of the first set of SSBs and prior to a duration for transmissions of the first subset of the first set of SSBs.

[0136] In an example, implementation, depending on when the base station 102 transmits a SSB triggering signaling, the SSB activation time point may or may not be within the duration where a subset of SSBs of the SCell is transmitted. For the case that the UE 104 monitors an associated part of SSBs after receiving the SSB triggering signaling, if the SSB activation time point is within the duration of an SSB burst set, and is happened before the associated part of SSBs, the UE 104 assumes that the SSB burst

set will be transmitted by the base station 102. That is to say, this SSB burst set is counted in the M SSB burst sets for the UE 104 to synchronize to the SCell. Otherwise, the UE 104 does not assume that the SSB burst set will be transmitted by the base station 102.

[0137] In some embodiments, the UE 104 may determine to monitor the set of SSBs 212 of the secondary cell or the subset 214 of the set of SSBs of the secondary cell, e.g., based on a configuration or an indication from the base station 102. In some implementations, the number N of the sets of SSBs to be monitored in the time period and the number M of the subsets of SSBs to be monitored in the time period may be the same. For example, the base station 102 may only transmit an indication of N to the UE 104. The UE 104 may monitor N sets of SSBs of the secondary cell after the time point before performing communication with the base station 102 when monitoring the set of SSBs 212 of the secondary cell, and may monitor N subsets of N sets of SSBs of the secondary cell after the time point before performing communication with the base station 102 when monitoring the subset 214 of the set of SSBs of the secondary cell.

[0138] FIG. 4A illustrates an example diagram of a case where the full set of SSBs in an SCell is monitored after the SCell is activated in accordance with aspects of the present disclosure. As shown in FIG. 4A, the time period may contain N=3 SSB burst sets for the UE 104 to synchronize to the SCell. In the example shown in FIG. 4A, the SSB activation time point is within the duration of an SSB burst set Q and the SSB burst set Q is not counted as the N SSB burst sets for the UE 104 to synchronize to the SCell.

[0139] FIG. 4B illustrates an example diagram of a case where an associated part of the full set of SSBs in an SCell is monitored after the SCell is activated in accordance with aspects of the present disclosure. As shown in FIG. 4B, the time period may contain M=3 SSB burst sets (i.e., M=3 associated parts of SSBs) for the UE 104 to synchronize to the SCell. In the example shown in FIG. 4B, the SSB activation time point is within the duration of an SSB burst set Q but before the associated part of SSBs in the SSB burst set Q. Thus, the associated part of SSBs in the SSB burst set Q is counted as the M associated parts of SSBs for the UE 104 to synchronize to the SCell.

[0140] Turning back to FIG. 2, in some embodiments, the indication 206 of activating the SSB transmissions in the secondary cell is carried in a MAC CE signaling or in a DCI signaling for the UE 104. The secondary cell may be activated after the indication 206 of activating the SSB transmissions is received. In other words, the UE 104 would decide

that the SCell is activated automatically after monitoring the SSBs and no further SCell activation signaling will be monitored since the triggering signaling is dedicated for the UE 104 (not for a group of UEs).

[0141] In some embodiments, the indication 206 of activating the SSB transmissions in the secondary cell is carried in a DCI signaling for a group of UEs comprising the UE 104. The UE 104 may further monitor an indication of activating the secondary cell in a time window after the reception of the indication 206 of activating the SSB transmissions.

[0142] For example, if SSB (either the full set of SSBs or the part of SSBs) of the SCell are triggered to be transmitted using a group UE specific DCI, the UE(s) in the corresponding UE group will monitor the SSBs after receiving the triggering DCI. Besides, the UE(s) in the corresponding UE group will determine a time window after the time slot with the triggering DCI, within which the UE(s) shall monitor the SCell activation command. If a UE in the corresponding UE group receives a SCell activation command in the time window, the UE thinks the SCell is activated, otherwise the UE thinks the SCell is not activated for it (but may be activated for another UE in the corresponding UE group).

[0143] In some embodiments, a duration length of the time window is predefined or is configured by the base station 102. In other words, the size of the time window may be either configured by the base station 102 or predefined.

[0144] FIG. 5A illustrates an example diagram of a case where the SSB transmission is activated by a group common DCI in accordance with aspects of the present disclosure. As shown in FIG. 5A, the UE 104 monitors the SCell activation command in a time window after the group common DCI is received. The UE 104 transmit/receive signals/channels after the SCell activation command is detected and after the UE 104 completes synchronization to the SCell.

[0145] FIG. 5B illustrates an example diagram of a case where the SSB transmission is activated by a UE specific signaling (either a DCI or MAC signaling) in accordance with aspects of the present disclosure. As shown in FIG. 5B, a SCell activation command is not needed, and the UE 104 just starts to transmit/receive signals/channels after the UE 104 completes synchronization to the SCell.

[0146] Turning back to FIG. 2, in some embodiments, the UE 104 may further receive, from the base station 102, an indication of deactivating the secondary cell and continue monitoring or skip monitoring SSB transmissions in the secondary cell based on a configuration from the base station 102. In other words, there is no SSB deactivation signaling. It can be up to the configuration from the base station 102 about whether the UE 104 needs to monitor the SSBs or not when the SCell deactivation signaling is received (i.e., after the SCell is deactivated). If the configuration indicates to continue monitoring the SSBs when the SCell deactivation signaling is received, the UE 104 assumes the SSBs are transmitted in the SCell after the SCell is deactivated.

[0147] In some embodiments, the UE 104 may further receive, from the base station 102, an indication of deactivating the secondary cell and continue monitoring SSB transmissions in the secondary cell in the absence of an indication of deactivating the SSB transmissions in the secondary cell. The UE 104 may receive, from the base station 102, an indication of deactivating the SSB transmissions in the secondary cell and skip monitoring SSB transmissions in the secondary cell. In other words, the SSB deactivation can be signaled in a dedicated signaling. If the UE 104 receives the SCell deactivation signaling, and before UE 104 receives the SSB deactivation signaling, the UE 104 keeps monitoring the SSBs in the SCell.

[0148] In some embodiments, the UE 104 may further receive, from the base station 102, an indication of deactivating the SSB transmissions in the secondary cell; and skip monitoring SSB transmissions in the secondary cell. The secondary cell is deactivated based on the indication of deactivating the SSB transmissions in the secondary cell. In other words, the SSB deactivation can be signaled in a dedicated signaling. If the UE 104 detects the SSB deactivation signaling, the UE 104 decides that the SCell is deactivated as well.

[0149] FIG. 6 illustrates an example of a device 600 that supports SSB transmissions in accordance with aspects of the present disclosure. The device 600 may be an example of a UE 104 or a network entity 102 as described herein. The device 600 may support wireless communication with one or more network entities 102, UEs 104, or any combination thereof. The device 600 may include components for bi-directional communications including components for transmitting and receiving communications, such as a processor 602, a memory 604, a transceiver 606, and, optionally, an I/O

controller 608. 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).

[0150] The processor 602, the memory 604, the transceiver 606, 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 602, the memory 604, the transceiver 606, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

[0151] In some implementations, the processor 602, the memory 604, the transceiver 606, 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 602 and the memory 604 coupled with the processor 602 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 602, instructions stored in the memory 604).

[0152] In an example in which the device 600 is implemented as a UE 104, the processor 602 may support wireless communication at the device 600 in accordance with examples as disclosed herein. The processor 602 may be configured to operable to support a means for receiving, from a network entity, an indication of activating a secondary cell or an indication of activating synchronization signal and physical broadcast channel (PBCH) block (SSB) transmissions in a secondary cell; and a means for monitoring a set of SSBs of the secondary cell or a subset of a set of SSBs of the secondary cell.

[0153] In an example in which the device 600 is implemented as a network entity 102, the processor 602 may support wireless communication at the device 600 in accordance with examples as disclosed herein. The processor 602 may be configured to operable to support a means for transmitting, to a user equipment, an indication of activating a secondary cell or an indication of activating synchronization signal and physical broadcast channel (PBCH) block (SSB) transmissions in a secondary cell; and a means

for transmitting, to the user equipment, a set of SSBs of the secondary cell or a subset of a set of SSBs of the secondary cell.

[0154] The processor 602 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 602 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 602. The processor 602 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 604) to cause the device 600 to perform various functions of the present disclosure such that the device 600 may perform any process of the disclosure as discussed with reference to FIGS. 2 to 3B.

[0155] The memory 604 may include random access memory (RAM) and read-only memory (ROM). The memory 604 may store computer-readable, computer-executable code including instructions that, when executed by the processor 602 cause the device 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. In some implementations, the code may not be directly executable by the processor 602 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 604 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.

[0156] The I/O controller 608 may manage input and output signals for the device 600. The I/O controller 608 may also manage peripherals not integrated into the device 600. In some implementations, the I/O controller 608 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 608 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 608 may be implemented as part of a processor, such as the processor 606. In some implementations, a user may interact with the device 600 via the I/O controller 608 or via hardware components controlled by the I/O controller 608.

[0157] In some implementations, the device 600 may include a single antenna 610. However, in some other implementations, the device 600 may have more than one antenna 610 (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 606 may communicate bi-directionally, via the one or more antennas 610, wired, or wireless links as described herein. For example, the transceiver 606 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 606 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 610 for transmission, and to demodulate packets received from the one or more antennas 610. The transceiver 606 may include one or more transmit chains, one or more receive chains, or a combination thereof.

[0158] 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 610 for transmitting the amplified signal into the air or wireless medium.

[0159] 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 610 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.

[0160] FIG. 7 illustrates an example of a processor 700 that supports SSB transmissions 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 be implemented in a device or its components as described herein. For example, the device may be an example of a UE 104 or a network entity 102 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, such as L1/L2/L3 cache. 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).

[0161] 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).

[0162] 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.

[0163] 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.

[0164] 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).

[0165] 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. For example, the processor 700 and/or the controller 702 may be coupled with or to the memory 704, and 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.

[0166] 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.

[0167] The processor 700 may support wireless communication in accordance with examples as disclosed herein. In an example in which the processor 700 is implemented in a UE 104, the processor 700 may be configured to or operable to support a means for receiving, from a network entity, an indication of activating a secondary cell or an indication of activating synchronization signal and physical broadcast channel (PBCH) block (SSB) transmissions in a secondary cell; and a means for monitoring a set of SSBs of the secondary cell or a subset of a set of SSBs of the secondary cell.

[0168] The processor 700 may support wireless communication in accordance with examples as disclosed herein. In an example in which the processor 700 is implemented in a network entity 102, the processor 700 may be configured to or operable to support a means for transmitting, to a user equipment, an indication of activating a secondary cell or an indication of activating synchronization signal and physical broadcast channel (PBCH) block (SSB) transmissions in a secondary cell; and a means for transmitting, to the user equipment, a set of SSBs of the secondary cell or a subset of a set of SSBs of the secondary cell.

[0169] FIG. 8 illustrates a flowchart of a method 800 that supports SSB transmissions 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.

[0170] At 805, the method may include receiving, from a base station, an indication of activating a secondary cell or an indication of activating synchronization signal and physical broadcast channel (PBCH) block (SSB) transmissions in a secondary cell. 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.

[0171] At 810, the method may include monitoring a set of SSBs of the secondary cell or a subset of a set of SSBs of the secondary cell. 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.

[0172] FIG. 9 illustrates a flowchart of a method 900 that supports SSB transmissions 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 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. In some embodiments, the method 900 may be performed as a specific example of the step 810 in the method 800.

[0173] At 905, the method may include monitoring a configuration for the association. 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.

[0174] If the configuration for the association is received at 905, the method proceeds to step 910. At 910, the method may include monitoring the set of SSBs of the secondary cell in the absence of the configuration. 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.

[0175] If the configuration for the association is not received at 905, the method proceeds to step 915. At 915, the method may include monitoring the subset of the set of SSBs of the secondary cell in the case that the configuration is received. The operations of 915 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 915 may be performed by a device as described with reference to FIG. 1A.

[0176] FIG. 1000 illustrates a flowchart of a method 1000 that supports SSB transmissions in accordance with aspects of the present disclosure. The operations of the method 1000 may be implemented by a device or its components as described herein. For example, the operations of the method 1000 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.

[0177] At 1005, the method may include transmitting, to a UE, an indication of activating a secondary cell or an indication of activating synchronization signal and physical broadcast channel (PBCH) block (SSB) transmissions in a secondary cell. The operations of 1005 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1005 may be performed by a device as described with reference to FIG. 1A.

[0178] At 1010, the method may include transmitting, to the UE, a set of SSBs of the secondary cell or a subset of a set of SSBs of the secondary cell. The operations of 1010 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1010 may be performed by a device as described with reference to FIG. 1A.

[0179] FIG. 11 illustrates a flowchart of a method 1100 that supports SSB transmissions in accordance with aspects of the present disclosure. The operations of the method 1100 may be implemented by a device or its components as described herein. For example, the operations of the method 1100 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. In some embodiments, the method 1100 may be a specific example of the step 1010 in the method 1000.

[0180] At 1105, the method may include transmitting, to the UE, a configuration for the association. The operations of 1105 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1105 may be performed by a device as described with reference to FIG. 1A.

[0181] At 1110, the method may include transmitting, to the UE, the subset of the set of SSBs of the secondary cell in the case that the configuration is transmitted. The operations of 1110 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1110 may be performed by a device as described with reference to FIG. 1A.

[0182] 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.

[0183] 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).

[0184] 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.

[0185] 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.

[0186] 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.

[0187] 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 from a base station, an indication of activating a secondary cell or an indication of activating synchronization signal and physical broadcast channel (PBCH) block (SSB) transmissions in a secondary cell; and
monitor a set of SSBs of the secondary cell or a subset of a set of SSBs of the secondary cell.
2. The user equipment of claim 1, wherein the subset of the set of SSBs of the secondary cell is associated with a first SSB among a first plurality of SSBs of a primary cell based on an association between the first plurality of SSBs and a second plurality of SSBs of the secondary cell.
3. The user equipment of claim 2, wherein the first plurality of SSBs comprise one of the following:
a maximum number of SSBs in the primary cell; or
a set of SSBs of the primary cell indicated by a ssb-PositionsInBurst for the primary cell; and
wherein the set of SSBs of the secondary cell is indicated by a ssb-PositionsInBurst for the secondary cell, and the second plurality of SSBs comprise one of the following:
a maximum number of SSBs in the secondary cell; or
the set of SSBs of the secondary cell.
4. The user equipment of claim 2, wherein the processor is further configured to:
monitor a configuration for the association;
wherein monitoring the set of SSBs of the secondary cell or the subset of the set of SSBs of the secondary cell comprises:

monitoring the set of SSBs of the secondary cell in the absence of the configuration; and

monitoring the subset of the set of SSBs of the secondary cell in the case that the configuration is received.

5. The user equipment of claim 4, wherein the configuration comprises:
an index of at least one SSB among the second plurality of SSBs associated with a SSB of the primary cell.

6. The user equipment of claim 2, wherein the processor is further configured to:

receive, via the transceiver from the base station, an indication that the set of SSBs is to be transmitted in the secondary cell or an indication that the subset of the set of SSBs is to be transmitted in the secondary cell.

7. The user equipment of claim 6, wherein the second plurality of SSBs of the secondary cell comprise a plurality of SSB groups each associated with a corresponding SSB in the first plurality of SSBs of the primary cell,

wherein the subset of the set of SSBs comprises one of the plurality of SSB groups associate with the first SSB of the primary cell.

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

determine a time point for activating the SSB transmissions in the secondary cell based on the reception of the indication of activating the secondary cell or the indication of activating the SSB transmissions in the secondary cell.

9. The user equipment of claim 8, wherein monitoring the set of SSBs of the secondary cell comprises:

monitoring N sets of SSBs of the secondary cell after the time point before performing communication with the base station, wherein N is a positive integer,

wherein the processor is further configured to:

receive, via the transceiver from the base station, an indication of N.

10. The user equipment of claim 9, wherein a first set of SSBs of the secondary cell is not included in the N sets of SSBs in the case that the time point is during a duration for transmissions of the first set of SSBs of the secondary cell.

11. The user equipment of claim 8, wherein monitoring the subset of the set of SSBs of the secondary cell comprises:

monitoring M subsets of M sets of SSBs of the secondary cell after the time point before performing communication with the base station, wherein M is a positive integer, wherein the processor is further configured to:
receive, via the transceiver from the base station, an indication of M.

12. The user equipment of claim 11, wherein a first subset of a first set of SSBs of the secondary cell is included in the M subsets of the M sets of SSBs in the case that the time point is during a duration for transmissions of the first set of SSBs and prior to a duration for transmissions of the first subset of the first set of SSBs.

13. The user equipment of claim 1, wherein the indication of activating the SSB transmissions in the secondary cell is carried in a MAC CE signaling or in a downlink control information (DCI) signaling for the user equipment.

14. The user equipment of claim 18, wherein the secondary cell is activated after the indication of activating the SSB transmissions is received.

15. The user equipment of claim 1, wherein the indication of activating the SSB transmissions in the secondary cell is received, and the processor is further configured to:

monitor an indication of activating the secondary cell in a time window after the reception of the indication of activating the SSB transmissions.

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

receive, via the transceiver from the base station, an indication of deactivating the secondary cell; and

continue monitoring or skip monitoring SSB transmissions in the secondary cell based on a configuration from the base station.

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

receive, via the transceiver from the base station, an indication of deactivating the SSB transmissions in the secondary cell; and

skip monitoring SSB transmissions in the secondary cell, wherein the secondary cell is deactivated based on the indication of deactivating the SSB transmissions in the secondary cell.

18. A base station comprising:

a processor; and

a transceiver coupled to the processor,

wherein the processor is configured to:

transmit, via the transceiver to a user equipment, an indication of activating a secondary cell or an indication of activating synchronization signal and physical broadcast channel (PBCH) block (SSB) transmissions in a secondary cell; and

transmit, via the transceiver to the user equipment, a set of SSBs of the secondary cell or a subset of a set of SSBs of the secondary cell.

19. A method performed by a user equipment, comprising:

receiving, from a base station, an indication of activating a secondary cell or an indication of activating synchronization signal and physical broadcast channel (PBCH) block (SSB) transmissions in a secondary cell; and

monitoring a set of SSBs of the secondary cell or a subset of a set of SSBs of the secondary cell.

20. A processor for wireless communication, comprising:

at least one memory; and

a controller coupled with the at least one memory and configured to cause the controller to:

receive, from a base station, an indication of activating a secondary cell or an indication of activating synchronization signal and physical broadcast channel (PBCH) block (SSB) transmissions in a secondary cell; and

monitor a set of SSBs of the secondary cell or a subset of a set of SSBs of the secondary cell.