CELL SELECTION WITH ON-DEMAND TRANSMISSION OF AT LEAST ONE PART OF ESSENTIAL SYSTEM INFORMATION

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to techniques for cell selection where at least one cell is associated with an on-demand basis or a semi-persistent pattern for transmission of one or more of at least one synchronization signal or at least one essential system information (SI).

BACKGROUND

[0002] A wireless communications system may include one or multiple network communication devices, which may be known as a network equipment (NE) supporting 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, or the like)). 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., 5G-Advanced (5G-A), sixth generation (6G), etc.).

SUMMARY

[0003] An article “a” before an element is unrestricted and understood to refer to “at least one” of those elements or “one or more” of those elements. The terms “a,” “at least one,” “one or more,” and “at least one of one or more” may be interchangeable. As used herein, including in the claims, “or” as used in a list of items (e.g., a list of items prefaced by a phrase such as “at least one of” or “one or more of” or “one or both of) indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C). Also, as used herein, the phrase “based on” shall not be construed as a reference to a closed set of conditions. For example, an

example step that is described as “based on condition A” may be based on both a condition A and a condition B without departing from the scope of the present disclosure. In other words, as used herein, the phrase “based on” shall be construed in the same manner as the phrase “based at least in part on.” Further, as used herein, including in the claims, a “set” may include one or more elements.

[0004] A UE for wireless communication is described. The UE may be configured to, capable of, or operable to perform a cell selection procedure for a set of one or more cells, where one or more of at least one synchronization signal or at least one essential SI associated with a first cell of the set of one or more cells corresponds to a periodic basis for transmission, and where at least one part of at least one essential SI associated with at least one second cell of the set of one or more cells is associated with an on-demand basis for transmission; select the first cell to camp on based at least in part on the cell selection procedure; assign the at least one second cell as a candidate cell for one or more of a cell reselection procedure or the cell selection procedure based at least in part on a failure to acquire the at least one part of the at least one essential SI.

[0005] A processor for wireless communication is described. The processor may be configured to, capable of, or operable to perform a cell selection procedure for a set of one or more cells, where one or more of at least one synchronization signal or at least one essential SI associated with a first cell of the set of one or more cells corresponds to a periodic basis for transmission, and where at least one part of at least one essential SI associated with at least one second cell of the set of one or more cells is associated with an on-demand basis for transmission; select the first cell to camp on based at least in part on the cell selection procedure; assign the at least one second cell as a candidate cell for one or more of a cell reselection procedure or the cell selection procedure based at least in part on a failure to acquire the at least one part of the at least one essential SI.

[0006] A method performed or performable by a UE for wireless communication is described. The method may include performing a cell selection procedure for a set of one or more cells, where one or more of at least one synchronization signal or at least one essential SI associated with a first cell of the set of one or more cells corresponds to a periodic basis for transmission, and where at least one part of at least one essential SI associated with at least one second cell of the set of one or more cells is associated with an on-demand basis for transmission; selecting the first cell to camp on based at least in

part on the cell selection procedure; assigning the at least one second cell as a candidate cell for one or more of a cell reselection procedure or the cell selection procedure based at least in part on a failure to acquire the at least one part of the at least one essential SI.

[0007] Another UE for wireless communication is described. The UE may be configured to, capable of, or operable to identify a cell of a set of one or more cells during one or more of a cell selection procedure or a cell reselection procedure, where one or more of at least one synchronization signal or at least one essential SI associated with the cell corresponds to a semi-persistent pattern or an on-demand basis for transmission, and where the at least one essential SI comprises one or more of a MIB or a SIB1; select the cell to camp on based at least in part on one or more of the cell selection procedure or the cell reselection procedure; receive a configuration associated with monitor for at least one indication that indicates an activation or deactivation of at least one transmission of the at least one synchronization signal or the at least one essential SI associated with the cell; and monitor the at least one indication based at least in part on the configuration.

[0008] Another processor for wireless communication is described. The processor may be configured to, capable of, or operable to identify a cell of a set of one or more cells during one or more of a cell selection procedure or a cell reselection procedure, where one or more of at least one synchronization signal or at least one essential SI associated with the cell corresponds to a semi-persistent pattern or an on-demand basis for transmission, and where the at least one essential SI comprises one or more of a MIB or a SIB1; select the cell to camp on based at least in part on one or more of the cell selection procedure or the cell reselection procedure; receive a configuration associated with monitor for at least one indication that indicates an activation or deactivation of at least one transmission of the at least one synchronization signal or the at least one essential SI associated with the cell; and monitor the at least one indication based at least in part on the configuration.

[0009] Another method performed or performable by a UE for wireless communication is described. The method may include identifying a cell of a set of one or more cells during one or more of a cell selection procedure or a cell reselection procedure, where one or more of at least one synchronization signal or at least one essential SI associated with the cell corresponds to a semi-persistent pattern or an on-demand basis for transmission, and where the at least one essential SI comprises one or

more of a MIB or a SIB1; selecting the cell to camp on based at least in part on one or more of the cell selection procedure or the cell reselection procedure; receiving a configuration associated with monitoring for at least one indication that indicates an activation or deactivation of at least one transmission of the at least one synchronization signal or the at least one essential SI associated with the cell; and monitoring the at least one indication based at least in part on the configuration.

[0010] A base station for wireless communication is described. The base station may be configured to, capable of, or operable to transmit one or more of at least one synchronization signal or at least one essential SI of a cell with an on-demand basis, where the at least one essential SI comprises one or more of a MIB or a SIB1; transmit a configuration associated with monitoring for at least one indication that indicates an activation or deactivation of at least one transmission of the at least one synchronization signal or the at least one essential SI associated with the cell; and transmit the at least one indication based at least in part on the configuration.

[0011] A processor for wireless communication by a base station is described. The processor may be configured to, capable of, or operable to transmit one or more of at least one synchronization signal or at least one essential SI of a cell with an on-demand basis, where the at least one essential SI comprises one or more of a MIB or a SIB1; transmit a configuration associated with monitoring for at least one indication that indicates an activation or deactivation of at least one transmission of the at least one synchronization signal or the at least one essential SI associated with the cell; and transmit the at least one indication based at least in part on the configuration.

[0012] A method performed or performable by an anchor base station for wireless communication is described. The method may include transmitting one or more of at least one synchronization signal or at least one essential SI of a cell with an on-demand basis, where the at least one essential SI comprises one or more of a MIB or a SIB1; transmitting a configuration associated with monitoring for at least one indication that indicates an activation or deactivation of at least one transmission of the at least one synchronization signal or the at least one essential SI associated with the cell; and transmitting the at least one indication based at least in part on the configuration.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Figure 1 illustrates an example of a wireless communications system in accordance with aspects of the present disclosure.

[0014] Figure 2 illustrates an example of a protocol stack in accordance with aspects of the present disclosure.

[0015] Figure 3 illustrates an example of a deployment of energy saving cells in accordance with aspects of the present disclosure.

[0016] Figure 4 illustrates an example of activation and deactivation of synchronization signals (SS), essential SI, and paging transmission in an energy saving cell in accordance with aspects of the present disclosure.

[0017] Figure 5 illustrates an example of a UE in accordance with aspects of the present disclosure.

[0018] Figure 6 illustrates an example of a processor in accordance with aspects of the present disclosure.

[0019] Figure 7 illustrates an example of an NE in accordance with aspects of the present disclosure.

[0020] Figure 8 illustrates a flowchart of a method performed by a UE in accordance with aspects of the present disclosure.

[0021] Figure 9 illustrates a flowchart of a method performed by a UE in accordance with aspects of the present disclosure.

[0022] Figure 10 illustrates a flowchart of a method performed by an NE in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

[0023] The expansion of telecommunication networks has led to increased emissions and energy consumption, which adversely impact the environment. A significant contributor to network energy usage is the transmission of synchronization signal and physical broadcast channel (SS/PBCH), which are necessary for initial access to a radio access network (RAN). However, these transmissions continue even when no UE is attempting to access the network (e.g., a cell), leading to unnecessary energy consumption. Additionally, operating expenses for telecommunication services are

substantial, driven by rising mobile data traffic, increasing spectrum costs, and the need for continual investment in network infrastructure. As mobile data traffic is projected to triple in the coming years, efficient energy management in network operations has become a critical challenge.

[0024] Telecommunication networks supporting technology generations, such as 5G offer significant energy-efficiency improvements per gigabyte compared to previous generations. However, emerging 5G use cases and the adoption of millimeter wave (mmWave) technology requires a higher density of network sites and antennas. This increased infrastructure, while enhancing network performance, also introduces the risk of higher overall energy consumption and emissions unless proactive measures are taken. Without intelligent energy management, the benefits of 5G efficiency gains may be offset by the rising energy demands of additional network components.

[0025] Furthermore, in scenarios where cells and network nodes are densely deployed, such as small cells, distributed multiple-input multiple-output (MIMO) configurations, to boost capacity and mitigate signal blockages, improper management can lead to excessive power consumption and inflated operational expenses. During a Third Generation Partnership Project (3GPP) Release-18 study on network energy saving, it was demonstrated that increasing the periodicity of common channels and signals in 3GPP 5G New Radio (NR) from 20 milliseconds (ms) to higher values, such as 160 ms, results in significant reduction in power. Specifically, in low-traffic load scenarios, this adjustment was shown to reduce average power consumption by up to 40%.

[0026] To address the shortcomings associated with network energy consumption, the present disclosure provides techniques for cell selection, cell reselection, and paging. A first set of techniques applies to cell selection and reselection in scenarios involving semi-persistent synchronization signal (SS) and/or essential system information (SI) transmission. In one aspect, a UE may receive an indication, via the SS and/or essential SI of a cell, whether the cell transmits SS and/or essential SI periodically or non-periodically. Beneficially, this indication may assist the UE in determining a source of handover or radio link failures, e.g., due to non-transmission of the SS and/or essential SI in accordance with the semi-persistent transmission pattern or on-demand transmission basis.

[0027] In another aspect, if a UE does not acquire (e.g., receive, obtain) master information block (MIB) and/or system information block type 1 (SIB1) due to the deactivation of essential SI transmission for a cell, the UE handles (e.g., assigns, classifies) the cell as candidate cell during cell selection and cell reselection procedures. If the strongest cell on a given frequency layer (e.g., the cell with the highest reference signal received power (RSRP) and/or reference signal received quality (RSRQ)) transmits SS and/or essential SI non-periodically, the UE may search for the next/second strongest cell(s) on the same frequency layer (e.g., the cell with the next highest RSRP and/or RSRQ). Beneficially, ignoring the cell with non-periodic transmission of SS and/or essential SI enhances the handover reliability and the handover execution would not be interrupted or prevented due to non-transmission of the SS and/or essential SI in accordance with the semi-persistent transmission pattern or on-demand transmission basis.

[0028] In one aspect, a UE may select a first cell with that transmits SS and/or essential SI periodically. The UE may receive, from the first cell, a configuration for monitoring (e.g., detecting) a dynamic indication for activation and/or deactivation of semi-persistent SS and/or essential SI transmission from a second cell. Upon receiving the dynamic indication for activation, the UE acquires the essential SI of the second cell and determines whether to reselect the second cell. Beneficially, the reliability and speed of communication monitoring configuration associated with a cell with non-periodic transmission of SS and/or essential SI is improved by transmitting this configuration via another cell with periodic transmission of SS and/or essential SI. In another aspect, the UE receives an indication of a cell-specific cell reselection priority of a cell and performs intra-frequency or equal-priority inter-frequency cell reselection based on the indicated cell-specific cell reselection priorities and one or more cell ranking criteria. Beneficially, the network may improve the reliability of handover by specifying selection/reselection priorities or cell ranking criteria.

[0029] Another set of techniques applies to paging and random access in an energy-efficient RAN. In one aspect, when a UE camps on a cell that transmits SS and/or essential SI semi-persistently, and the UE monitors a dynamic indication for activation/deactivation of SS and/or essential SI transmission of the cell, the UE determines that valid paging occasions of the cell correspond to paging occasions of a paging cycle associated with a time window of active SS transmission. Further, the UE

determines that valid random access channel (RACH) occasions are RACH occasions associated with the same time window of active SS transmission. Beneficially, the reliability and speed of handover may be improved by indicating windows of active transmission of the SS and/or essential SI from a cell with non-periodic transmission of the SS and/or essential SI.

[0030] In another aspect, if a UE detects a downlink control information (DCI) format carrying a paging early indication (PEI) and an indication for activation/deactivation of SS and/or essential SI transmission, and if the detected DCI format indicates that SS and/or essential SI transmission is deactivated but a paging message may be pending (e.g., present) for the UE, the UE reselects to a cell with periodic SS and/or essential SI transmission and monitors paging in the reselected cell. Beneficially, this aspect improves network energy savings by triggering reselection to an activated cell for paging.

[0031] While presented as distinct solutions, one or more of the solutions described herein may be implemented in combination with each other. Aspects of the present disclosure are described in the context of a wireless communications system.

[0032] **Figure 1** illustrates an example of a wireless communications system 100 in accordance with aspects of the present disclosure. The wireless communications system 100 may include one or more NE 102, one or more UE 104, and a core network (CN) 106. 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 a Long-Term Evolution (LTE) network or an LTE-Advanced (LTE-A) network. In some other implementations, the wireless communications system 100 may be a New Radio (NR) network, such as a 5G network, a 5G-Advanced (5G-A) network, or a 5G ultrawideband (5G-UWB) network.

[0033] 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 (RAT) 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, for example, 6G. 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.

[0034] The one or more NE 102 may be dispersed throughout a geographic region to form the wireless communications system 100. One or more of the NE 102 described herein may be or include or may be referred to as a network node, a base station, a network element, a network function, a network entity, a radio access network (RAN), a NodeB, an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. An NE 102 and a UE 104 may communicate via a communication link, which may be a wireless or wired connection. For example, an NE 102 and a UE 104 may perform wireless communication (e.g., receive signaling, transmit signaling) over a Uu interface.

[0035] An NE 102 may provide a geographic coverage area for which the NE 102 may support services for one or more UEs 104 within the geographic coverage area. For example, an NE 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, an NE 102 may be moveable, for example, a satellite associated with a non-terrestrial network (NTN). In some implementations, different geographic coverage areas associated with the same or different radio access technologies may overlap, but the different geographic coverage areas may be associated with different NE 102.

[0036] The one or more UE 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 remote unit, a mobile device, a wireless device, a remote device, a subscriber device, a transmitter device, a receiver device, or some other suitable terminology. In some implementations, 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.

[0037] A UE 104 may be able to support wireless communication directly with other UEs 104 over a communication link. 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 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.

[0038] An NE 102 may support communications with the CN 106, or with another NE 102, or both. For example, an NE 102 may interface with other NE 102 or the CN 106 through one or more backhaul links (e.g., S1, N2, N3, or network interface). In some implementations, the NE 102 may communicate with each other directly. In some other implementations, the NE 102 may communicate with each other indirectly (e.g., via the CN 106). In some implementations, one or more NE 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).

[0039] The CN 106 may support user authentication, access authorization, tracking, connectivity, and other access, routing, or mobility functions. The CN 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 NE 102 associated with the CN 106.

[0040] The CN 106 may communicate with a packet data network over one or more backhaul links (e.g., via an S1, N2, N3, or another network interface). The packet data network may include an application server. In some implementations, one or more UEs 104 may communicate with the application server. A UE 104 may establish a session (e.g., a protocol data unit (PDU) session, or a PDN connection, or the like) with the CN 106 via an NE 102. The CN 106 may route traffic (e.g., control information, data, and the like) between the UE 104 and the application server using the established session (e.g., the established PDU session). The PDU session may be an example of a logical

connection between the UE 104 and the CN 106 (e.g., one or more network functions of the CN 106).

[0041] In the wireless communications system 100, the NEs 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 NEs 102 and the UEs 104 may support different resource structures. For example, the NEs 102 and the UEs 104 may support different frame structures. In some implementations, such as in 4G, the NEs 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 NEs 102 and the UEs 104 may support various frame structures (i.e., multiple frame structures). The NEs 102 and the UEs 104 may support various frame structures based on one or more numerologies.

[0042] 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., μ=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., μ=0) associated with the first subcarrier spacing (e.g., 15 kHz) may utilize one slot per subframe. A second numerology (e.g., μ=1) may be associated with a second subcarrier spacing (e.g., 30 kHz) and a normal cyclic prefix. A third numerology (e.g., μ=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., μ=3) may be associated with a fourth subcarrier spacing (e.g., 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g., μ=4) may be associated with a fifth subcarrier spacing (e.g., 240 kHz) and a normal cyclic prefix.

[0043] 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.

[0044] 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., μ=0, μ=1, μ=2, μ=3, μ=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.#

[0045] Each slot may include a number (e.g., quantity) of symbols (e.g., orthogonal frequency domain multiplexing (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., μ=0) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

[0046] 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 NEs 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 NEs 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 NEs 102 and the UEs 104, among other equipment or devices for short-range, high data rate capabilities.

[0047] 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., μ=0), which includes 15 kHz subcarrier spacing; a second numerology (e.g., μ=1), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., μ=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., μ=2), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., μ=3), which includes 120 kHz subcarrier spacing.

[0048] Wireless communication in unlicensed spectrum (also referred to as "shared spectrum") in contrast to licensed spectrum offer some obvious cost advantages allowing communication to obviate overlaying operator's licensed spectrum and rather use license free spectrum according to local regulation in specific geographies. From the third generation partnership project (3GPP) technology perspective, the unlicensed operation can be on the Uu interface (referred to as NR-U) or also on sidelink interface (e.g., SL-U).

[0049] For initial access, a UE 104 detects a candidate cell and performs downlink (DL) synchronization. For example, the gNB (e.g., an embodiment of the NE 102) may transmit a SS/PBCH transmission, referred to as a synchronization signal block (SSB). In various embodiments, the SSB comprises the primary synchronization signal (PSS), the secondary synchronization signal (SSS), and the master information block (MIB). The synchronization signal (i.e., comprising the PSS and SSS) is a predefined data sequence known to the UE 104 (or derivable using information already stored at the UE 104) and is in a predefined location in time relative to frame/subframe boundaries, etc. The UE 104 searches for the SSB and uses the SSB to obtain DL timing information (e.g., symbol timing) for the DL synchronization. The UE 104 may also decode system information (SI) based on the SSB. Note that with beam-based communication, each DL beam may be associated with a respective SSB.

[0050] After performing DL synchronization and acquiring essential system information, such as the MIB and the SIB1, the UE 104 performs uplink (UL) synchronization and resource request by performing a random-access procedure, referred to as "RACH procedure" by selecting and transmitting a preamble on the physical random access channel (PRACH). The PRACH preamble is transmitted during a random access channel (RACH) occasion, i.e., a predetermined set of time-frequency resources

that are available for the reception of the PRACH preamble. Note that with beam-based communication, the UE 104 may select a certain DL beam and transmit the PRACH preamble on a corresponding UL beam. In such embodiments, there may be a mapping between SSB and RACH occasion, allowing the network to determine which beam the UE 104 has selected.

[0051] Regarding random access, two types of RACH procedure are supported in a 3GPP wireless communication network: A) a 4-step random-access (RA) type initiated by the sending of a RACH message 1 (Msg1) and 2-step RA type with RACH message A (MsgA). Both types of RACH procedure support contention-based random access (CBRA) and contention-free random access (CFRA).

[0052] The UE 104 selects the RA type at the initiation of the RACH procedure, e.g., based on network configuration. In one example, when CFRA resources are not configured, an RSRP threshold is used by the UE 104 to select between 2-step RA type and 4-step RA type. In another example, when CFRA resources for 4-step RA type are configured, the UE 104 performs random access with 4-step RA type. In another example, when CFRA resources for 2-step RA type are configured, the UE 104 performs random access with 2-step RA type.

[0053] Note that the network does not configure CFRA resources for 4-step and 2-step RA types at the same time for a bandwidth part (BWP). Additionally, the CFRA with 2-step RA type is only supported for handover.

[0054] The Msg1 of the 4-step RA type consists of a preamble transmitted on a physical random access channel (PRACH). After the Msg1 transmission, the UE 104 monitors for a response from the network within a configured window. For CFRA, a dedicated preamble for Msg1 transmission is assigned by the network and upon receiving a random access response (RAR) from the network, the UE 104 ends the random access procedure. For CBRA, upon reception of the RAR, the UE 104 sends a RACH message 3 (Msg3) using a UL grant scheduled in the RAR and monitors for contention resolution. If contention resolution is not successful after Msg3 (re)transmission(s), then the UE 104 goes back to Msg1 transmission.

[0055] The MsgA of the 2-step RA type includes a preamble on the PRACH and a payload on a physical uplink shared channel (PUSCH). After the MsgA transmission, the

UE 104 monitors for a response from the network within a configured window. For CFRA, a dedicated preamble and PUSCH resource are configured for MsgA transmission and upon receiving the network response, the UE 104 ends the random access procedure. For CBRA, if contention resolution is successful upon receiving the network response, then the UE 104 ends the random access procedure; however, if a fallback indication is received in a RACH message B (MsgB), the UE 104 performs Msg3 transmission using the UL grant scheduled in the fallback indication and monitors for contention resolution. If contention resolution is not successful after Msg3 (re)transmission(s), the UE 104 goes back to MsgA transmission.

[0056] If the random access procedure with 2-step RA type is not completed after a number of MsgA transmissions, the UE 104 can be configured to switch to CBRA with 4-step RA type.

[0057] In 3GPP New Radio (NR), the gNB may transmit the maximum 64 SSBs and the maximum 64 corresponding copies of physical downlink control channel (PDCCH) and/or physical downlink shared channel (PDSCH) for delivery of SIB1 in high frequency bands (e.g., 28 GHz). This may cause significant network energy consumption even for very low traffic load conditions. According to 3GPP Technical Report (TR) 38.864 (v18.1.0), for network energy savings, on-demand SSB and/or SIB1 (SSB/SIB1) transmissions and a cell without SSB/SIB1 transmission were considered. When a cell does not transmit SSB/SIB1, for a UE 104 to access the cell, the UE 104 should obtain SI of the cell from other associated carriers/cells and synchronize from other associated carriers/cells. When a cell is in a long period of cell inactivity, a UE 104 served by the cell can trigger SSB/SIB1 transmissions by sending a request to the cell.

[0058] **Figure 2** illustrates an example of a protocol stack 200, in accordance with aspects of the present disclosure. While Figure 2 shows a UE 206, a RAN node 208, and a 5G core network (5GC) 210 (e.g., comprising at least an AMF), these are representative of a set of UEs 104 interacting with an NE 102 (e.g., base station) and a CN 106. As depicted, the protocol stack 200 comprises a user plane protocol stack 202 and a control plane protocol stack 204. The user plane protocol stack 202 includes a physical (PHY) layer 212, a medium access control (MAC) sublayer 214, a radio link control (RLC) sublayer 216, a packet data convergence protocol (PDCP) sublayer 218, and a service data adaptation protocol (SDAP) sublayer 220. The control plane protocol stack 204 includes a PHY layer

212, a MAC sublayer 214, an RLC sublayer 216, and a PDCP sublayer 218. The control plane protocol stack 204 also includes a radio resource control (RRC) layer 222 and a non-access stratum (NAS) layer 224.

[0059] The access stratum (AS) layer 226 (also referred to as "AS protocol stack") for the user plane protocol stack 202 consists of at least SDAP, PDCP, RLC and MAC sublayers, and the physical layer. The AS layer 228 for the control plane protocol stack 204 consists of at least RRC, PDCP, RLC and MAC sublayers, and the physical layer. The layer-1 (L1) includes the PHY layer 212. The layer-2 (L2) is split into the SDAP sublayer 220, PDCP sublayer 218, RLC sublayer 216, and MAC sublayer 214. The layer-3 (L3) includes the RRC layer 222 and the NAS layer 224 for the control plane and includes, e.g., an internet protocol (IP) layer and/or PDU Layer (not depicted) for the user plane. L1 and L2 are referred to as "lower layers," while L3 and above (e.g., transport layer, application layer) are referred to as "higher layers" or "upper layers."

[0060] The PHY layer 212 offers transport channels to the MAC sublayer 214. The PHY layer 212 may perform a beam failure detection procedure using energy detection thresholds, as described herein. In certain embodiments, the PHY layer 212 may send an indication of beam failure to a MAC entity at the MAC sublayer 214. The MAC sublayer 214 offers logical channels to the RLC sublayer 216. The RLC sublayer 216 offers RLC channels to the PDCP sublayer 218. The PDCP sublayer 218 offers radio bearers to the SDAP sublayer 220 and/or RRC layer 222. The SDAP sublayer 220 offers QoS flows to the core network (e.g., 5GC). The RRC layer 222 provides for the addition, modification, and release of carrier aggregation and/or dual connectivity. The RRC layer 222 also manages the establishment, configuration, maintenance, and release of signaling radio bearers (SRBs) and data radio bearers (DRBs).

[0061] The NAS layer 224 is between the UE 206 and an AMF in the 5GC 210. NAS messages are passed transparently through the RAN. The NAS layer 224 is used to manage the establishment of communication sessions and for maintaining continuous communications with the UE 206 as it moves between different cells of the RAN. In contrast, the AS layers 226 and 228 are between the UE 206 and the RAN (i.e., RAN node 208) and carry information over the wireless portion of the network. While not depicted in Figure 2, the IP layer exists above the NAS layer 224, a transport layer exists above the IP layer, and an application layer exists above the transport layer.

[0062] The MAC sublayer 214 is the lowest sublayer in the L2 architecture of the NR protocol stack. Its connection to the PHY layer 212 below is through transport channels, and the connection to the RLC sublayer 216 above is through logical channels. The MAC sublayer 214 therefore performs multiplexing and demultiplexing between logical channels and transport channels: the MAC sublayer 214 in the transmitting side constructs MAC PDUs (also known as transport blocks (TBs)) from MAC service data units (SDUs) received through logical channels, and the MAC sublayer 214 in the receiving side recovers MAC SDUs from MAC PDUs received through transport channels.

[0063] The MAC sublayer 214 provides a data transfer service for the RLC sublayer 216 through logical channels, which are either control logical channels which carry control data (e.g., RRC signaling) or traffic logical channels which carry user plane data. On the other hand, the data from the MAC sublayer 214 is exchanged with the PHY layer 212 through transport channels, which are classified as UL or downlink (DL). Data is multiplexed into transport channels depending on how it is transmitted over the air.

[0064] The PHY layer 212 is responsible for the actual transmission of data and control information via the air interface, i.e., the PHY layer 212 carries all information from the MAC transport channels over the air interface on the transmission side. Some of the important functions performed by the PHY layer 212 include coding and modulation, link adaptation (e.g., adaptive modulation and coding (AMC)), power control, cell search and random access (for initial synchronization and handover purposes) and other measurements (inside the 3GPP system (i.e., NR and/or LTE system) and between systems) for the RRC layer 222. The PHY layer 212 performs transmissions based on transmission parameters, such as the modulation scheme, the coding rate (i.e., the modulation and coding scheme (MCS)), the number of physical resource blocks (PRBs), etc.

[0065] In some embodiments, the protocol stack 200 may be an NR protocol stack used in a 5G NR system. Note that an LTE protocol stack comprises similar structure to the protocol stack 200, with the differences that the LTE protocol stack lacks the SDAP sublayer 220 in the AS layer 226, that an EPC replaces the 5GC 210, and that the NAS layer 224 is between the UE 206 and an MME in the EPC. Also note that the present disclosure distinguishes between a protocol layer (such as the aforementioned PHY layer 212, MAC sublayer 214, RLC sublayer 216, PDCP sublayer 218, SDAP sublayer 220, RRC

layer 222 and NAS layer 224) and a transmission layer in MIMO communication (also referred to as a “MIMO layer” or a “data stream”).

[0066] Regarding RRC states, 3GPP defines three different RRC states/modes for 5G NR: RRC_IDLE, RRC_INACTIVE, and RRC_CONNECTED. Initially, i.e., upon powering up, the UE is in an idle mode corresponding to the RRC_IDLE state. Before performing data transfer (including placing calls), the UE must establish a connection with the network which is done using initial access via RRC connection establishment procedure. Once RRC connection is established, the UE is in the RRC_CONNECTED state. The RRC connection may be suspended due to inactivity, wherein the UE transitions to the RRC_INACTIVE state. Via the RRC release procedure, the RRC connection is released and the UE transitions to the RRC_IDLE state.

[0067] Cell search is a procedure for a UE to acquire time and frequency synchronization with a cell and to detect the physical layer cell identity of the cell. In 3GPP 5G NR, for a UE to access to a network, the UE performs cell search, acquires essential system information of a cell such as MIB and SIB1, and selects a suitable cell among detected cells.

[0068] For initial cell selection, i.e., when there is no prior knowledge of which radio frequency (RF) channels are NR frequencies, a UE scans all RF channels (also referred to as frequency layers) in the NR bands according to its capabilities to find a suitable cell. On each carrier frequency of the RF channels/frequency layers, the UE only needs to search for the strongest cell (e.g., the cell with the highest RSRP and/or RSRQ), except for operation with shared spectrum channel access where the UE may search for the next/second strongest cell(s). Once a suitable cell is found, this cell shall be selected. If a UE has stored information of frequencies and optionally also information on cell parameters from previously received measurement control information elements or from previously detected cells and once the UE has found a suitable cell, the UE shall select it. If no suitable cell is found, the UE shall scan all RF channels in the NR bands according to its capabilities to find a suitable cell.

[0069] In 5G NR, when the cell status “barred” is indicated for a cell, a UE is not permitted to select/reselect the cell, not even for emergency calls. The UE shall exclude the barred cell as a candidate for cell selection/reselection for 300 seconds. If the field *intraFreqReselection* in MIB message is set to "allowed", the UE may select another cell

on the same carrier frequency if re-selection criteria are fulfilled. If the field *intraFreqReselection* in MIB message is set to "not allowed," if the cell operates in licensed spectrum, or if the cell belongs to a public land mobile network (PLMN) which is indicated as being equivalent to the registered PLMN or the selected PLMN of the UE, or if the cell belongs to the registered standalone non-public network (SNPN) or the selected SNPN of the UE, the UE shall not re-select to another cell on the same carrier frequency as the barred cell and exclude such cell(s) as candidate(s) for cell selection/reselection for 300 seconds. If a cell is to be treated as if the cell status is "barred" due to being unable to acquire MIB or due to being unable to acquire the SIB1, the UE may exclude the barred cell as a candidate for cell selection/reselection for up to 300 seconds.

[0070] Regarding cell selection, the cell selection criterion *S* is fulfilled when: $S_{rxlev} > 0$ AND $S_{qual} > 0$, where:

$$S_{rxlev} = Q_{rxlevmeas} - (Q_{rxlevmin} + Q_{rxlevminoffset}) - P_{compensation} - Qoffset_{temp}$$

$$S_{qual} = Q_{qualmeas} - (Q_{qualmin} + Q_{qualminoffset}) - Qoffset_{temp}$$

[0071] Note that for initial cell selection (i.e., having no stored cell selection parameters), the UE can compute Srxlev and Squal after acquiring system information of a cell. The terms of the above equations are defined in Table 1, below:

Table 1

Name	Description
Srxlev	Cell selection reception (RX) level value (dB)
Squal	Cell selection quality value (dB)
$Qoffset_{temp}$	Offset temporarily applied to a cell (dB)
$Q_{rxlevmeas}$	Measured cell RX level value (RSRP)
$Q_{qualmeas}$	Measured cell quality value (RSRQ)
$Q_{rxlevmin}$	Minimum required RX level in the cell (dBm). If the UE supports supplementary uplink (SUL) frequency for this cell, $Q_{rxlevmin}$ is obtained from *q-RxLevMinSUL*, if present, in *SIB1*, *SIB2* and *SIB4*, additionally, if $Q_{rxlevminoffsetcellSUL}$ is present in *SIB3* and *SIB4* for the concerned cell, this cell specific offset is added to the corresponding Qrxlevmin to achieve the required minimum RX level in the concerned cell; else $Q_{rxlevmin}$ is obtained from *q-RxLevMin* in *SIB1, SIB2* and *SIB4*, additionally, if $Q_{rxlevminoffsetcell}$ is present in *SIB3* and *SIB4* for the concerned cell, this cell specific offset is added to the corresponding Qrxlevmin to achieve the required minimum RX level in the concerned cell.
$Q_{qualmin}$	Minimum required quality level in the cell (dB). Additionally, if $Q_{qualminoffsetcell}$ is signaled for the concerned cell, this cell specific offset is added to achieve the required minimum quality level in the concerned cell.
$Q_{rxlevminoffset}$	Offset to the signaled $Q_{rxlevmin}$ taken into account in the Srxlev evaluation as a result of a periodic search for a higher priority PLMN while camped normally in a visited PLMN (VPLMN).
$Q_{qualminoffset}$	Offset to the signaled $Q_{qualmin}$ taken into account in the Squal evaluation as a result of a periodic search for a higher priority PLMN while camped normally in a VPLMN.
$P_{compensation}$	For FR1, if the UE supports the *additionalPmax* in the *NR-NS-PmaxList*, if present, in *SIB1, SIB2* and *SIB4:* $max(P_{EMAX1} - P_{PowerClass}, 0) - (min(P_{EMAX2}, P_{PowerClass}) - min(P_{EMAX1}, P_{PowerClass}))$ *(dB);* *else:* $max(P_{EMAX1} - P_{PowerClass}, 0)$ *(dB)* For FR2, $P_{compensation}$ is set to 0. For IAB-MT, $P_{compensation}$ is set to 0.
P_{EMAX1}, P_{EMAX2}	Maximum transmission (TX) power level of a UE may use when transmitting on the uplink in the cell (dBm) defined as P_{EMAX}. If UE supports supplemental uplink (SUL) frequency for this cell, P_{EMAX1} and P_{EMAX2} are obtained from the *p-Max* for SUL in *SIB1* and *NR-NS-PmaxList* for SUL respectively in *SIB1, SIB2* and *SIB4*, else P_{EMAX1} and P_{EMAX2} are obtained from the *p-Max* and *NR-NS-PmaxList* respectively in *SIB1*, *SIB2* and *SIB4* for normal UL.
$P_{PowerClass}$	Maximum RF output power of the UE (dBm) according to the UE power class.

[0072] Regarding reselection priorities handling, absolute priorities of different NR frequencies or inter-RAT frequencies may be provided to the UE in the SI, in the *RRCRelease* message, or by inheriting from another RAT at inter-RAT cell (re)selection.

In the case of SI, an NR frequency or inter-RAT frequency may be listed without providing a priority (i.e., the field *cellReselectionPriority* is absent for that carrier frequency). If any fields with *cellReselectionPriority* or *nsag-CellReselectionPriority* are provided in dedicated signaling, the UE shall ignore any fields with *cellReselectionPriority* and *nsag-CellReselectionPriority* provided in SI.

[0073] When UE is camped normally (i.e., camped on a suitable cell that at least fulfills the cell selection criteria and is not barred), if it supports slice-based cell reselection and has received network slice access stratum group(s) (NSAG(s)) and their priorities from non-access stratum (NAS), then the UE shall derive re-selection priorities according to the following rules:

[0074] Rule 1: Frequencies that support at least one prioritized network slice access stratum group (NSAG) received from NAS have higher re-selection priority than frequencies that support none of the NSAG(s) received from NAS.

[0075] Rule 2: Frequencies that support at least one NSAG provided by NAS are prioritized in the order of the NAS-provided priority for the NSAG with highest priority supported on the carrier frequency.

[0076] Rule 3: Among the frequencies (one or multiple) that support the highest prioritized NSAG(s) with the same NAS-provided priorities, the frequencies are prioritized in the order of their *nsag-CellReselectionPriority* given for these NSAG(s).

[0077] Rule 4: Frequencies that support an NSAG provided by NAS and that indicate *nsag-CellReselectionPriority* for the NSAG have higher re-selection priority than frequencies that support this prioritized NSAG without indicating *nsag-CellReselectionPriority* for the NSAG.

[0078] Rule 5: Frequencies that support none of the NSAG(s) provided by NAS are prioritized in the order of their *cellReselectionPriority*.

[0079] If UE is in camped on any cell state, the UE shall only apply the priorities provided by SI from current cell, and the UE preserves priorities provided by dedicated signaling and *deprioritisationReq* received in *RRCRelease* unless specified otherwise. When the UE is camped normally (i.e., camped on a suitable cell that at least fulfills the cell selection criteria and is not barred) and has only dedicated priorities other than for the

current carrier frequency, the UE shall consider the current carrier frequency to be the lowest priority carrier frequency (i.e., lower than any of the network configured values).

[0080] When the high speed dedicated network (HSDN) capable UE is in High-mobility state, the UE shall always consider the HSDN cells to be the highest priority (i.e., higher than any other network configured priorities). When the HSDN capable UE is not in High-mobility state, the UE shall always consider HSDN cells to be the lowest priority (i.e., lower than any other network configured priorities).

[0081] If the UE is configured to perform both NR sidelink communication and vehicle to everything (V2X) sidelink communication, the UE may consider the carrier frequency providing both NR sidelink communication configuration and V2X sidelink communication configuration to be the highest priority. If the UE is configured to perform NR sidelink communication and not perform V2X communication, the UE may consider the carrier frequency providing NR sidelink communication configuration to be the highest priority. If the UE is configured to perform V2X sidelink communication and not perform NR sidelink communication, the UE may consider the carrier frequency providing V2X sidelink communication configuration to be the highest priority.

[0082] Note that the carrier frequency only providing the anchor frequency configuration should not be prioritized for V2X service during cell reselection. When UE is configured to perform NR sidelink communication or V2X sidelink communication performs cell reselection, it may consider the frequencies providing the intra-carrier and inter-carrier configuration have equal priority in cell reselection.

[0083] In certain embodiments, the prioritization among the frequencies which the UE considers to be the highest priority frequency is left to UE implementation. In various embodiments, the UE is configured to perform V2X sidelink communication or NR sidelink communication, if it has the capability and is authorized for the corresponding sidelink operation.

[0084] Note that when UE is configured to perform both NR sidelink communication and V2X sidelink communication, but cannot find a frequency which can provide both NR sidelink communication configuration and V2X sidelink communication configuration, the UE may consider the frequency providing either NR sidelink

communication configuration or V2X sidelink communication configuration to be the highest priority.

[0085] The UE shall only perform cell reselection evaluation for NR frequencies and inter-RAT frequencies that are given in SI and for which the UE has a priority provided.

[0086] In case UE receives an *RRCRelease* message with *deprioritisationReq*, the UE shall consider current frequency and stored frequencies due to the previously received *RRCRelease* message with *deprioritisationReq* or all the frequencies of NR to be the lowest priority frequency (i.e., lower than any of the network configured values) while T325 is running irrespective of camped RAT. The UE shall delete the stored deprioritization request(s) (i.e., *deprioritisationReq*) when a PLMN selection or SNPN selection is performed on request by NAS. Note that the UE should search for a higher priority layer for cell reselection as soon as possible after the change of priority.

[0087] The UE shall delete priorities provided by dedicated signaling when: A) the UE enters a different RRC state; or B) the optional validity time of dedicated priorities (i.e., timer T320) expires; or C) the UE receives an *RRCRelease* message with the field *cellReselectionPriorities* is absent; or D) a PLMN selection or SNPN selection is performed on request by NAS. Note that equal priorities between RATs are not supported.

[0088] The UE shall not consider any exclude-listed cells as a candidate for cell reselection. The UE shall consider only the allow-listed cells, if configured, as candidates for cell reselection.

[0089] The UE in RRC_IDLE state shall inherit the priorities provided by dedicated signaling and the remaining validity time (i.e., timer T320 in evolved universal terrestrial radio access (E-UTRA) and NR), if configured, at inter-RAT cell (re)selection. Note that the network may assign dedicated cell reselection priorities for frequencies not configured by SI.

[0090] Regarding NR inter-frequency and inter-RAT cell reselection criteria, if *threshServingLowQ* is broadcast in SI and more than 1 second has elapsed since the UE camped on the current serving cell, cell reselection to a cell on a higher priority NR frequency or inter-RAT frequency than the serving frequency shall be performed if a cell

of a higher priority NR or evolved universal terrestrial radio access network (E-UTRAN) RAT/frequency fulfils Squal > $Thresh_{X, HighQ}$ during a time interval $Treselection_{RAT}$.

[0091] Otherwise, cell reselection to a cell on a higher priority NR frequency or inter-RAT frequency than the serving frequency shall be performed if a cell of a higher priority RAT/ frequency fulfils Srxlev > $Thresh_{X, HighP}$ during a time interval $Treselection_{RAT}$; and if more than 1 second has elapsed since the UE camped on the current serving cell.

[0092] Cell reselection to a cell on an equal priority NR frequency shall be based on ranking for intra-frequency cell reselection.

[0093] If *threshServingLowQ* is broadcast in system information and more than 1 second has elapsed since the UE camped on the current serving cell, cell reselection to a cell on a lower priority NR frequency or inter-RAT frequency than the serving frequency shall be performed if the serving cell fulfils Squal < $Thresh_{Serving, LowQ}$ and a cell of a lower priority NR or E-UTRAN RAT/ frequency fulfils Squal > $Thresh_{X, LowQ}$ during a time interval $Treselection_{RAT}$.

[0094] Otherwise, cell reselection to a cell on a lower priority NR frequency or inter-RAT frequency than the serving frequency shall be performed if the serving cell fulfils Srxlev < $Thresh_{Serving, LowP}$ and a cell of a lower priority RAT/ frequency fulfils Srxlev > $Thresh_{X, LowP}$ during a time interval $Treselection_{RAT}$, and if more than 1 second has elapsed since the UE camped on the current serving cell.

[0095] Cell reselection to a higher priority RAT/frequency shall take precedence over a lower priority RAT/frequency if multiple cells of different priorities fulfil the cell reselection criteria.

[0096] If more than one cell meets the above criteria, the UE shall reselect a cell as follows. If the highest-priority frequency is an NR frequency, then the UE reselects the highest ranked cell among the cells on the highest priority frequency(ies) meeting the criteria. Otherwise, if the highest-priority frequency is from another RAT, then the UE reselects the strongest cell among the cells on the highest priority frequency(ies) meeting the criteria of that RAT.

[0097] Paging allows the network to reach UEs in the RRC_IDLE and RRC_INACTIVE states through Paging messages, and to notify UEs in RRC_IDLE, RRC_INACTIVE and RRC_CONNECTED state of system information change and

indications from earthquake and tsunami warning system and/or commercial mobile alert system (ETWS/CMAS) through Short Messages. Both Paging messages and Short Messages are addressed with paging radio network temporary identifier (P-RNTI) on PDCCH, but while the former is sent on the paging control channel (PCCH) (e.g., a (DL) logical channel), the latter is sent over PDCCH directly.

[0098] While in RRC_IDLE the UE monitors the paging channels for CN-initiated paging. While in RRC_INACTIVE with no ongoing small-data transmission (SDT) procedure the UE monitors paging channels for RAN-initiated paging and CN-initiated paging. A UE need not monitor paging channels continuously though. Paging discontinuous reception (DRX) is defined where the UE in RRC_IDLE or RRC_INACTIVE is only required to monitor paging channels during one paging occasion (PO) per DRX cycle. The Paging DRX cycles are configured by the network.

[0099] For CN-initiated paging, a default cycle is broadcast in system information. For CN-initiated paging, a UE-specific cycle can be configured via NAS signaling. For RAN-initiated paging, a UE-specific cycle is configured via RRC signaling. The UE uses the shortest of the DRX cycles applicable, i.e., a UE in RRC_IDLE uses the shortest of the first two cycles above, while a UE in RRC_INACTIVE uses the shortest of the three cycles.

[0100] Regarding the determination of paging occasions in the UE, the UE may use DRX in RRC_IDLE and RRC_INACTIVE state in order to reduce power consumption. The UE monitors one PO per DRX cycle. A PO is a set of PDCCH monitoring occasions and can consist of multiple time slots (e.g., subframe or OFDM symbol) where paging downlink control information (DCI) can be sent. One paging frame (PF) is one radio frame and may contain one or multiple PO(s) or starting point of a PO.

[0101] In multi-beam operations, the UE assumes that the same paging message and the same short message are repeated in all transmitted beams and thus the selection of the beam(s) for the reception of the paging message and short message is up to UE implementation. The paging message is the same for both RAN-initiated paging and CN-initiated paging.

[0102] The UE initiates RRC connection resume procedure upon receiving RAN-initiated paging. If the UE receives a CN-initiated paging in RRC_INACTIVE state, the UE moves to RRC_IDLE and informs NAS.

[0103] Regarding the PEI, this indication PEI incorporates a special wake up signal that UE monitors before the PO. The PEI indicates UE the presence or absence of paging message in the PO. If the PEI is present, then the UE proceeds with relevant SSB measurements and paging message reception in the PO.

[0104] When a paging message for the PEI capable UE is received from the CN at the gNB or is generated by the gNB, the gNB determines the PO and the associated PEI occasion for the UE. Before the UE is paged in the PO, the gNB transmits the associated PEI and indicates the corresponding subgroup derived based on UE ID of the UE that is paged in the PEI.

[0105] **Figure 3** depicts an exemplary RAN deployment 300 of energy saving cells with overlapping coverage, in accordance with aspects of the disclosure. The RAN deployment 300 comprises a plurality of cells, including a first cell (denoted “Cell 1”) 302, a second cell (denoted “Cell 2”) 304, a third cell (denoted “Cell 3”) 306, a fourth cell (denoted “Cell 4”) 308, a fifth cell (denoted “Cell 5”) 310, and a sixth cell (denoted “Cell 6”) 312. In some embodiments, the Cells 1-6 are deployed in the same frequency layer. In other embodiments, the first cell 302 is deployed in a different frequency layer than one or more of Cells 2-6. A frequency layer, also referred to as an RF channel, refers to the carrier frequency where a cell transmitting synchronization signal can be expected. In various embodiments, the first cell 302 is an anchor cell that may provide synchronization for a neighbor cell (e.g., one or more of Cells 2-6). In some implementations, the anchor cell that may provide neighbor cell information that indicates a basis for transmission for the SS and/or essential SI associated with the neighbor cell.

[0106] In some embodiments, one or more of the cells 1-6 may transmit SS and/or essential SI with a periodic (i.e., regular) transmission pattern. However, to save energy a respective cell may instead transmit the SS and/or the essential SI with a semi-persistent transmission pattern, or may only transmit the system information on demand. In the depicted embodiment, the first cell 302, the fourth cell 308, the fifth cell 310, and the sixth cell 312 each transmit SS and essential SI periodically and serve UEs 314 in an

RRC connected state. However, the second cell 304 and the third cell 306 transmit SS and essential SI semi-persistently only with a UE 316 in an RRC idle or inactive state.

[0107] In some embodiments, an energy saving cell (e.g., the second cell 304 and/or the third cell 306) transmits its SS and/or essential SI with a semi-persistent transmission pattern (or transmits its SS and/or essential SI only on demand) when it is not serving any UE 314 in the RRC connected state. In such embodiments, the energy saving cell may switch to transmitting its SS and/or essential SI with the periodic transmission pattern when it serves a UE 314 in the RRC connected state.

[0108] As used herein, a "periodic transmission pattern" or "periodic basis for transmission" refers to the regular transmission, e.g., of the SS and/or essential SI, at regular intervals. In contrast, a "semi-persistent transmission pattern" or "semi-periodic basis for transmission" refers to the transmission, e.g., of the SS and/or essential SI, according to an irregular pattern. As discussed in greater detail below, the semi-persistent transmission pattern may comprise an activation period and a deactivation period, where the SS and/or essential SI is transmitted at regular intervals during the activation period, while no transmission of SS and/or essential SI is made during the deactivation period. As used herein, an "on-demand transmission pattern" or "on-demand basis for transmission" refers to the transmission, e.g., of the SS and/or essential SI, in response to a request (e.g., a "demand") for the SS and/or essential SI and not according to a regular pattern.

[0109] Techniques are disclosed herein to enable network energy saving by minimization of SSB/ MIB/ SI transmission and/or paging, e.g., by using semi-persistent transmission patterns or an on-demand basis for transmission, without adversely affecting the user experience due to longer call setup time, or without delaying system information change notification.

[0110] Aspects of a first solution describe techniques for cell selection and re-selection for cells with semi-persistent SS and/or essential SI transmission. In some implementations, a radio access network (RAN) may activate and deactivate transmission of synchronization signal and/or essential system information (SI) such as MIB and SIB1 of a cell in a short time scale, e.g., 640ms, 1280ms.

[0111] In one example, within a first time window of 640ms, synchronization signals (SS) are transmitted with a periodicity selected from {5, 10, 20, 40, 80, 160ms}, MIB

with a periodicity of 80ms or same as the SS periodicity, and SIB1 with a periodicity of 160ms. In a following second time window of 640ms, SS, MIB, and SIB1 are not transmitted.

[0112] In another example, once activated, SS and/or essential SI are transmitted periodically for an indicated duration, with an SS periodicity smaller than the indicated duration. After the indicated duration elapses, a UE assumes that SS and/or essential SI transmissions are deactivated.

[0113] In one implementation, a UE receives an indication that a cell transmits SS and/or essential SI periodically or not via SS and/or essential SI of the cell. In one implementation, a first set of SS sequences or a first set of orthogonal cover codes applicable to SS sequences are predefined for cells with periodic SS and/or essential SI transmission, while a second set of SS sequences or a second set of orthogonal cover codes applicable to the SS sequences are predefined or configured for cells with semi-persistent or on-demand based transmission of SS and/or essential SI. The UE identifies whether a cell transmits SS and/or essential SI periodically or not based on detection of SS of the cell.

[0114] In another implementation, the MIB of a cell includes a bit field indicating whether SS and/or essential SI of the cell are transmitted periodically or not. For example, a value ‘0’ of the bit field indicates semi-persistent or on-demand transmission of SS and/or essential SI, and a value ‘1’ of the bit field indicates periodic transmission of SS and/or essential SI.

[0115] In one implementation, if a UE detects a cell (i.e., detects SS of the cell), identifies that the cell transmits essential SI semi-persistently or on an on-demand basis, and does not acquire MIB and/or SIB1 due to deactivation of the essential SI transmission, the UE considers that the cell is not “Barred”. That is, the UE shall treat the cell as candidate during cell selection and cell reselection procedures.

[0116] In an additional implementation, if the strongest cell of a given RF channel (e.g., the cell with the highest RSRP and/or RSRQ on the frequency layer) has non-periodic transmission of SS and/or essential SI, a UE may search for the next strongest cell(s) (i.e., one or more second strongest cells). The UE identifies that the cell transmits the essential SI semi-persistently or on an on-demand basis by detecting the SS of the cell

and/or by receiving an indication in a physical broadcast channel (PBCH) from the cell. Alternatively, or additionally, the UE identifies that the cell has non-periodic transmission of the essential SI by receiving neighbor cell information from another cell, where the neighbor cell information indicates a basis for transmission of the SS and/or essential SI (e.g., a periodic, a semi-periodic, or an on-demand basis for transmission). In one embodiment, the neighbor cell information (also referred to as assistance information) is broadcast in system information, such as SIB1, SIB4, or a new SIB.

[0117] In 6G RAN, there might be many cells transmitting SS and/or essential SI semi-persistently or on an on-demand basis for energy savings. If those cells are excluded for cell selection and reselection, too many idle/inactive UEs may camp on a cell transmitting SS and/or essential SI periodically, which may cause access delay, e.g., due to frequent random access collisions.

[0118] If activation and deactivation of SS and/or essential SI transmission of a cell occur in a short time scale, e.g., 640ms, 1280ms, a UE keeps the cell as candidate and tries to acquire MIB and/or SIB1 of the cell when the transmission of MIB and/or SIB1 of the cell is activated. For the initial cell selection, instead of waiting for the activation of the MIB and/or SIB1 transmission, the UE may search and select the next/second strongest cell(s) in the same frequency layer (e.g., RF channel or carrier frequency).

[0119] In one implementation, a UE selects a first cell, which transmits SS and/or essential SI periodically, and receives, from the first cell, a configuration for monitoring a dynamic activation and deactivation indication of SS and/or essential SI transmission of a second cell, where the second cell transmits SS and/or essential SI semi-persistently. The UE monitors a dynamic activation and deactivation indication of SS and/or essential SI transmission of the second cell according to the received monitoring configuration. The monitoring configuration comprises at least a physical downlink control channel (PDCCH) monitoring configuration with a control channel resource set (CORESET) and timing information such as periodicity and slot and/or symbol offset.

[0120] In one implementation, the UE is configured to monitor a dynamic activation and deactivation indication of SS and/or essential SI transmission of the second cell upon determining that a first cell measurement value (e.g., RSRP value, RSRQ value, signal-to interference and noise ratio (SINR) value, received signal strength indicator (RSSI) value) is below a configured or predefined threshold value. In another or additional

implementation, the UE is configured to monitor a dynamic activation and deactivation indication of SS and/or essential SI transmission of the second cell upon determining that the best SS index (or beam index) of the first cell measurement corresponds to one or more configured SS indices (or beam indices) of the first cell.

[0121] In one implementation, a dynamic activation and deactivation indication of semi-persistent SS and/or essential SI transmission of the second cell is sent by the first cell via a medium access control (MAC) control element (CE) carried in a physical downlink shared channel (PDSCH) and/or downlink control information (DCI) carried in a PDCCH.

[0122] In one example, the MAC CE indicates a set of neighbor cells including the second cell with dynamic activation of SS and/or essential SI transmission. In another example, each bitfield of the DCI corresponds to one or more neighbor cells and indicates an activation/deactivation of the transmission of SS and/or essential SI of the one or more neighbor cells. Upon receiving a dynamic activation indication, the UE detects (if not already detected) and measures SS of the second cell, acquires the essential SI (e.g., MIB and/or SIB1) of the second cell, and determines whether to reselect to the second cell or not.

[0123] In another implementation, a dynamic activation and deactivation indication of semi-persistent SS and/or essential SI transmission of the second cell is sent by the second cell.

[0124] In one implementation, the second cell transmits SS periodically but transmits essential SI semi-persistently with a dynamic activation and deactivation indication. The UE monitors a dynamic activation and deactivation indication of essential SI transmission of the second cell, only if the UE has successfully detected the SS of the second cell. For example, a dynamic activation indication is DCI scheduling a PDSCH carrying the essential SI of the second cell.

[0125] In another example, a bit field for a dynamic activation and deactivation indication is configured within DCI carrying other information such as paging early indication (PEI). Upon receiving a dynamic activation indication, the UE acquires the essential SI (e.g., MIB and/or SIB1) of the second cell and determines whether to reselect to the second cell or not.

[0126] In another implementation, the second cell transmits SS and essential SI semi-persistently with a dynamic activation and deactivation indication. A monitoring occasion for a dynamic activation and deactivation indication of SS and essential SI transmission of the second cell comprises an SS occasion, a PBCH occasion, and a PDCCH monitoring occasion for PDCCH scheduling a PDSCH carrying the remaining essential SI. In the monitoring occasion, the UE first tries to detect SS of the second cell. By successfully detecting the SS of the second cell, the UE identifies that transmission of SS and essential SI of the second cell is activated, and further performs blind decoding of PDCCH candidates to receive the essential SI.

[0127] According to aspects of a second solution, when a UE camps on a cell transmitting SS and/or essential SI semi-persistently, the UE may receive, from the cell, a configuration to monitor an indication of activation/deactivation (or being active/inactive) for SS and/or essential SI transmission of the cell. The UE may determine that the cell on which it camps transmits the SS and/or essential SI semi-persistently based on detection of SS and acquisition of essential SI which were transmitted previously. In one implementation, a set of monitoring configurations for a dynamic activation/deactivation indication are predefined, and MIB of the cell further indicates a selected monitoring configuration.

[0128] **Figure 4** depicts an exemplary semi-persistent transmission pattern 400 including the activation and deactivation of SS, essential SI, and paging transmission in an energy saving cell, in accordance with aspects of the present disclosure. In a first time window 402 of SS and essential SI transmission, a UE receives an activation indication 404 for SS and essential SI transmission and further receives a positive PEI (i.e., command to monitor paging DCI) for two associated paging cycles 406, 408. For monitoring the paging DCI, the UE may reacquire time and/or frequency synchronization using SS of the energy saving cell. In a second time window 410 of SS and essential SI transmission, the UE does not detect a DCI format indicating activation/deactivation of SS and essential SI transmission and PEI. Upon not detecting the DCI format, the UE assumes that SS and essential SI transmission is deactivated, and further assumes that paging occasions of associated paging cycles are not valid (or disabled).

[0129] In one implementation, when a UE camps on a cell transmitting SS and/or essential SI semi-persistently and the UE monitors a dynamic activation/deactivation

indication of SS and/or essential SI transmission of the cell, the UE assumes that valid paging occasions of the cell are paging occasions of a paging cycle associated with a time window of active SS transmission.

[0130] In an implementation, a RAN configures a paging cycle of the cell as an integer multiple or a factor of the activation/deactivation time window duration (e.g., paging cycle of 320ms for an activation/deactivation time window duration of 640ms). Further, the UE assumes that valid random access channel (RACH) occasions are RACH occasions associated with a time window of active SS transmission.

[0131] In an implementation, the RAN configures a SS-to-RACH occasion mapping periodicity of the cell as an integer multiple or a factor of the activation/deactivation time window duration (e.g., SS-to-RACH occasions mapping periodicity of 160ms for an activation/deactivation time window duration of 640ms).

[0132] In an implementation, a monitoring configuration of a dynamic indication of activation/deactivation for SS and/or essential SI transmission of a cell determines periodically occurring PDCCH monitoring occasions based on a periodicity and subframe, slot, and/or symbol offset(s), and the activation/deactivation indication is conveyed in PDCCH, e.g., via DCI. In one example, a DCI format comprises a dynamic indication of activation/deactivation for SS and/or essential SI transmission and paging DCI. In another example, a DCI format comprises the dynamic indication of activation/deactivation and PEI.

[0133] Before a UE camping on a cell performs blind decoding of PDCCH for an activation/deactivation indication for SS and/or essential SI transmission of the cell, the UE may try to re-acquire time and frequency synchronization of the cell by trying to detect potentially newly transmitted SS. When the UE does not detect a DCI format carrying the dynamic indication of activation/deactivation in a monitoring occasion, the UE assumes that SS and/or essential SI transmission is deactivated for a corresponding period, and further assumes that paging reception on associated paging occasions and random access on associated RACH occasions are disabled. If the UE needs to access to a network while the cell being inactive (i.e., not transmitting SS and/or essential SI) for mobile originated data, the UE may reselect to a different cell that transmits SS and/or essential SI periodically.

[0134] In an implementation, if a UE detects a DCI format carrying PEI and an activation/deactivation indication for SS and/or essential SI transmission and if the detected DCI format indicates that SS and/or essential SI transmission is deactivated but there may be a paging message for the UE, the UE reselects to a cell with periodic SS and/or essential SI transmission and monitors paging in the reselected cell. Additionally, the UE may have received an indication of one or more cells for re-selection as part of essential SI in the previous transmission of essential SI. This allows a network to minimize paging transmission for network energy savings, while the network can page UEs without delay.

[0135] In other implementations, a RAN does not configure paging occasions for a cell that activates and deactivates transmission of SS and/or essential SI. Alternatively and/or additionally, the RAN does not configure RACH occasions for the cell that transmits SS and/or essential SI semi-persistently.

[0136] According to aspects of a third solution, a UE receives information of cell-specific cell reselection priority of a cell for intra-frequency cell reselection and for equal priority inter-frequency cell reselection. Cell reselection to a cell on an equal priority intra-RAT frequency or on the same frequency is based on cell-specific cell reselection priority and cell ranking criteria. In an implementation, a cell-specific cell reselection priority of a cell is indicated in MIB or SIB1 of the cell.

[0137] In one implementation, a UE performs cell reselection to a cell of a higher priority RAT or of a higher priority frequency, if multiple cells of different priorities fulfil the cell reselection criteria. If a UE performs cell reselection to a cell on an equal priority frequency or on the same frequency (i.e., intra-frequency cell reselection), the UE performs cell reselection to the highest ranked cell among cells with the highest cell-specific cell reselection priority, which is found to be suitable.

[0138] In one example, the cell-ranking criterion R_s for serving cell and R_n for neighboring cells is defined by:

$$R_s = Q_{meas,s} + Q_{hyst} - Qoffset_{temp}$$

$$R_n = Q_{meas,n} - Qoffset - Qoffset_{temp}$$

[0139] The terms of the above equations are defined in Table 2, below:

Table 2

Q_{meas}	RSRP measurement quantity used in cell reselections.
Qoffset	For intra-frequency: Equal to $Qoffset_{s,n}$, if $Qoffset_{s,n}$ is valid, otherwise this is equal to zero. For inter-frequency: Equal to $Qoffset_{s,n}$ plus $Qoffset_{frequency}$, if $Qoffset_{s,n}$ is valid, otherwise this is equal to $Qoffset_{frequency}$.
$Qoffset_{temp}$	Offset temporarily applied to a cell

[0140] In one example, a UE would reselect a new cell with the same cell-specific cell reselection priority, only if 1) the new cell has a higher rank than a serving cell during a time interval $Treselection_{RAT}$ and 2) more than 1 second has elapsed since the UE camped on the current serving cell.

[0141] In another example, cell reselection to a cell with a higher cell-specific cell reselection priority than cell-specific cell reselection priority of a current serving cell is performed if a cell with the higher cell-specific cell reselection priority fulfils $Squal > Thresh_{X,\ HighQ}$ (if a threshold value for quality measure is indicated) or $Srxlev > Thresh_{X,\ HighP}$ during a time interval $Treselection_{RAT}$, and if more than 1 second has elapsed since the UE camped on the current serving cell. Note that the threshold value for quality measure may be a configured threshold or a predefined threshold.

[0142] In yet another example, cell reselection to a cell with a lower cell-specific cell reselection priority than cell-specific cell reselection priority of a current serving cell is performed if more than 1 second has elapsed since the UE camped on the current serving cell and if the current serving cell fulfils $Squal < Thresh_{Serving,\ LowQ}$ and a cell with the lower cell-specific cell reselection priority fulfils $Squal > Thresh_{X,\ LowQ}$ during a time interval $Treselection_{RAT}$ if a threshold value for quality measure is indicated; otherwise, the current serving cell fulfils $Srxlev < Thresh_{Serving,\ LowP}$ and a cell with the lower cell-specific cell reselection priority fulfils $Srxlev > Thresh_{X,\ LowP}$ during a time interval $Treselection_{RAT}$.

[0143] When low power small cells and coverage providing macro cells are deployed in the same frequency layer (e.g., RF channel, or carrier frequency), a network can assign a cell-specific cell reselection priority into each cell to manage UE's cell association. Depending on traffic conditions and/or other considerations, a network may want to

offload some UEs to overlaying small cells and/or alternatively, the network may want other UEs to camp on an underlaying macro cell so that small cells can transition into energy saving state easily.

[0144] In an exemplary implementation, a network assigns a higher cell-specific cell reselection priority to a macro cell over small cells deployed under the macro cell coverage so that UEs in an idle or inactive state (i.e., RRC_IDLE, RRC_INACTIVE) within the macro cell coverage can select the macro cell preferably over the small cells.

[0145] In another exemplary implementation, a network assigns a higher cell-specific cell reselection priority to some small cells over a macro cell so that some idle or inactive UEs can camp on one of the small cells and potential random access collision and/or insufficient resources for scheduling PDCCHs (i.e., PDCCH blocking) in the macro cell can be avoided.

[0146] **Figure 5** illustrates an example of a UE 500 in accordance with aspects of the present disclosure. The UE 500 may include a processor 502, a memory 504, a controller 506, and a transceiver 508. The processor 502, the memory 504, the controller 506, or the transceiver 508, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[0147] The processor 502, the memory 504, the controller 506, or the transceiver 508, or various combinations or components thereof may be implemented in hardware (e.g., circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[0148] The processor 502 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a central processing unit (CPU), an ASIC, a field programmable gate array (FPGA), or any combination thereof). In some implementations, the processor 502 may be configured to operate the memory 504. In some other implementations, the memory 504 may be integrated into the processor 502. The

processor 502 may be configured to execute computer-readable instructions stored in the memory 504 to cause the UE 500 to perform various functions of the present disclosure.

[0149] The memory 504 may include volatile or non-volatile memory. The memory 504 may store computer-readable, computer-executable code including instructions that, when executed by the processor 502, cause the UE 500 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as the memory 504 or another type of memory. Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer.

[0150] In some implementations, the processor 502 and the memory 504 coupled with the processor 502 may be configured to cause the UE 500 to perform various functions (e.g., operations, signaling) described herein (e.g., executing, by the processor 502, instructions stored in the memory 504). In some implementations, the processor 502 may include multiple processors and the memory 504 may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may be individually or collectively, configured to perform various functions (e.g., operations, signaling) of the UE 500 as disclosed herein.

[0151] The processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to perform a cell selection procedure for a set of one or more cells, where one or more of at least one synchronization signal or at least one essential SI associated with a first cell of the set of one or more cells corresponds to a periodic basis for transmission, and where at least one part of at least one essential SI associated with at least one second cell of the set of one or more cells is associated with an on-demand basis for transmission. Alternatively, the at least one part of at least one essential SI associated with the at least one second cell may correspond to a semi-persistent basis for transmission. In various implementations, the at least one essential SI comprises one or more of a MIB or a SIB1.

[0152] The processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to select the first cell to camp on based at least in part on the cell selection procedure. The processor 502 coupled with the memory

504 may be configured to, capable of, or operable to cause the UE 500 to identify the at least one second cell of the set of one or more cells during the cell selection procedure.

[0153] The processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to assign the at least one second cell as a candidate cell for one or more of a cell reselection procedure or the cell selection procedure based at least in part on a failure to acquire the at least one part of the at least one essential SI, e.g., associated with the at least one second cell. In some implementations, the failure to acquire the at least one part of the at least one essential SI is based at least in part on a deactivation associated with the on-demand basis. Alternatively, the failure to acquire the at least one part of the at least one essential SI may be based at least in part on a deactivation associated with the semi-persistent pattern. As described above, the semi-persistent pattern may include a period of activated transmission followed by a period of deactivated transmission of synchronization signal and/or essential SI. Similarly, the on-demand basis for transmission may include a period of activated transmission (i.e., triggered by a request for synchronization signal and/or essential SI of the second cell) followed by an indeterminate period of deactivated transmission of the synchronization signal and/or essential SI.

[0154] In some implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to detect at least one synchronization signal associated with the at least one second cell and to determine, based on the detected at least one synchronization signal, that the at least one part of the at least one essential SI associated with the at least one second cell is transmitted on the on-demand basis (or corresponds to the semi-persistent pattern). In some such implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to assign the at least one second cell of the set of one or more cells as the candidate cell based at least in part on the at least one part of the at least one essential SI being associated with the at least one second cell corresponds to the semi-persistent pattern.

[0155] In some implementations, the first cell of the set of one or more cells and the at least one second cell of the set of one or more cells are associated with a radio frequency (RF) channel. In certain implementations, the at least one second cell is a first strongest cell of the set of one or more cells associated with the RF channel (e.g., the cell

with the highest RSRP and/or RSRQ) and the first cell is a second strongest cell (i.e., next strongest cell) of the set of one or more cells associated with the RF channel (e.g., the cell with the next highest RSRP and/or RSRQ).

[0156] In certain implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to search for the second strongest cell of the set of one or more cells associated with RF channel based at least in part on at least one part of essential SI associated with the first strongest cell associated with the on-demand basis (or corresponding to the semi-persistent pattern), where the first cell is selected based at least in part on the search for the second strongest cell.

[0157] In some implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to receive neighbor cell information (e.g., assistance information) from the first cell, e.g., broadcast in SI. In such implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to determine, based at least in part on the neighbor cell information, that the at least one part of the at least one essential SI associated with the at least one second cell is associated with the on-demand basis (or corresponds to the semi-persistent pattern).

[0158] In some implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to receive a configuration for requesting the at least one part of the at least one essential SI associated with the at least one second cell. In some implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to receive a configuration associated with monitoring for at least one indication (e.g., the dynamic activation/ deactivation indication described above) that indicates an activation or deactivation of at least one transmission of the at least one part of the at least one essential SI associated with the at least one second cell and to acquire the at least one part of the at least one essential SI associated with the at least one second cell.

[0159] In certain implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to obtain at least one measurement value associated with the first cell and to monitor for the at least one indication in response to the at least one measurement value associated with the first cell

satisfying (e.g., being lower than) a threshold value (e.g., a configured threshold value or a predefined threshold value). In one implementation, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to receive that at least one indication from the first cell. In another implementation, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to receive the at least one indication from the second cell.

[0160] In certain implementations, the synchronization signal of the second cell is associated with the periodic pattern (e.g., a periodic basis for transmission). In such implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to monitor for the at least one indication based at least in part on successful detection of the synchronization signal of the second cell.

[0161] In certain implementations, the synchronization signal and an entirety of the essential SI of the second cell is associated with the on-demand basis (or semi-persistent pattern). In such implementations, the at least one indication indicates a transmission of the synchronization signal and the entirety of the essential SI of the second cell.

[0162] In some implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to perform the cell reselection procedure and to camp on to the at least one second cell based at least in part on the cell reselection procedure. In certain implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to receive information of cell-specific cell reselection priorities of the first cell and of the second cell. In such implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to perform the cell reselection to the second cell based on a set of measurement values associated with the first cell and the second cell and further based on the cell-specific cell reselection priorities of the first cell and of the second cell.

[0163] As another example of supporting the wireless communication of the UE, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to support a means for identifying a cell of a set of one or more cells during one or more of a cell selection procedure or a cell reselection procedure, where one or more of at least one synchronization signal or at least one

essential SI associated with the cell is associated with an on-demand basis for transmission. Alternatively, the at least one part of at least one essential SI associated with the at least one second cell may correspond to a semi-persistent pattern. Here, the at least one essential SI may include one or more of a MIB or a SIB1 for the cell. The processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to support a means for selecting the cell to camp on based at least in part on one or more of the cell selection procedure or the cell reselection procedure.

[0164] The processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to receive a configuration associated with monitoring for at least one indication that indicates an activation or deactivation of at least one transmission of the at least one synchronization signal or the at least one essential SI associated with the cell. The processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to monitor the at least one indication based at least in part on the configuration.

[0165] In some implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to receive the MIB associated with the cell, the MIB indicating the configuration. In such implementations, the configuration is selected from a set of predefined monitoring configurations associated with the at least one indication.

[0166] In some implementations, the at least one indication indicates a time window of active synchronization signal transmission. In such implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to monitor a paging DCI only on paging occasions of a paging cycle associated with the time window of active synchronization signal transmission.

[0167] In some implementations, the at least one indication indicates a time window of active synchronization signal transmission. In such implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to perform a random access only on PRACH occasions associated with the time window of active synchronization signal transmission.

[0168] In some implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to receive a DCI format comprising the at least one indication and a PEI. In certain implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 to detect the DCI format, where the at least one indication indicates that transmission of the at least one synchronization signal or the at least one essential SI associated with the cell is deactivated, and where the PEI indicates the UE to monitor paging DCI in an associated paging cycle. In such implementations, the processor 502 coupled with the memory 504 may be configured to, capable of, or operable to cause the UE 500 configured to reselect to another cell (i.e., second cell) corresponding to a periodic pattern (e.g., a periodic basis for transmission) based at least in part on detecting the DCI format, and to monitor the paging DCI in the reselected cell (i.e., second cell).

[0169] The controller 506 may manage input and output signals for the UE 500. The controller 506 may also manage peripherals not integrated into the UE 500. In some implementations, the controller 506 may utilize an operating system (OS) such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 506 may be implemented as part of the processor 502.

[0170] In some implementations, the UE 500 may include at least one transceiver 508. In some other implementations, the UE 500 may have more than one transceiver 508. The transceiver 508 may represent a wireless transceiver. The transceiver 508 may include one or more receiver chains 510, one or more transmitter chains 512, or a combination thereof.

[0171] A receiver chain 510 may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receiver chain 510 may include one or more antennas for receiving the signal over the air or wireless medium. The receiver chain 510 may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receiver chain 510 may include at least one demodulator configured to demodulate the received signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receiver chain 510 may include at least one decoder for decoding/ processing the demodulated signal to receive the transmitted data.

[0172] A transmitter chain 512 may be configured to generate and transmit signals (e.g., control information, data, packets). The transmitter chain 512 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 transmitter chain 512 may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 512 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0173] **Figure 6** illustrates an example of a processor 600 in accordance with aspects of the present disclosure. The processor 600 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 600 may include a controller 602 configured to perform various operations in accordance with examples as described herein. The processor 600 may optionally include at least one memory 604, which may be, for example, an L1/L2/L3 cache. Additionally, or alternatively, the processor 600 may optionally include one or more arithmetic-logic units (ALUs) 606. 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).

[0174] The processor 600 may be a processor chipset and include a protocol stack (e.g., a software stack) executed by the processor chipset to perform various operations (e.g., receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) in accordance with examples as described herein. The processor chipset may include one or more cores, one or more caches (e.g., memory local to or included in the processor chipset (e.g., the processor 600)) or other memory (e.g., random access memory (RAM), read-only memory (ROM), dynamic RAM (DRAM), synchronous dynamic RAM (SDRAM), static RAM (SRAM), ferroelectric RAM (FeRAM), magnetic RAM (MRAM), resistive RAM (RRAM), flash memory, phase change memory (PCM), and others).

[0175] The controller 602 may be configured to manage and coordinate various operations (e.g., signaling, receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) of the processor 600 to cause the processor 600 to support various operations in accordance with examples as described herein. For example, the controller 602 may operate as a control unit of the processor 600, generating control signals that manage the operation of various components of the processor 600. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0176] The controller 602 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 604 and determine subsequent instruction(s) to be executed to cause the processor 600 to support various operations in accordance with examples as described herein. The controller 602 may be configured to track memory address of instructions associated with the memory 604. The controller 602 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 602 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 600 to cause the processor 600 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 602 may be configured to manage flow of data within the processor 600. The controller 602 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 600.

[0177] The memory 604 may include one or more caches (e.g., memory local to or included in the processor 600) or other memory, such as RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementations, the memory 604 may reside within or on a processor chipset (e.g., local to the processor 600). In some other implementations, the memory 604 may reside external to the processor chipset (e.g., remote to the processor 600).

[0178] The memory 604 may store computer-readable, computer-executable code including instructions that, when executed by the processor 600, cause the processor 600 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. The

controller 602 and/or the processor 600 may be configured to execute computer-readable instructions stored in the memory 604 to cause the processor 600 to perform various functions. For example, the processor 600 and/or the controller 602 may be coupled with or to the memory 604, the processor 600, the controller 602, and the memory 604 may be configured to perform various functions described herein. In some examples, the processor 600 may include multiple processors and the memory 604 may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions herein.

[0179] The one or more ALUs 606 may be configured to support various operations in accordance with examples as described herein. In some implementations, the one or more ALUs 606 may reside within or on a processor chipset (e.g., the processor 600). In some other implementations, the one or more ALUs 606 may reside external to the processor chipset (e.g., the processor 600). One or more ALUs 606 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 606 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 606 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 606 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 606 to handle conditional operations, comparisons, and bitwise operations.

[0180] In some implementations, the processor 600 may support various functions (e.g., operations, signaling) of a UE, in accordance with examples as disclosed herein. For example, the controller 602 coupled with the memory 604 may be configured to, capable of, or operable to cause the processor 600 to perform a cell selection procedure for a set of one or more cells, where one or more of at least one synchronization signal or at least one essential SI associated with a first cell of the set of one or more cells corresponds to a periodic basis for transmission, and where at least one part of at least one essential SI associated with at least one second cell of the set of one or more cells is associated with an on-demand basis for transmission; select the first cell to camp on based at least in part on the cell selection procedure; assign the at least one second cell as a candidate cell for

one or more of a cell reselection procedure or the cell selection procedure based at least in part on a failure to acquire the at least one part of the at least one essential SI.

[0181] As another example, the controller 602 coupled with the memory 604 may be configured to, capable of, or operable to cause the processor 600 to identify a cell of a set of one or more cells during one or more of a cell selection procedure or a cell reselection procedure, where one or more of at least one synchronization signal or at least one essential SI associated with the cell corresponds to a semi-persistent pattern or an on-demand basis for transmission, and where the at least one essential SI comprises one or more of a MIB or a SIB1; select the cell to camp on based at least in part on one or more of the cell selection procedure or the cell reselection procedure; receive a configuration associated with monitor for at least one indication that indicates an activation or deactivation of at least one transmission of the at least one synchronization signal or the at least one essential SI associated with the cell; and monitor the at least one indication based at least in part on the configuration. Additionally, the controller 602 coupled with the memory 604 may be configured to, capable of, or operable to cause the processor 600 to perform one or more functions (e.g., operations, signaling) of the UE as described herein.

[0182] Additionally, or alternatively, in some other implementations, the processor 600 may support various functions (e.g., operations, signaling) of an NE (e.g., base station), in accordance with examples as disclosed herein. For example, the controller 602 coupled with the memory 604 may be configured to, capable of, or operable to cause the processor 600 to transmit one or more of at least one synchronization signal or at least one essential SI of a cell with an on-demand basis, where the at least one essential SI comprises one or more of a MIB or a SIB1; transmit a configuration associated with monitoring for at least one indication that indicates an activation or deactivation of at least one transmission of the at least one synchronization signal or the at least one essential SI associated with the cell; and transmit the at least one indication based at least in part on the configuration. Alternatively, the at least one part of the at least one essential SI may be transmitted according to a semi-persistent pattern. Additionally, the controller 602 coupled with the memory 604 may be configured to, capable of, or operable to cause the processor 600 to perform one or more functions (e.g., operations, signaling) of the NE as described herein.

[0183] **Figure 7** illustrates an example of an NE 700 in accordance with aspects of the present disclosure. The NE 700 may include a processor 702, a memory 704, a controller 706, and a transceiver 708. The processor 702, the memory 704, the controller 706, or the transceiver 708, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[0184] The processor 702, the memory 704, the controller 706, or the transceiver 708, or various combinations or components thereof may be implemented in hardware (e.g., circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[0185] The processor 702 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, or any combination thereof). In some implementations, the processor 702 may be configured to operate the memory 704. In some other implementations, the memory 704 may be integrated into the processor 702. The processor 702 may be configured to execute computer-readable instructions stored in the memory 704 to cause the NE 700 to perform various functions of the present disclosure.

[0186] The memory 704 may include volatile or non-volatile memory. The memory 704 may store computer-readable, computer-executable code including instructions when executed by the processor 702 cause the NE 700 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as the memory 704 or another type of memory. Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer.

[0187] In some implementations, the processor 702 and the memory 704 coupled with the processor 702 may be configured to cause the NE 700 to perform various functions (e.g., operations, signaling) described herein (e.g., executing, by the processor 702,

instructions stored in the memory 704). In some implementations, the processor 702 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 be individually or collectively, configured to perform various functions (e.g., operations, signaling) of the NE 700 as disclosed herein.

[0188] The processor 702 coupled with the memory 704 may be configured to, capable of, or operable to cause the NE 700 to transmit one or more of at least one synchronization signal or at least one essential SI of a cell with an on-demand basis, where the at least one essential SI comprises one or more of a MIB or a SIB1. on-demand basis. Alternatively, the at least one part of the at least one essential SI may be transmitted according to a semi-persistent pattern.

[0189] The processor 702 coupled with the memory 704 may be configured to, capable of, or operable to cause the NE 700 to transmit a configuration associated with monitoring for at least one indication (e.g., the dynamic activation/ deactivation indication described above) that indicates an activation or deactivation of at least one transmission of the at least one synchronization signal or the at least one essential SI associated with the cell.

[0190] The processor 702 coupled with the memory 704 may be configured to, capable of, or operable to cause the NE 700 to transmit the at least one indication based at least in part on the configuration. In some implementations, the configuration is selected from a set of predefined monitoring configurations associated with the at least one indication. In such implementations, the processor 702 coupled with the memory 704 may be configured to, capable of, or operable to cause the NE 700 to transmit a MIB associated with the cell, the MIB indicating the configuration.

[0191] In some implementations, the at least one indication indicates a time window of active synchronization signal transmission. In such implementations, the processor 702 coupled with the memory 704 may be configured to, capable of, or operable to cause the NE 700 to transmit a paging DCI only on paging occasions of a paging cycle associated with the time window of active synchronization signal transmission.

[0192] In some implementations, the at least one indication indicates a time window of active synchronization signal transmission. In certain implementations, the processor

702 coupled with the memory 704 may be configured to, capable of, or operable to cause the NE 700 to monitor a PRACH only on PRACH occasions associated with the time window of active synchronization signal transmission. In some implementations, the processor 702 coupled with the memory 704 may be configured to, capable of, or operable to cause the NE 700 to transmit a DCI format comprising the at least one indication and a PEI.

[0193] In some implementations, the cell is a first cell and the processor 702 coupled with the memory 704 may be configured to, capable of, or operable to cause the NE 700 to transmit at least one second synchronization signal or at least one second essential SI of a second cell with a periodic pattern (e.g., a periodic basis for transmission) and to transmit neighbor cell information from the second cell. In such implementations, the neighbor cell information indicates that the at least one synchronization signal or the at least one essential SI of the first cell is associated with the on-demand basis (or the semi-persistent pattern).

[0194] The controller 706 may manage input and output signals for the NE 700. The controller 706 may also manage peripherals not integrated into the NE 700. In some implementations, the controller 706 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 706 may be implemented as part of the processor 702.

[0195] In some implementations, the NE 700 may include at least one transceiver 708. In some other implementations, the NE 700 may have more than one transceiver 708. The transceiver 708 may represent a wireless transceiver. The transceiver 708 may include one or more receiver chains 710, one or more transmitter chains 712, or a combination thereof.

[0196] A receiver chain 710 may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receiver chain 710 may include one or more antennas for receiving the signal over the air or wireless medium. The receiver chain 710 may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receiver chain 710 may include at least one demodulator configured to demodulate the received signal and obtain the transmitted data by reversing the modulation technique applied during transmission of

the signal. The receiver chain 710 may include at least one decoder for decoding/ processing the demodulated signal to receive the transmitted data.

[0197] A transmitter chain 712 may be configured to generate and transmit signals (e.g., control information, data, packets). The transmitter chain 712 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 transmitter chain 712 may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 712 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0198] **Figure 8** depicts one embodiment of a method 800 in accordance with aspects of the present disclosure. In various embodiments, the operations of the method 800 may be implemented by a UE as described herein. In some implementations, the UE may execute a set of instructions to control the function elements of the UE to perform the described functions.

[0199] At step 802, the method 800 may include performing a cell selection procedure for a set of one or more cells, where one or more of at least one synchronization signal or at least one essential SI associated with a first cell of the set of one or more cells corresponds to a periodic basis for transmission, and where at least one part of at least one essential SI associated with at least one second cell of the set of one or more cells is associated with an on-demand basis for transmission. Here, the at least one essential SI comprises one or more of a MIB or a SIB1. The operations of step 802 may be performed in accordance with examples as described herein. In some implementations, aspects of the operation of step 802 may be performed by a UE, as described with reference to Figure 5.

[0200] At step 804, the method 800 may include selecting the first cell to camp on based at least in part on the cell selection procedure. The operations of step 804 may be performed in accordance with examples as described herein. In some implementations,

aspects of the operation of step 804 may be performed by a UE, as described with reference to Figure 5.

[0201] At step 806, the method 800 may include assigning the at least one second cell as a candidate cell for one or more of a cell reselection procedure or the cell selection procedure based at least in part on a failure to acquire the at least one part of the at least one essential SI. The operations of step 806 may be performed in accordance with examples as described herein. In some implementations, aspects of the operation of step 806 may be performed by a UE, as described with reference to Figure 5.

[0202] It should be noted that the method 800 described herein describes one possible implementation, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible.

[0203] **Figure 9** depicts one embodiment of a method 900 in accordance with aspects of the present disclosure. The operations of the method 900 may be implemented by a UE as described herein. In some implementations, the UE may execute a set of instructions to control the function elements of the UE to perform the described functions.

[0204] At step 902, the method 900 may include identifying a cell of a set of one or more cells during one or more of a cell selection procedure or a cell reselection procedure, where one or more of at least one synchronization signal or at least one essential SI associated with the cell corresponds to a semi-persistent pattern or an on-demand basis for transmission. Here, the at least one essential SI comprises one or more of a MIB or a SIB1. The operations of step 902 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of step 902 may be performed by a UE, as described with reference to Figure 5.

[0205] At step 904, the method 900 may include selecting the cell to camp on based at least in part on one or more of the cell selection procedure or the cell reselection procedure. The operations of step 904 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of step 904 may be performed by a UE, as described with reference to Figure 5.

[0206] At step 906, the method 900 may include receiving a configuration associated with monitoring for at least one indication that indicates an activation or deactivation of at least one transmission of the at least one synchronization signal or the at least one

essential SI associated with the cell. The operations of step 906 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of step 906 may be performed by a UE, as described with reference to Figure 5.

[0207] At step 908, the method 900 may include monitoring the at least one indication based at least in part on the configuration. The operations of step 908 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of step 908 may be performed by a UE, as described with reference to Figure 5.

[0208] It should be noted that the method 900 described herein describes one possible implementation, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible.

[0209] **Figure 10** depicts one embodiment of a method 1000 in accordance with aspects of the present disclosure. The operations of the method 1000 may be implemented by a NE, e.g., in a RAN, as described herein. In some implementations, the NE may execute a set of instructions to control the function elements of the NE to perform the described functions.

[0210] At step 1002, the method 1000 may include transmitting one or more of at least one synchronization signal or at least one essential SI of a cell with an on-demand basis, where the at least one essential SI comprises one or more of a MIB or a SIB1. The operations of step 1002 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of step 1002 may be performed by a NE, as described with reference to Figure 7.

[0211] At step 1004, the method 1000 may include transmitting a configuration associated with monitoring for at least one indication that indicates an activation or deactivation of at least one transmission of the at least one synchronization signal or the at least one essential SI associated with the cell. The operations of step 1004 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of step 1004 may be performed by a NE, as described with reference to Figure 7.

[0212] At step 1006, the method 1000 may include transmitting the at least one indication based at least in part on the configuration. The operations of step 1006 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of step 1006 may be performed by a NE, as described with reference to Figure 7.

[0213] It should be noted that the method 1000 described herein describes one possible implementation, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible.

[0214] 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.