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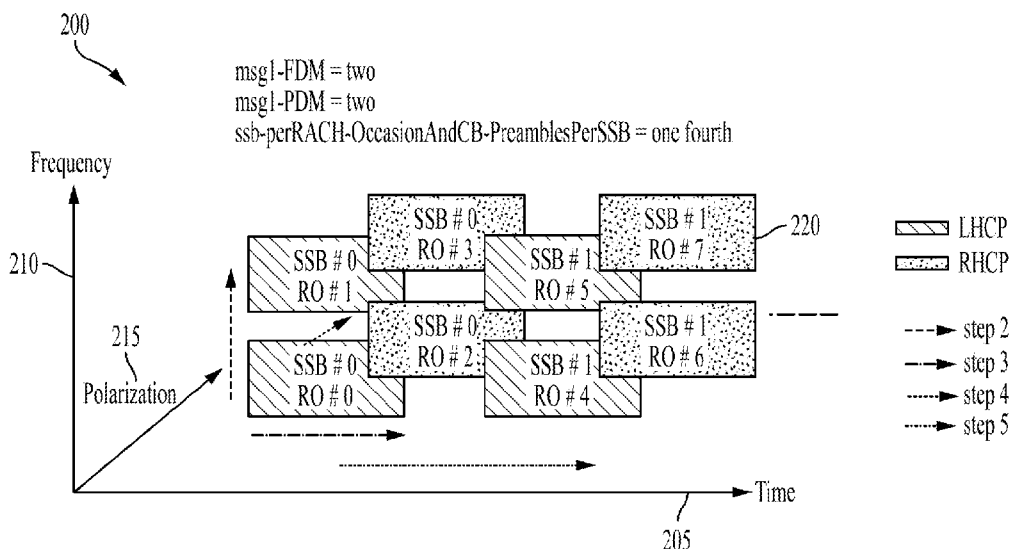


FIG. 2

(57) Abstract: Various aspects of the present disclosure relate to methods, apparatuses, and systems that support associating polarization types to random access channel transmissions. A UE and a network entity share polarization information, such as when the network entity configures the UE to associate a polarization type with random access channel (RACH) resources. The UE can employ or utilize polarization-based repetitions for Msg1, Msg3, and/or MsgA transmissions during the initial access procedures. In doing so, the UE can utilize the same time and frequency resources when performing polarization-based repetitions, enhancing coverage of the access procedures.

POLARIZATION-BASED REPETITIONS IN INITIAL ACCESS PROCEDURES

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 63/396,889, filed on August 10, 2022, entitled POLARIZATION-BASED REPETITIONS IN INITIAL ACCESS PROCEDURES, which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to wireless communications, and more specifically to network access procedures for user equipment (UEs).

BACKGROUND

[0003] A wireless communications system may include one or multiple network communication devices, such as base stations, which may be otherwise known as an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. Each network communication device, such as a base station, may support wireless communications for one or multiple user communication devices, which may be otherwise known as user equipment (UE), or other suitable terminology. The wireless communications system may support wireless communications with one or multiple user communication devices by utilizing resources of the wireless communication system (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers). Additionally, the wireless communications system may support wireless communications across various radio access technologies including third generation (3G) radio access technology, fourth generation (4G) radio access technology, fifth generation (5G) radio access technology, among other suitable radio access technologies beyond 5G (e.g., sixth generation (6G)).

[0004] A user communication device performs an initial access procedure, such as a random access channel (RACH) process, to acquire uplink synchronization with a network entity, such as a gNB of a wireless communications system supporting the 5G radio access

technology. The RACH process includes the UE sending a RACH preamble (e.g., Msg1) to the gNB, and, after a random access response from the gNB, sending a connection request or scheduled transmission (e.g., Msg3), often in repetition, to the gNB. The gNB, in response to the connection request, sends back a connection setup response indicating a successful uplink connection between the UE and the gNB.

SUMMARY

[0005] The present disclosure relates to methods, apparatuses, and systems that support associating polarization types to random access channel transmissions. A UE and a network entity share polarization information, such as when the network entity configures the UE to associate a polarization type with RACH resources. The UE can employ or utilize polarization-based repetitions for Msg1, Msg3, and/or MsgA transmissions during the initial access procedures. In doing so, the UE can utilize the same time and frequency resources when performing polarization-based repetitions, enhancing coverage of the access procedures.

[0006] Some implementations of the method and apparatuses described herein may further include a UE comprising a processor and a memory coupled with the processor, the processor configured to receive, from a network entity, a configuration that indicates polarization types associated with a repetition for uplink physical channels transmission during an initial access procedure, and transmit the repeated uplink physical channels based on the indicated polarization types.

[0007] In some implementations of the method and apparatuses described herein, the configuration indicates polarization types for performing repetitions for Msg1, Msg3, MsgA, or a combination thereof.

[0008] In some implementations of the method and apparatuses described herein, transmitting the repeated uplink physical channels includes transmitting multiple uplink physical channels multiple times while applying one or more polarization types.

[0009] In some implementations of the method and apparatuses described herein, transmitting the repeated uplink physical channels based on the indicated polarization types includes associating same frequency and time resources with different polarization types.

[0010] In some implementations of the method and apparatuses described herein, transmitting the repeated uplink physical channels based on the indicated polarization types includes configuring multiple, repeated physical random-access channel (PRACH) preamble transmissions for one or more detected signal synchronization blocks (SSBs) in a polarization domain.

[0011] In some implementations of the method and apparatuses described herein, transmitting the repeated uplink physical channels based on the indicated polarization types includes configuring PRACH transmissions for multiple RACH occasions (ROs).

[0012] In some implementations of the method and apparatuses described herein, transmitting the repeated uplink physical channels based on the indicated polarization types includes performing Msg3 repetitions in a polarization domain.

[0013] In some implementations of the method and apparatuses described herein, transmitting the repeated uplink physical channels based on the indicated polarization types includes configuring multiple MsgA repetitions in a polarization domain.

[0014] In some implementations of the method and apparatuses described herein, transmitting the repeated uplink physical channels based on the indicated polarization types includes transmitting MsgA preamble and MsgA PUSCH transmission in parallel using two different polarizations types at a same time.

[0015] In some implementations of the method and apparatuses described herein, a MsgA PUSCH occasion may overlap in time and frequency with any MsgA PRACH occasion but would differ in a polarization domain.

[0016] In some implementations of the method and apparatuses described herein, the polarization type includes left-hand circular polarization (LHCP) or right-hand circular polarization (RHCP).

[0017] In some implementations of the method and apparatuses described herein, the configuration is received from the network entity via radio resource control (RRC) signaling.

[0018] In some implementations of the method and apparatuses described herein, the configuration is received from the network entity of a non-terrestrial network (NTN).

[0019] Some implementations of the method and apparatuses described herein may further include a method performed by a UE, the method comprising receiving, from a network entity, a configuration that indicates polarization types associated with a repetition for uplink physical channels transmission during an initial access procedure and transmitting the repeated uplink physical channels based on the indicated polarization types.

[0020] In some implementations of the method and apparatuses described herein, the configuration indicates polarization types for performing repetitions for Msg1, Msg3, MsgA, or a combination thereof.

[0021] In some implementations of the method and apparatuses described herein, transmitting the repeated uplink physical channels includes transmitting multiple uplink physical channels multiple times while applying one or more polarization types.

[0022] In some implementations of the method and apparatuses described herein, transmitting the repeated uplink physical channels based on the indicated polarization types includes associating same frequency and time resources with different polarization types.

[0023] In some implementations of the method and apparatuses described herein, transmitting the repeated uplink physical channels based on the indicated polarization types includes configuring multiple, repeated physical random-access channel (PRACH) preamble transmissions for one or more detected signal synchronization blocks (SSBs) in a polarization domain.

[0024] In some implementations of the method and apparatuses described herein, transmitting the repeated uplink physical channels based on the indicated polarization types includes configuring PRACH transmissions for multiple RACH occasions (ROs).

[0025] In some implementations of the method and apparatuses described herein, transmitting the repeated uplink physical channels based on the indicated polarization types includes performing Msg3 repetitions in a polarization domain.

[0026] In some implementations of the method and apparatuses described herein, transmitting the repeated uplink physical channels based on the indicated polarization types includes configuring multiple MsgA repetitions in a polarization domain.

[0027] In some implementations of the method and apparatuses described herein, transmitting the repeated uplink physical channels based on the indicated polarization types includes transmitting MsgA preamble and MsgA PUSCH transmission in parallel using two different polarizations types at a same time.

[0028] In some implementations of the method and apparatuses described herein, a MsgA PUSCH occasion may overlap in time and frequency with any MsgA PRACH occasion but would differ in a polarization domain.

[0029] In some implementations of the method and apparatuses described herein, the polarization type includes left-hand circular polarization (LHCP) or right-hand circular polarization (RHCP).

[0030] In some implementations of the method and apparatuses described herein, the configuration is received from the network entity via radio resource control (RRC) signaling.

[0031] In some implementations of the method and apparatuses described herein, the configuration is received from the network entity of a non-terrestrial network (NTN).

[0032] Some implementations of the method and apparatuses described herein may further include a network entity, comprising a processor and a memory coupled with the processor, the processor configured to cause the network entity to transmit, to a UE, a configuration that indicates polarization types associated with a repetition for uplink physical channels transmission during an initial access procedure performed by the UE.

[0033] In some implementations of the method and apparatuses described herein, the configuration is transmitted via RRC signaling.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] FIG. 1 illustrates an example of a wireless communications system that supports polarization-based repetitions in initial access procedures, in accordance with aspects of the present disclosure.

[0035] FIG. 2 illustrates an example of a diagram that supports one synchronization signal block (SSB) sharing multiple RACH occasions (ROs) in a polarization domain in accordance with aspects of the present disclosure.

[0036] FIG. 3 illustrates an example of a diagram that supports triggering Msg3 repetitions in the polarization domain in accordance with aspects of the present disclosure.

[0037] FIG. 4 illustrates an example of a block diagram of a UE that supports polarization-based repetitions in initial access procedures in accordance with aspects of the present disclosure.

[0038] FIG. 5 illustrates a flowchart of a method that supports polarization-based repetitions in initial access procedures in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

[0039] In wireless communication systems, such as satellite-based networks or other non-terrestrial network (NTNs), performance degradation can occur when polarization is not known or shared between network entities and user communication devices. For example, due to issues with a low link budget for NTNs, polarization mismatches between devices can result in frequent delays in connection establishment processes. Further, polarization mismatches in specific messaging (e.g., Msg1 or Msg3 of the RACH process) can lead reductions in coverage during initial access procedures, potential beam failures, and other drawbacks.

[0040] To address such problems, the technology described herein enables the sharing of polarization between devices, such as the configuration of UEs with polarization type information by network entities. For example, a network entity can configure a UE to employ or utilize polarization-based repetitions for Msg1, Msg3, and/or MsgA transmission during the initial access procedures. In doing so, the UE can utilize the same time and

frequency resources when performing polarization-based repetitions, because the repetitions are orthogonal in their polarization.

[0041] Thus, the sharing of polarization information during initial access procedures can enhance coverage of the random access channel during uplink synchronization. Further, the use of the polarization domain, orthogonal to the time domain and/or frequency domain, enhances the coverage during the access procedures without utilizing additional time or frequency resources, among other benefits.

[0042] Aspects of the present disclosure are described in the context of a wireless communications system. Aspects of the present disclosure are further illustrated and described with reference to device diagrams and flowcharts.

[0043] FIG. 1 illustrates an example of a wireless communications system 100 that supports polarization-based repetitions in initial access procedures in accordance with aspects of the present disclosure. The wireless communications system 100 may include one or more network entities 102, one or more UEs 104, a core network 106, and a packet data network 108. The wireless communications system 100 may support various radio access technologies. In some implementations, the wireless communications system 100 may be a 4G network, such as an LTE network or an LTE-Advanced (LTE-A) network. In some other implementations, the wireless communications system 100 may be a 5G network, such as an NR network. In other implementations, the wireless communications system 100 may be a combination of a 4G network and a 5G network, or other suitable radio access technology including Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20. The wireless communications system 100 may support radio access technologies beyond 5G. Additionally, the wireless communications system 100 may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

[0044] The one or more network entities 102 may be dispersed throughout a geographic region to form the wireless communications system 100. One or more of the network entities 102 described herein may be or include or may be referred to as a network node, a

base station, a network element, a radio access network (RAN), a base transceiver station, an access point, a NodeB, an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. A network entity 102 and a UE 104 may communicate via a communication link 110, which may be a wireless or wired connection. For example, a network entity 102 and a UE 104 may perform wireless communication (e.g., receive signaling, transmit signaling) over a Uu interface.

[0045] A network entity 102 may provide a geographic coverage area 112 for which the network entity 102 may support services (e.g., voice, video, packet data, messaging, broadcast, etc.) for one or more UEs 104 within the geographic coverage area 112. For example, a network entity 102 and a UE 104 may support wireless communication of signals related to services (e.g., voice, video, packet data, messaging, broadcast, etc.) according to one or multiple radio access technologies. In some implementations, a network entity 102 may be moveable, for example, a satellite associated with a non-terrestrial network. In some implementations, different geographic coverage areas 112 associated with the same or different radio access technologies may overlap, but the different geographic coverage areas 112 may be associated with different network entities 102. Information and signals described herein may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[0046] The one or more UEs 104 may be dispersed throughout a geographic region of the wireless communications system 100. A UE 104 may include or may be referred to as a mobile device, a wireless device, a remote device, a remote unit, a handheld device, or a subscriber device, or some other suitable terminology. In some implementations, the UE 104 may be referred to as a unit, a station, a terminal, or a client, among other examples. Additionally, or alternatively, the UE 104 may be referred to as an Internet-of-Things (IoT) device, an Internet-of-Everything (IoE) device, or machine-type communication (MTC) device, among other examples. In some implementations, a UE 104 may be stationary in

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

[0047] The one or more UEs 104 may be devices in different forms or having different capabilities. Some examples of UEs 104 are illustrated in FIG. 1. A UE 104 may be capable of communicating with various types of devices, such as the network entities 102, other UEs 104, or network equipment (e.g., the core network 106, the packet data network 108, a relay device, an integrated access and backhaul (IAB) node, or another network equipment), as shown in FIG. 1. Additionally, or alternatively, a UE 104 may support communication with other network entities 102 or UEs 104, which may act as relays in the wireless communications system 100.

[0048] A UE 104 may also be able to support wireless communication directly with other UEs 104 over a communication link 114. For example, a UE 104 may support wireless communication directly with another UE 104 over a device-to-device (D2D) communication link. In some implementations, such as vehicle-to-vehicle (V2V) deployments, vehicle-to-everything (V2X) deployments, or cellular-V2X deployments, the communication link 114 may be referred to as a sidelink. For example, a UE 104 may support wireless communication directly with another UE 104 over a PC5 interface.

[0049] A network entity 102 may support communications with the core network 106, or with another network entity 102, or both. For example, a network entity 102 may interface with the core network 106 through one or more backhaul links 116 (e.g., via an S1, N2, N2, or another network interface). The network entities 102 may communicate with each other over the backhaul links 116 (e.g., via an X2, Xn, or another network interface). In some implementations, the network entities 102 may communicate with each other directly (e.g., between the network entities 102). In some other implementations, the network entities 102 may communicate with each other or indirectly (e.g., via the core network 106). In some implementations, one or more network entities 102 may include subcomponents, such as an access network entity, which may be an example of an access node controller (ANC). An ANC may communicate with the one or more UEs 104 through one or more other access network transmission entities, which may be referred to as a radio heads, smart radio heads, or transmission-reception points (TRPs).

[0050] In some implementations, a network entity 102 may be configured in a disaggregated architecture, which may be configured to utilize a protocol stack physically or logically distributed among two or more network entities 102, such as an integrated access backhaul (IAB) network, an open RAN (O-RAN) (e.g., a network configuration sponsored by the O-RAN Alliance), or a virtualized RAN (vRAN) (e.g., a cloud RAN (C-RAN)). For example, a network entity 102 may include one or more of a central unit (CU), a distributed unit (DU), a radio unit (RU), a RAN Intelligent Controller (RIC) (e.g., a Near-Real Time RIC (Near-RT RIC), a Non-Real Time RIC (Non-RT RIC)), a Service Management and Orchestration (SMO) system, or any combination thereof.

[0051] An RU may also be referred to as a radio head, a smart radio head, a remote radio head (RRH), a remote radio unit (RRU), or a transmission reception point (TRP). One or more components of the network entities 102 in a disaggregated RAN architecture may be co-located, or one or more components of the network entities 102 may be located in distributed locations (e.g., separate physical locations). In some implementations, one or more network entities 102 of a disaggregated RAN architecture may be implemented as virtual units (e.g., a virtual CU (VCU), a virtual DU (VDU), a virtual RU (VRU)).

[0052] Split of functionality between a CU, a DU, and an RU may be flexible and may support different functionalities depending upon which functions (e.g., network layer functions, protocol layer functions, baseband functions, radio frequency functions, and any combinations thereof) are performed at a CU, a DU, or an RU. For example, a functional split of a protocol stack may be employed between a CU and a DU such that the CU may support one or more layers of the protocol stack and the DU may support one or more different layers of the protocol stack. In some implementations, the CU may host upper protocol layer (e.g., a layer 3 (L3), a layer 2 (L2)) functionality and signaling (e.g., Radio Resource Control (RRC), service data adaptation protocol (SDAP), Packet Data Convergence Protocol (PDCP)). The CU may be connected to one or more DUs or RUs, and the one or more DUs or RUs may host lower protocol layers, such as a layer 1 (L1) (e.g., physical (PHY) layer) or an L2 (e.g., radio link control (RLC) layer, medium access control (MAC) layer) functionality and signaling, and may each be at least partially controlled by the CU

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[0053] Additionally, or alternatively, a functional split of the protocol stack may be employed between a DU and an RU such that the DU may support one or more layers of the protocol stack and the RU may support one or more different layers of the protocol stack. The DU may support one or multiple different cells (e.g., via one or more RUs). In some implementations, a functional split between a CU and a DU, or between a DU and an RU may be within a protocol layer (e.g., some functions for a protocol layer may be performed by one of a CU, a DU, or an RU, while other functions of the protocol layer are performed by a different one of the CU, the DU, or the RU).

[0054] A CU may be functionally split further into CU control plane (CU-CP) and CU user plane (CU-UP) functions. A CU may be connected to one or more DUs via a midhaul communication link (e.g., F1, F1-c, F1-u), and a DU may be connected to one or more RUs via a fronthaul communication link (e.g., open fronthaul (FH) interface). In some implementations, a midhaul communication link or a fronthaul communication link may be implemented in accordance with an interface (e.g., a channel) between layers of a protocol stack supported by respective network entities 102 that are in communication via such communication links.

[0055] The core network 106 may support user authentication, access authorization, tracking, connectivity, and other access, routing, or mobility functions. The core network 106 may be an evolved packet core (EPC), or a 5G core (5GC), which may include a control plane entity that manages access and mobility (e.g., a mobility management entity (MME), an access and mobility management functions (AMF)) and a user plane entity that routes packets or interconnects to external networks (e.g., a serving gateway (S-GW), a Packet Data Network (PDN) gateway (P-GW), or a user plane function (UPF)). In some implementations, the control plane entity may manage non-access stratum (NAS) functions, such as mobility, authentication, and bearer management (e.g., data bearers, signal bearers, etc.) for the one or more UEs 104 served by the one or more network entities 102 associated with the core network 106.

[0056] The core network 106 may communicate with the packet data network 108 over one or more backhaul links 116 (e.g., via an S1, N2, N2, or another network interface). The packet data network 108 may include an application server 118. In some implementations,

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

[0057] In the wireless communications system 100, the network entities 102 and the UEs 104 may use resources of the wireless communication system 100 (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers)) to perform various operations (e.g., wireless communications). In some implementations, the network entities 102 and the UEs 104 may support different resource structures. For example, the network entities 102 and the UEs 104 may support different frame structures. In some implementations, such as in 4G, the network entities 102 and the UEs 104 may support a single frame structure. In some other implementations, such as in 5G and among other suitable radio access technologies, the network entities 102 and the UEs 104 may support various frame structures (i.e., multiple frame structures). The network entities 102 and the UEs 104 may support various frame structures based on one or more numerologies.

[0058] One or more numerologies may be supported in the wireless communications system 100, and a numerology may include a subcarrier spacing and a cyclic prefix. A first numerology (e.g., $\mu=0$) may be associated with a first subcarrier spacing (e.g., 15 kHz) and a normal cyclic prefix. In some implementations, the first numerology (e.g., $\mu=0$) associated with the first subcarrier spacing (e.g., 15 kHz) may utilize one slot per subframe. A second numerology (e.g., $\mu=1$) may be associated with a second subcarrier spacing (e.g., 30 kHz) and a normal cyclic prefix. A third numerology (e.g., $\mu=2$) may be associated with a third subcarrier spacing (e.g., 60 kHz) and a normal cyclic prefix or an extended cyclic prefix. A fourth numerology (e.g., $\mu=3$) may be associated with a fourth subcarrier spacing (e.g., 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g., $\mu=4$) may be associated with a fifth subcarrier spacing (e.g., 240 kHz) and a normal cyclic prefix.

[0059] 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.

[0060] Additionally or alternatively, a time interval of a resource (e.g., a communication resource) may be organized according to slots. For example, a subframe may include a number (e.g., quantity) of slots. The number of slots in each subframe may also depend on the one or more numerologies supported in the wireless communications system 100. For instance, the first, second, third, fourth, and fifth numerologies (i.e., $\mu=0$, $\mu=1$, $\mu=2$, $\mu=3$, $\mu=4$) associated with respective subcarrier spacings of 15 kHz, 30 kHz, 60 kHz, 120 kHz, and 240 kHz may utilize a single slot per subframe, two slots per subframe, four slots per subframe, eight slots per subframe, and 16 slots per subframe, respectively. Each slot may include a number (e.g., quantity) of symbols (e.g., OFDM symbols). In some implementations, the number (e.g., quantity) of slots for a subframe may depend on a numerology. For a normal cyclic prefix, a slot may include 14 symbols. For an extended cyclic prefix (e.g., applicable for 60 kHz subcarrier spacing), a slot may include 12 symbols. The relationship between the number of symbols per slot, the number of slots per subframe, and the number of slots per frame for a normal cyclic prefix and an extended cyclic prefix may depend on a numerology. It should be understood that reference to a first numerology (e.g., $\mu=0$) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

[0061] In the wireless communications system 100, an electromagnetic (EM) spectrum may be split, based on frequency or wavelength, into various classes, frequency bands, frequency channels, etc. By way of example, the wireless communications system 100 may support one or multiple operating frequency bands, such as frequency range designations FR1 (410 MHz – 7.125 GHz), FR2 (24.25 GHz – 52.6 GHz), FR3 (7.125 GHz – 24.25 GHz), FR4 (52.6 GHz – 114.25 GHz), FR4a or FR4-1 (52.6 GHz – 71 GHz), and FR5

(114.25 GHz – 300 GHz). In some implementations, the network entities 102 and the UEs 104 may perform wireless communications over one or more of the operating frequency bands. In some implementations, FR1 may be used by the network entities 102 and the UEs 104, among other equipment or devices for cellular communications traffic (e.g., control information, data). In some implementations, FR2 may be used by the network entities 102 and the UEs 104, among other equipment or devices for short-range, high data rate capabilities.

[0062] FR1 may be associated with one or multiple numerologies (e.g., at least three numerologies). For example, FR1 may be associated with a first numerology (e.g., $\mu=0$), which includes 15 kHz subcarrier spacing; a second numerology (e.g., $\mu=1$), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., $\mu=2$), which includes 60 kHz subcarrier spacing. FR2 may be associated with one or multiple numerologies (e.g., at least 2 numerologies). For example, FR2 may be associated with a third numerology (e.g., $\mu=2$), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., $\mu=3$), which includes 120 kHz subcarrier spacing.

[0063] As described herein, in some embodiments, a network entity can configure a UE, via implicit or explicit communication, to utilize polarization-based repetitions during Msg1, Msg3, and/or MsgA transmissions. In some embodiments, a UE, such as the UE 104, performs multiple/repeated PRACH preamble transmissions for one or multiple detected SSBs in the polarization domain. The number, or amount, of repetitions in the polarization domain may be explicitly configured by RRC, via RACH RRC information elements, for both contention based and contention free random channel access methods.

[0064] In some cases, the number of repetitions is based on two circular polarization types (e.g., left-hand circular polarization, or LHCP, and right-hand circular polarization, or RHCP). For example, RACH information elements can include a parameter field “*PolRep*,” with values {0,1}, to indicate a default repetition method based on the LHCP and RHCP. Thus, a parameter field of false indicates no repetition in the polarization domain, and a field of true indicates that the UE shall employ repetition in the polarization domain by transmitting PRACH preambles in both LHCP and RHCP.

[0065] In some cases, the number of polarization types to be used for repetitions can be greater than two, and can be pre-defined in the specification (e.g., via a mapping table that defines an index corresponding to polarization types to be used for repetition. For example, the mapping table can define “0” to represent LHCP and Linear, “1” to represent RHCP and LHCP, and “2” to represent RHCP, LHCP, and Linear. As described herein, RRC signaling can also indicate the number of polarization types (e.g., 1, 2, or 3) when the UE performs repetitions.

[0066] In some embodiments, the UE can perform RO configuration in the polarization domain where multiple ROs are configured for an SSB using time, frequency and polarize resources. FIG. 2 illustrates an example of a diagram 200 that supports one synchronization signal block (SSB) sharing multiple RACH occasions (ROs) in a polarization domain in accordance with aspects of the present disclosure. The diagram 200 illustrates the use of resources in a time domain 205, a frequency domain 210, and a polarization domain 215

[0067] As depicted, if higher layer parameters are $msg1-FDM=2$, $msg1-FDM=2$, and $ssb-perRACH-OccasionAndCB-PreamblesPerSSB = \text{one fourth}$, a single SSB is associated with 4 ROs 220. The UE can perform repetitions as follows: the UE utilizes the first two frequency resources over a single resource instance in the time domain 205 with one polarization, and then moves on to the next polarization using the same two time and frequency resources. The UE, then moves to the next time RO instance along the time domain 205.

[0068] In some embodiments, when there is no RO configuration in the polarization domain, a repetition in the polarization domain includes repeating configured ROs, using time-frequency resources, for an SSB candidate in the polarization domain.

[0069] In some embodiments, the UE is configured to perform PRACH repetitions in the polarization domain for a single detected SSB using the same PRACH preamble (e.g., to employ polarization diversity). In some cases, a UE is configured with one RO for an SSB candidate and configured (e.g., by default) to perform circular polarization-based repetitions using a polarization diversity method. Upon detection of the SSB, the UE may first transmit a preamble on the configured RO with one circular polarization type (e.g.,

LHCP) and then transmit the same preamble on the same time-frequency resources with a second circular polarization type (e.g., RHCP).

[0070] In some cases, UEs are configured with multiple beams and/or multiple ROs for an SSB candidate and configured to perform polarization diversity-based repetitions. Based on such configuration, the UEs can perform multiple PRACH preamble transmissions in the time-frequency domain and in the polarization domain. For example, the UE can repeat a preamble for each of the configured ROs for an SSB in the polarization domain (e.g., repeating the same preamble for a RO with multiple, different, configured polarizations).

[0071] In some embodiments, a UE is configured to perform PRACH repetitions in the polarization domain for a single detected SSB using different PRACH preambles (e.g., exhibiting polarization multiplexing). The utilization of polarization multiplexing can lower the probability of preamble collisions between UEs of a cell, such as in an NTN, which can have a large cell size with a large number attempting initial access to the network.

[0072] In some cases, a UE is configured with one RO for an SSB candidate and is configured (e.g., as a default configuration) to perform circular polarization-based repetitions using polarization multiplexing. Upon detection of the SSB, the UE first transmits a preamble on the configured RO with one circular polarization type (e.g., LHCP) and then transmits a second preamble on the same time-frequency resources using a second circular polarization type (e.g., RHCP).

[0073] In some cases, the configuration indicates that the UE randomly chooses a preamble from a preamble set for use with different polarizations of one RO. In other cases, each polarization repetition is configured or associated a set of preambles (e.g., preambles 0-31 are associated with LHCP, and preambles 32-63 are associated with RHCP).

[0074] In some cases, UEs are configured with multiple beams and/or multiple ROs for an SSB candidate and configured to perform polarization multiplexing-based repetitions. For example, a UE employs different preambles for repetitions in the polarization domain for each of the beams/ROs.

[0075] In some embodiments, a configuration can indicate a combination or mixture of polarization diversity and spatial multiplexing based repetitions when multiple beams

and/or multiple ROs are configured for an SSB. For example, some of the beams/ROs may use polarization diversity based repetitions and some other beams/ROs may use polarization multiplexing based repetitions for an SSB candidate.

[0076] In some embodiments, a UE is configured to transmit multiple PRACH preambles associated with multiple SSBs at the same time while they are multiplexed in the polarization domain. For example, a UE detects the multiple SSBs and simultaneously transmits the PRACH preambles associated with the best detected SSBs with different polarizations. In some cases, the number of polarization domain transmissions is based on the UE polarization capability and the number of best detected SSBs.

[0077] In some cases, a separate RO is defined in the polarization domain for each SSB, there is only one valid RO configured for one SSB in the polarization domain, or there is only one valid RO and the UE transmits preambles for multiple SSBs in the polarization domain. The configuration may include a list of valid preambles associated with all SSBs to be used for the second polarizations type, so the network has knowledge of the second SSB.

[0078] For example, if a UE has the capability of transmitting LHCP and RHCP polarizations, the UE identifies the best two SSBs (e.g., SSBs having a highest Reference Signal Received Power (RSRP) value within a predefined threshold) and searches for a valid RO for the first SSB. The UE may then transmit a PRACH preamble associated with the first SSB on the respective valid RO using a first polarization type (e.g., LHCP), and then search for the PRACH preamble associated with the second SSB on the same RO using a second polarization type (e.g., RHCP).

[0079] In some embodiments, the network does not explicitly indicate the use of polarization-based repetitions. Instead, a UE can perform repetitions based on the RSRP of a detected SSB. For example, if the RSRP level of an SSB is below a certain threshold, the UE would employ polarization-based repetitions for the RO of that SSB, where the type of repetitions (e.g., diversity or multiplexing) and polarization types (e.g., LHCP, RHCP, Linear, and so on) are separately configured, pre-defined or autonomously chosen by the UE. The threshold value for the RSRP level can also be predefined, configured through

RRC signaling, or autonomously selected by the UE and may depend on various factors such as cell layout, frequency reuse fact, and/or position of the UE (e.g., for contention free random access procedures).

[0080] In some embodiments, the UE performs or applies Msg3 repetitions in the polarization domain, in addition to time domain repetitions, where the multiple polarization-based repetitions can utilize the same time and frequency resources. The configuration of polarization-based repetitions can depend on the polarization capabilities of the UE.

[0081] In some cases, the network has knowledge of the polarization capability of the UE (e.g., what polarization types the UE can employ) and configures the polarization-based repetitions based on the indicated UE capability. The UE can explicitly or implicitly indicate polarization capabilities to the network during or within the Msg1 transmission of the initial access procedure.

[0082] For example, a UE may be configured to use multiple polarization-based PRACH repetitions (e.g., configured with LHCP, RHCP, and linear polarization types). However, the UE may have only LHCP and RHCP capabilities, and applies PRACH repetitions based its capabilities. In response to received PRACH repetitions, the network determines the UE capability of only LHCP and RHCP, and subsequently configures polarization-based Msg3 repetitions in a random access response (RAR) message using only LHCP and RHCP.

[0083] In some cases, the UE can configure the polarization-based Msg3 repetitions without receiving network configuration, where the repetitions on multiple polarizations are configured with a specified pattern. The UE applies repetitions based on its known capabilities, utilizing all or one of the polarizations-based repetitions in the specified pattern.

[0084] In some embodiments, the configuration of Msg3 repetitions in the time domain is indicated by a higher layer parameter “*numberOfMsg3Repetitions*,” which is configured/associated with a polarization type in order to avoid a polarization loss. The Msg3 repetitions can also be configured by a RRC parameter or by a field in downlink

control information (DCI), where the same or different polarization types may be configured with the repetitions.

[0085] For example, if *numberOfMsg3Repetitions*=4 and a polarization association parameter is the same, then all configured time domain repetitions utilize the same polarization type. In some cases, the configuration can define the different polarization pattern combinations associated with each repetition number, and an index for these patterns may be configured through DCI or RRC (e.g., in the Physical Uplink Shared Channel (PUSCH) scheduled by a RAR UL grant). The following table (Table 1) illustrates different combinations of polarization mapping for Msg3 repetition number 4.

Index	Polarization pattern
0	LLLL
1	RRRR
2	LLRR
3	RRLL
4	LRLR
5	RLRL
6	RRLR
7	LLRL

Table 1

[0086] In some cases, all the configured Msg3 repetitions use the same polarization type that is configured for PRACH preambles, where one polarization type is configured.

[0087] In some embodiments, the number of Msg3 repetitions can be increased by associating two circular polarization types with each of the repetitions. For example, the Msg3 repetitions can increase from 16 to 32 by using two orthogonal polarizations, LHCP and RHCP, with each repetition (and without using additional time and frequency resources). Such a configuration can utilize resources in an efficient manner while increasing the repetition factor often useful in an NTN due to higher path loss in the network.

[0088] In some cases, the number of Msg3 repetitions can be increased by predefining each number with a type of polarization. For example, the repetition numbers 1-16 are associated with LHCP, and the numbers 17-32 are associated with RHCP. Given the associations, the repetition would follow a similar sequence. Following the example, when configured with the number 16, all repetitions would use LHCP, However, when

configured with the number 20, the first 4 repetitions would employ LHCP and RHCP, and the remaining repetitions would employ LHCP.

[0089] In some cases, each odd and even repetition number can be associated with a polarization type (e.g., odd with LHCP and even with RHCP), where the even repetition numbers utilize one time resource and repeat using two polarizations on the same time resource. For example, an even repetition number of 8 indicates 4 time domain occurrences (resources) by repeating Msg 3 at each time occurrence using two circular polarization types. An odd repetition number such as 7 would indicate 4 time domain occurrences (resources), but Msg 3 is repeated at the first 3 time occurrences using two circular polarization types and at the last time occurrence with only LHCP.

[0090] In some embodiments, the network can employ separate signaling to indicate that the number of configured Msg3 repetitions include, or do not include, polarization-based repetitions. The signaling can include the RAR UL grant or Msg 1 configurations by using DCI or a parameter in RRC. In some cases, the configuration can include a new higher layer parameter (e.g., “*Polbasedrepetitions*”) along with higher layer parameter *numberOfMsg3Repetitions* to indicate whether time-based repetitions are to include additional polarization-based repetitions.

[0091] In some embodiments, the UE performs or applies polarization-based repetitions for Msg3 by default, such when the UE is configured to perform multiple/repeated PRACH preamble transmissions for one or multiple detected SSBs. The UE can employ a same polarization pattern for the Msg3 time domain repetitions as indicated for PRACH preamble transmission. For example, when repeated PRACH preambles use LHCP and RHCP, the Msg3 time domain repetitions also employ polarization-based repetitions, such as LHCP and RHCP based repetitions.

[0092] In some embodiments, the configuration can include one higher layer parameter (e.g., only one parameter) to indicate the utilization of polarization-based repetitions for both Msg1 and Msg3 transmissions. Similarly, the configuration can include only one higher layer parameter to indicate the type of polarization to be used for repetitions of Msg1 and Msg3.

[0093] In some embodiments, the UE activates or requests polarization-based Msg3 repetition when an SSB or Msg2 RSRP falls below a configured RSRP threshold value (e.g., when $RSRP < RSRP \text{ threshold}$). In such cases, the UE repeats the Msg3 repeated via configured polarization types for repetitions, using the polarization types configured for PRACH repetitions or specifically configured for Msg3 repetitions. When there are no polarization types configured for repetitions, the UE may repeat Msg3 using its polarization type capabilities.

[0094] In some cases, the parameter field “*rsrp-ThresholdSSB*” in a RACH configuration IE can be employed for polarization-based repetitions. When a synchronization signal RSRP (SS-RSRP) of an SSB is well above a *rsrp-ThresholdSSB* value, the UE may not apply repetitions for Msg3. However, when the value is near the threshold, the UE would apply a polarization-based repetition.

[0095] In some embodiments, a configuration can include or introduce a new RSRP threshold field for the four step RACH procedure that defines the use/activation/request of polarization-based repetitions. FIG. 3 illustrates an example of a diagram 300 that supports triggering Msg3 repetitions in the polarization domain in accordance with aspects of the present disclosure. As depicted, a threshold value for a field “*rsrp-ThresholdPol*” 305 is set below a threshold value for a field “*rsrp-ThresholdSSB*” 310. When the value falls below the field “*rsrp-ThresholdPol*” 305 and above the field “*rsrp-ThresholdSSB*” 310 the UE triggers Msg3 repetition in the polarization domain. In some cases, the new field value is set higher than the value for the field “*rsrp-ThresholdSSB*” 310 to trigger Msg3 repetitions.

[0096] In some embodiments, the UE can be configured to perform multiple/repeated MsgA preamble transmissions for one or multiple detected SSBs on one or multiple ROs by employing multiple polarizations. However, in such cases, the UE may not be configured with single or multiple resources to perform MsgA PUSCH repetition in the polarization domain.

[0097] The UE can receive the configuration through RRC signaling, such as a configuration that indicates the type of polarizations to be employed for MsgA transmission. The UE can apply the indicated polarization type for both MsgA PRACH

preamble transmission and MsgA PUSCH transmission. In some cases, instead of indicating a single polarization type, the configuration can indicate multiple polarization types. The UE may determine that MsgA is to be repeated in the polarization domain using the configured time and frequency resources.

[0098] For example, the indication for repetition of MsgA PRACH and MsgA PUSCH can be separately configured by a field (e.g., indicating that repetition in the polarization domain is to be done or not done), while multiple polarization types may indicate a UE can select a single polarization (out of multiple polarizations) for MsgA transmission based on the capabilities of the UE. When the UE has more than polarization type capability (from the configured polarization types), the UE may repeat MsgA with polarizations using the same time and frequency resources.

[0099] In some embodiments, the UE transmits a MsgA preamble and a MsgA PUSCH transmission in parallel using two different polarizations types at a same time, (e.g., MsgA preamble transmission is performed with LHCP while MsgA PUSCH transmission is performed with RHCP). Thus, a PUSCH occasion may overlap in time and frequency with any PRACH occasion but would differ in the polarization domain.

[0100] In some embodiments, a MsgA PUSCH occasion is configured in the polarization domain, where a parameter may be used to indicate that number of PUSCH occasions available in the polarization domain. For example, the number of PUSCH occasions available in the frequency domain, configured by a *nrMsgA-PO-FDM* parameter, are repeated in the polarization domain for each configured time instance.

[0101] Thus, as described herein, a UE, such as the UE 104, can perform random access procedures that employ polarization-based repetitions for Msg1, Msg3, and/or MsgA transmissions.

[0102] FIG. 4 illustrates an example of a block diagram 400 of a device 402 that supports polarization-based repetitions in initial access procedures in accordance with aspects of the present disclosure. The device 402 may be an example of a UE 104 as described herein. The device 402 may support wireless communication with one or more network entities 102, UEs 104, or any combination thereof. The device 402 may include

components for bi-directional communications including components for transmitting and receiving communications, such as a processor 404, a memory 406, a transceiver 408, and an I/O controller 410. 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).

[0103] The processor 404, the memory 406, the transceiver 408, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. For example, the processor 404, the memory 406, the transceiver 408, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

[0104] In some implementations, the processor 404, the memory 406, the transceiver 408, or various combinations or components thereof may be implemented in hardware (e.g., in communications management circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA) or other programmable logic device, a discrete gate or transistor logic, discrete hardware components, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure. In some implementations, the processor 404 and the memory 406 coupled with the processor 404 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 404, instructions stored in the memory 406).

[0105] For example, the processor 404 may support wireless communication at the device 402 in accordance with examples as disclosed herein. The processor 404 may be configured as or otherwise support a means for receiving, from a network entity, a configuration indicating a polarization type associated with a physical random access channel (PRACH) and performing PRACH repetitions in a polarization domain associated with the indicated polarization type.

[0106] Further, the processor 400 may be configured as or otherwise support a means for receiving, from a network entity, a configuration that indicates polarization types

associated with a repetition for an uplink physical channels transmission during an initial access procedure and transmitting the repeated uplink physical channels based on the indicated polarization types.

[0107] The processor 404 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, a microcontroller, an ASIC, an FPGA, a programmable logic device, a discrete gate or transistor logic component, a discrete hardware component, or any combination thereof). In some implementations, the processor 404 may be configured to operate a memory array using a memory controller. In some other implementations, a memory controller may be integrated into the processor 404. The processor 404 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 406) to cause the device 402 to perform various functions of the present disclosure.

[0108] The memory 406 may include random access memory (RAM) and read-only memory (ROM). The memory 406 may store computer-readable, computer-executable code including instructions that, when executed by the processor 404 cause the device 402 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. In some implementations, the code may not be directly executable by the processor 404 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 406 may include, among other things, a basic I/O system (BIOS) which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[0109] The I/O controller 410 may manage input and output signals for the device 402. The I/O controller 410 may also manage peripherals not integrated into the device M02. In some implementations, the I/O controller 410 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 410 may utilize an operating system such as iOS®, ANDROID®, MS-DOS®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system. In some implementations, the I/O controller 410 may be implemented as part of a processor, such as the processor M06. In

some implementations, a user may interact with the device 402 via the I/O controller 410 or via hardware components controlled by the I/O controller 410.

[0110] In some implementations, the device 402 may include a single antenna 412. However, in some other implementations, the device 402 may have more than one antenna 412 (i.e., multiple antennas), including multiple antenna panels or antenna arrays, which may be capable of concurrently transmitting or receiving multiple wireless transmissions. The transceiver 408 may communicate bi-directionally, via the one or more antennas 412, wired, or wireless links as described herein. For example, the transceiver 408 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 408 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 412 for transmission, and to demodulate packets received from the one or more antennas 412.

[0111] FIG. 5 illustrates a flowchart of a method 500 that supports polarization-based repetitions in initial access procedures in accordance with aspects of the present disclosure. The operations of the method 500 may be implemented by a device or its components as described herein. For example, the operations of the method 500 may be performed by the UE 104 as described with reference to FIGs. 1 through 4. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[0112] At 510, the method may include receiving, from a network entity, a configuration that indicates polarization types associated with a repetition for an uplink physical channels transmission during an initial access procedure. The operations of 510 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 510 may be performed by a device as described with reference to FIG. 1.

[0113] At 520, the method may include transmitting the repeated uplink physical channels based on the indicated polarization types. The operations of 520 may be performed in accordance with examples as described herein. In some implementations,

aspects of the operations of 520 may be performed by a device as described with reference to FIG. 1.

[0114] It should be noted that the methods described herein describes possible implementations, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible. Further, aspects from two or more of the methods may be combined.

[0115] The various illustrative blocks and components described in connection with the disclosure herein may be implemented or performed with a general-purpose processor, a DSP, an ASIC, a CPU, an FPGA or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices (e.g., a combination of a DSP and a microprocessor, multiple microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[0116] The functions described herein may be implemented in hardware, software executed by a processor, firmware, or any combination thereof. If implemented in software executed by a processor, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Other examples and implementations are within the scope of the disclosure and appended claims. For example, due to the nature of software, functions described herein may be implemented using software executed by a processor, hardware, firmware, hardwiring, or combinations of any of these. Features implementing functions may also be physically located at various positions, including being distributed such that portions of functions are implemented at different physical locations.

[0117] Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer. By way

of example, and not limitation, non-transitory computer-readable media may include RAM, ROM, electrically erasable programmable ROM (EEPROM), flash memory, compact disk (CD) ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other non-transitory medium that may be used to carry or store desired program code means in the form of instructions or data structures and that may be accessed by a general-purpose or special-purpose computer, or a general-purpose or special-purpose processor.

[0118] Any connection may be properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of computer-readable medium. Disk and disc, as used herein, include CD, laser disc, optical disc, digital versatile disc (DVD), floppy disk and Blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above are also included within the scope of computer-readable media.

[0119] 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.

[0120] The terms “transmitting,” “receiving,” or “communicating,” when referring to a network entity, may refer to any portion of a network entity (e.g., a base station, a CU, a

DU, a RU) of a RAN communicating with another device (e.g., directly or via one or more other network entities).

[0121] The description set forth herein, in connection with the appended drawings, describes example configurations and does not represent all the examples that may be implemented or that are within the scope of the claims. The term “example” used herein means “serving as an example, instance, or illustration,” and not “preferred” or “advantageous over other examples.” The detailed description includes specific details for the purpose of providing an understanding of the described techniques. These techniques, however, may be practiced without these specific details. In some instances, known structures and devices are shown in block diagram form to avoid obscuring the concepts of the described example.

[0122] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

CLAIMS

What is claimed is:

1. A User equipment (UE), comprising:
 - a processor; and
 - a memory coupled with the processor, the processor configured to cause the UE to:
 - receive, from a network entity, a configuration that indicates polarization types associated with a repetition for uplink physical channels transmission during an initial access procedure; and
 - transmit the repeated uplink physical channels based on the indicated polarization types.
2. The UE of claim 1, wherein the configuration indicates polarization types for performing repetitions for Msg1, Msg3, MsgA, or a combination thereof.
3. The UE of claim 1, wherein transmitting the repeated uplink physical channels includes transmitting multiple uplink physical channels multiple times while applying one or more polarization types.
4. The UE of claim 1, wherein transmitting the repeated uplink physical channels based on the indicated polarization types includes associating same frequency and time resources with different polarization types.
5. The UE of claim 1, wherein transmitting the repeated uplink physical channels based on the indicated polarization types includes configuring multiple, repeated physical random-access channel (PRACH) preamble transmissions for one or more detected signal synchronization blocks (SSBs) in a polarization domain.

6. The UE of claim 1, wherein transmitting the repeated uplink physical channels based on the indicated polarization types includes configuring PRACH transmissions for multiple RACH occasions (ROs).

7. The UE of claim 1, wherein transmitting the repeated uplink physical channels based on the indicated polarization types includes performing Msg3 repetitions in a polarization domain.

8. The UE of claim 1, wherein transmitting the repeated uplink physical channels based on the indicated polarization types includes configuring multiple MsgA repetitions in a polarization domain.

9. The UE of claim 1, wherein transmitting the repeated uplink physical channels based on the indicated polarization types includes transmitting MsgA preamble and MsgA PUSCH transmission in parallel using two different polarizations types at a same time.

10. The UE of claim 1, wherein a MsgA PUSCH occasion may overlap in time and frequency with any MsgA PRACH occasion but would differ in a polarization domain.

11. The UE of claim 1, wherein the polarization type includes left-hand circular polarization (LHCP) or right-hand circular polarization (RHCP).

12. The UE of claim 1, wherein the configuration is received from the network entity via radio resource control (RRC) signaling.

13. The UE of claim 1, wherein the configuration is received from the network entity of a non-terrestrial network (NTN).

14. A method performed by a user equipment (UE), the method comprising:

receiving, from a network entity, a configuration that indicates polarization types associated with a repetition for uplink physical channels transmission during an initial access procedure; and

transmitting the repeated uplink physical channels based on the indicated polarization types.

15. The method of claim 14, wherein the configuration indicates polarization types for performing repetitions for Msg1, Msg3, MsgA, or a combination thereof.

16. The method of claim 14, wherein the polarization type includes left-hand circular polarization (LHCP) or right-hand circular polarization (RHCP).

17. The method of claim 14, wherein the configuration is received from the network entity via radio resource control (RRC) signaling.

18. A processor for wireless communication, comprising:

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

receive, from a network entity, a configuration that indicates polarization types associated with a repetition for uplink physical channels transmission during an initial access procedure; and
transmit the repeated uplink physical channels based on the indicated polarization types.

19. A network entity, comprising:

a processor; and

a memory coupled with the processor, the processor configured to cause the network entity to:

transmit, to a user equipment (UE), a configuration that indicates polarization types associated with a repetition for uplink physical channels transmission during an initial access procedure performed by the UE.

20. The network entity of claim 19, wherein the configuration is transmitted via radio resource control (RRC) signaling.

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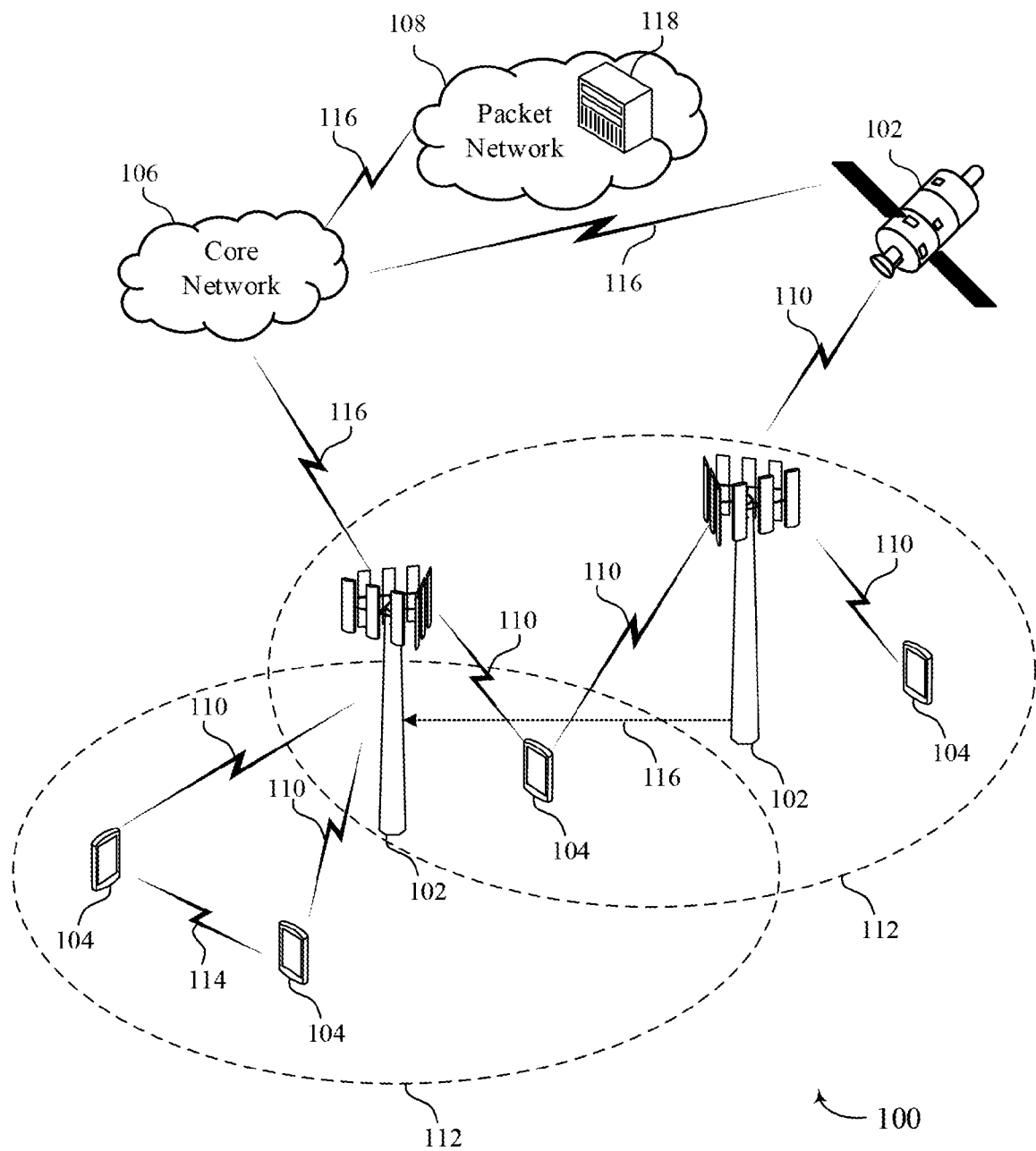


FIG. 1

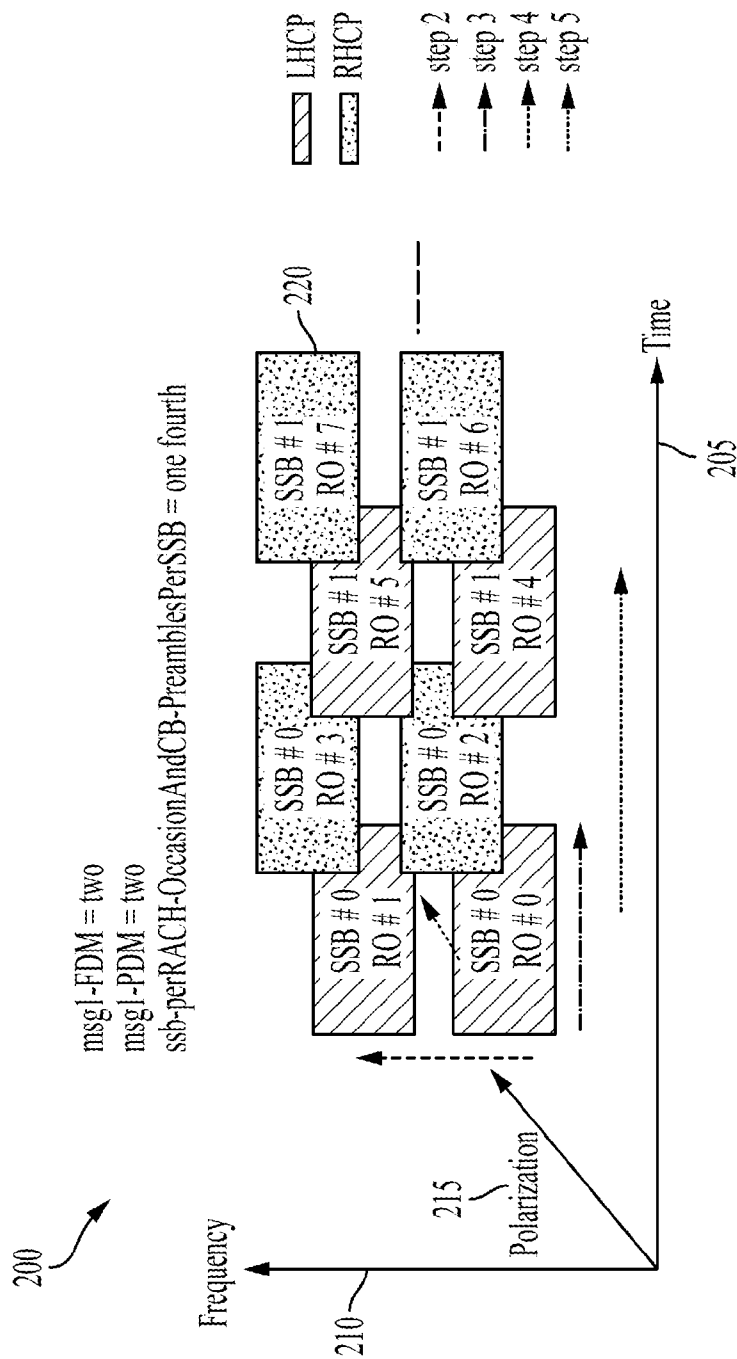


FIG. 2

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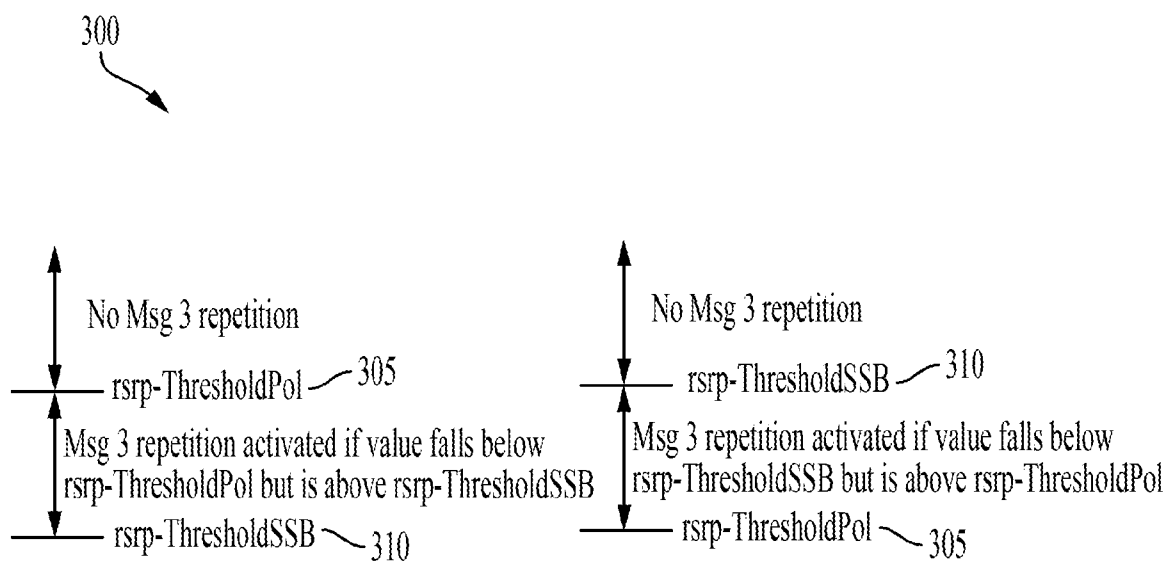


FIG. 3

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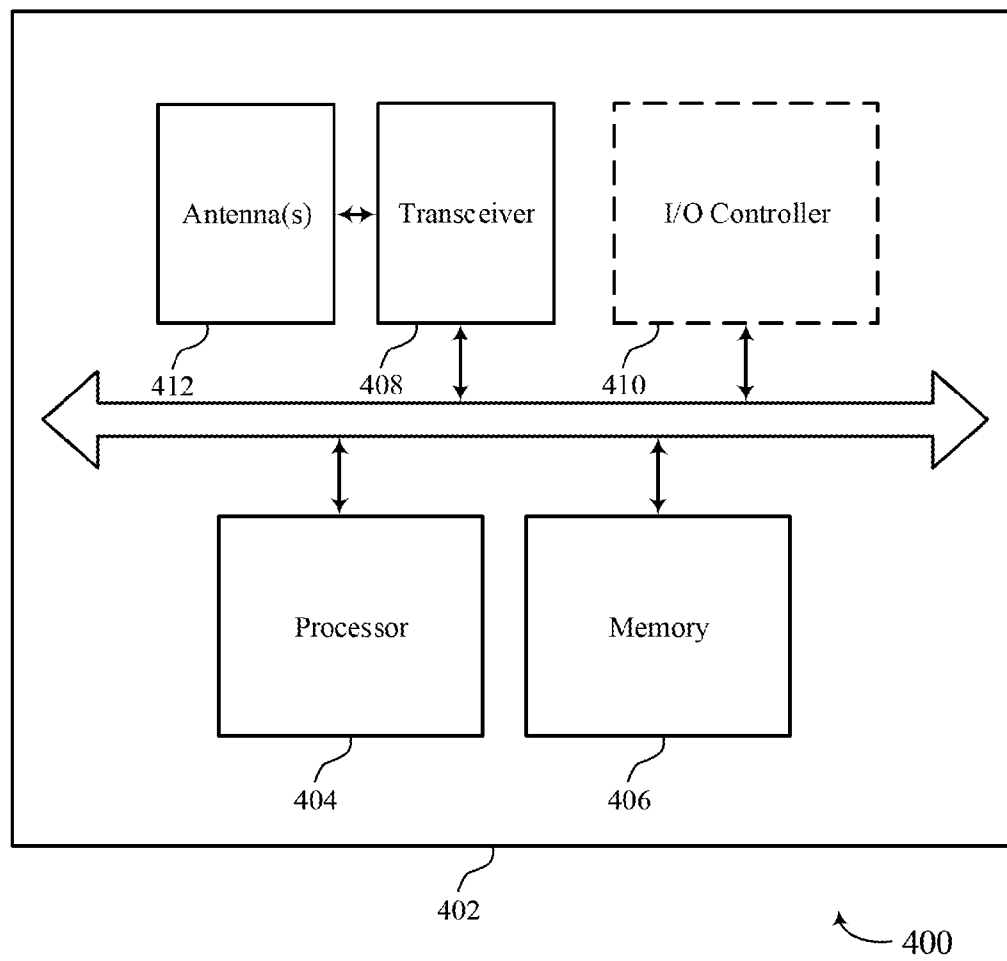


FIG. 4

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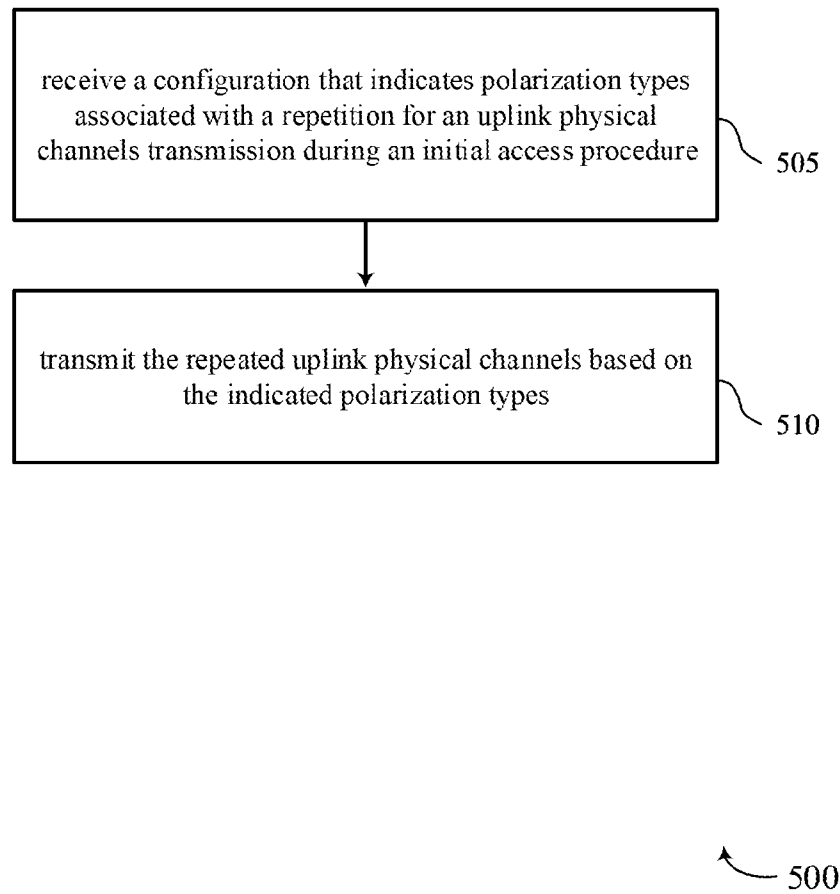


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2023/058104

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04L1/02 H04L1/08 H04W74/08
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04L H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2022/152181 A1 (FG INNOVATION CO LTD [CN]) 21 July 2022 (2022-07-21) page 25, paragraph 107 - page 37, paragraph 160 page 52, paragraph 253 - page 66, paragraph 341 page 73, paragraph 377 - paragraph 383 ----- -/--	1-20

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

3 November 2023

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2023/058104

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	NOKIA ET AL: "Other aspects related to NTN operation for Rel-18", 3GPP DRAFT; R1-2203845, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG1, no. e-Meeting; 20220509 - 20220520 29 April 2022 (2022-04-29), XP052153223, Retrieved from the Internet: URL:https://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_109-e/Docs/R1-2203845.zip R1-2203845.docx [retrieved on 2022-04-29] the whole document -----	1-20
A	ERICSSON: "On physical layer control procedures for NTN", 3GPP DRAFT; R1-1910981 ON PHYSICAL LAYER CONTROL PROCEDURES FOR NTN, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FR , vol. RAN WG1, no. Chongqing, China; 20191014 - 20191020 5 October 2019 (2019-10-05), XP051789761, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_98b/Docs/R1-1910981.zip [retrieved on 2019-10-05] * sections 4-6 * -----	1-20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2023/058104

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2022152181 A1	21-07-2022	US 2022232503 A1 WO 2022152181 A1	21-07-2022 21-07-2022