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(54) INITIAL ACCESS WITH A LICENSED-TO-UNLICENSED FREQUENCY-TRANSLATING NETWORK CONTROLLED REPEATER

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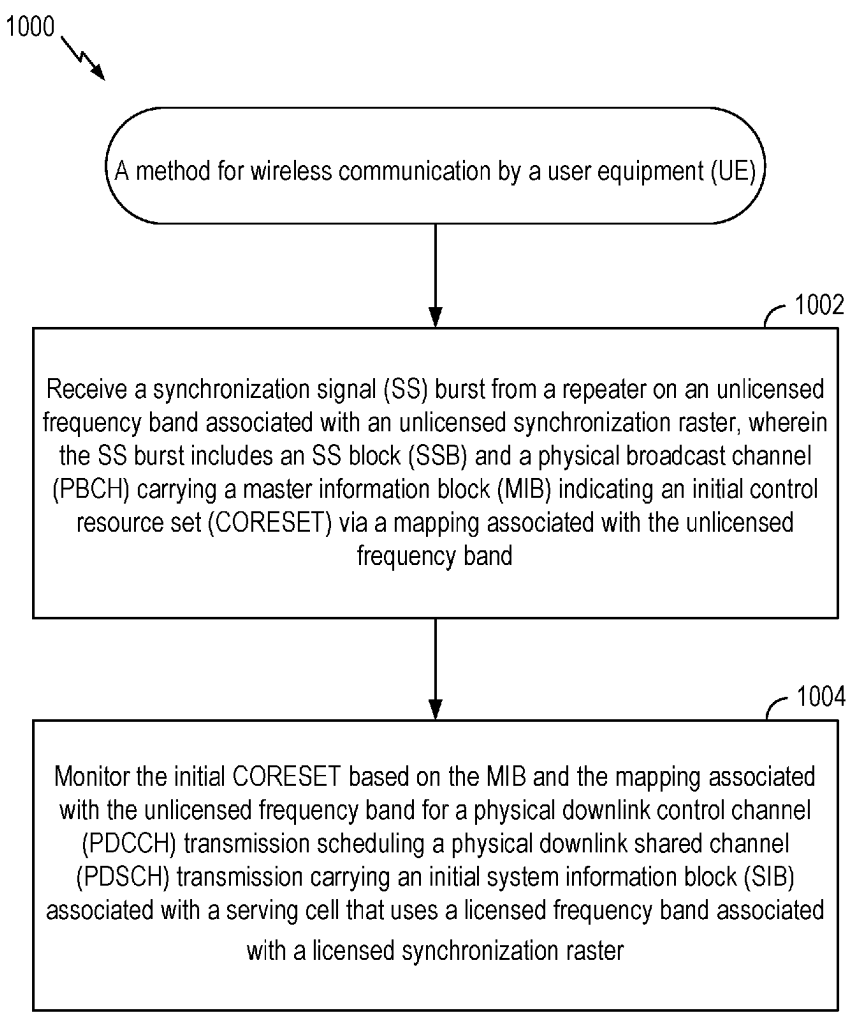
CPC ***H04W 48/16*** (2013.01); ***H04L 5/0053*** (2013.01); ***H04W 48/12*** (2013.01); ***H04W 74/0833*** (2013.01)

(57) **ABSTRACT**

Certain aspects of the present disclosure provide techniques for initial access with licensed-to-unlicensed frequency-translating network controlled repeaters (FT-NCRs). A method for wireless communication by a user equipment (UE) includes receiving a synchronization signal (SS) burst from a repeater on an unlicensed frequency band associated with an unlicensed synchronization raster. The SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with the unlicensed frequency band. The method includes monitoring the initial CORESET based on the MIB and the mapping associated with the unlicensed frequency band for a physical downlink control channel (PDCCH) transmission scheduling a physical downlink shared channel (PDSCH) transmission carrying an initial system information block (SIB) associated with a serving cell that uses a licensed frequency band associated with a licensed synchronization raster.



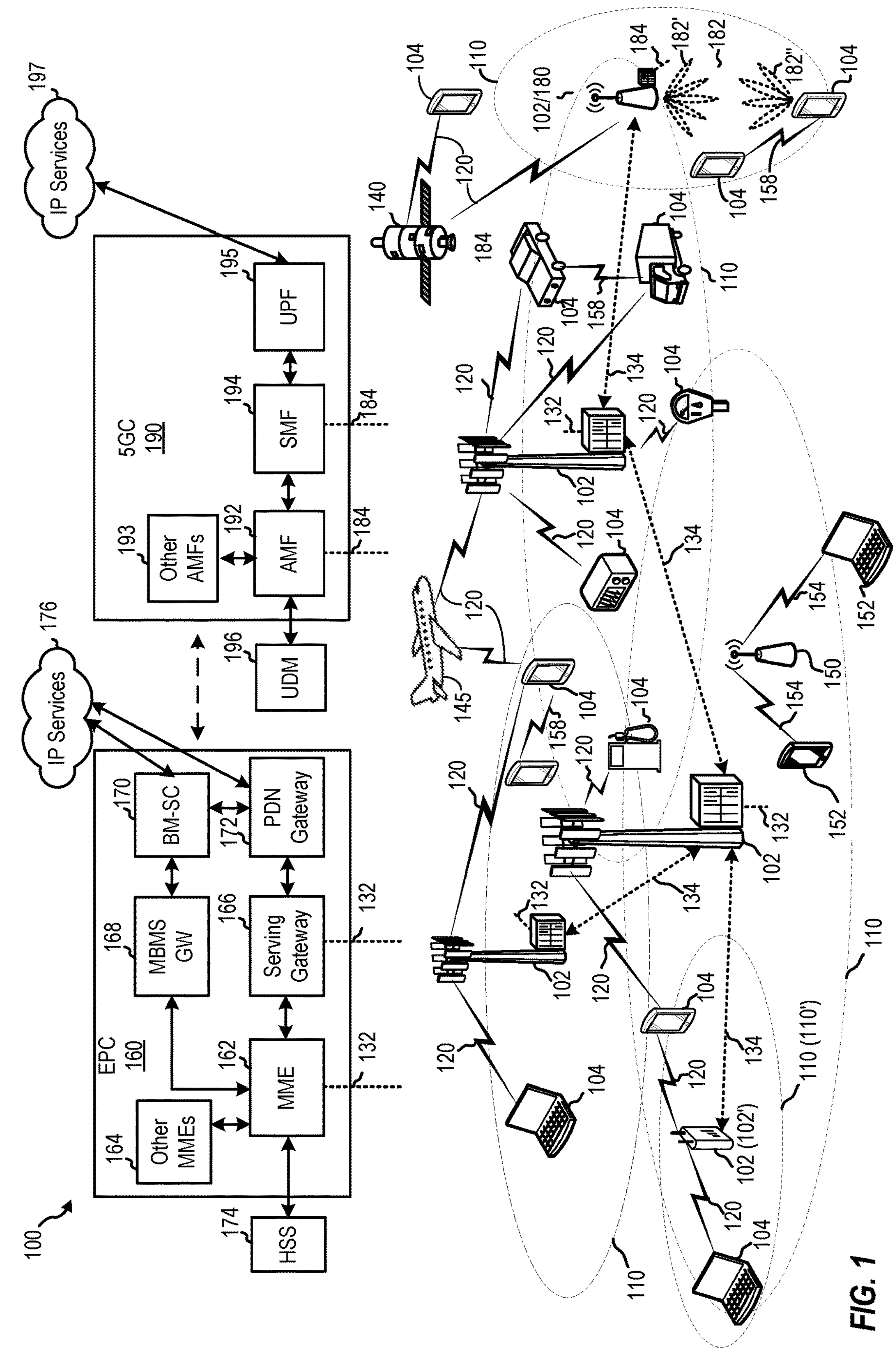

100
IP Services
197
IP Services
176
EPC
160
5GC
190
HSS
174
Other MMEs
164
MME
162
MBMS GW
168
Serving Gateway
166
BM-SC
170
PDN Gateway
172
UDM
196
Other AMFs
193
AMF
192
SMF
194
UPF
195
132
184
102
102 (102')
102/180
104
110
110 (110')
120
134
140
145
150
152
154
158
182
182'
182''

FIG. 1

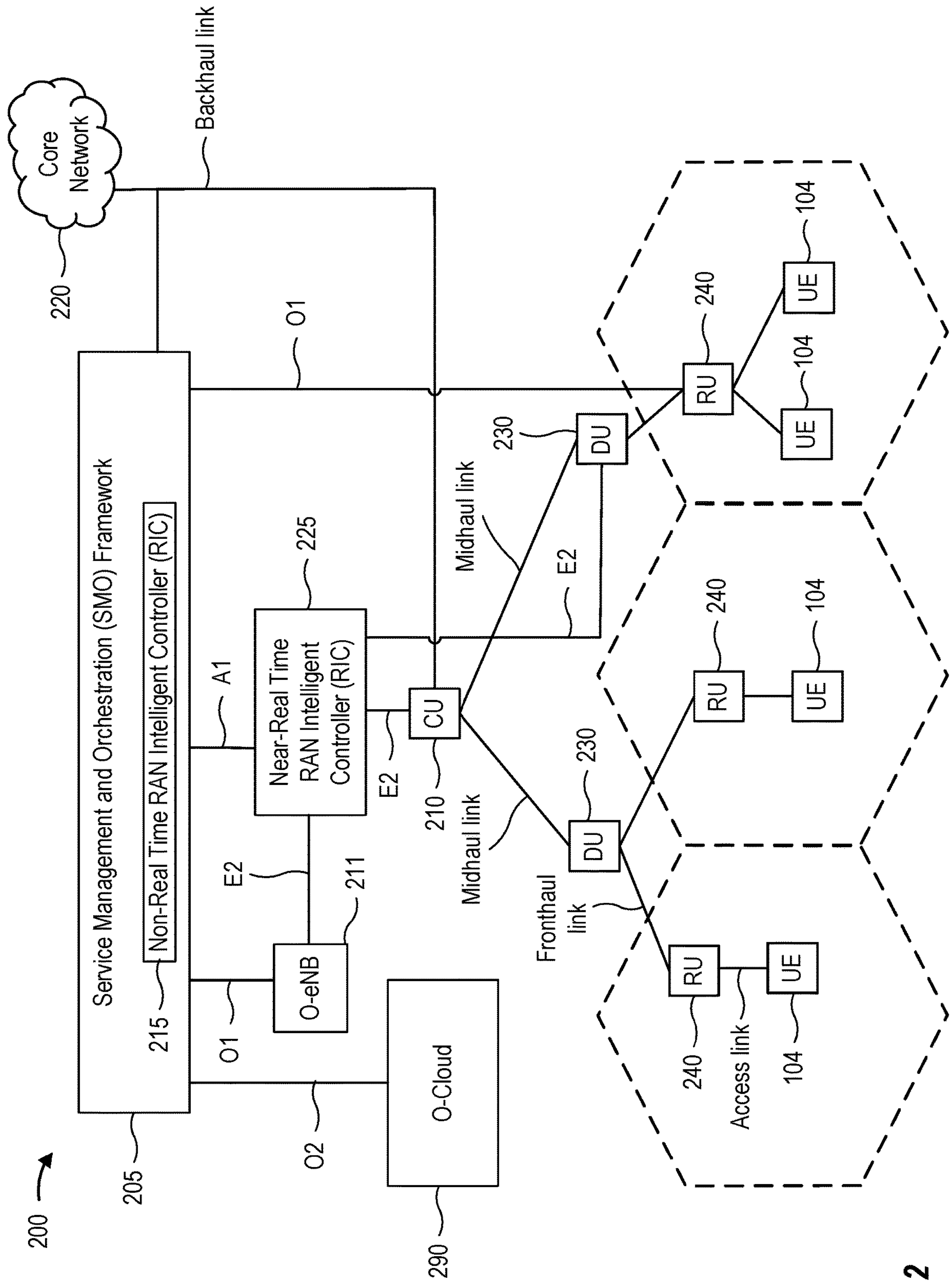

200
205
Service Management and Orchestration (SMO) Framework
Non-Real Time RAN Intelligent Controller (RIC)
215
220
Core Network
Backhaul link
O1
O1
O2
A1
E2
E2
E2
Near-Real Time RAN Intelligent Controller (RIC)
225
O-eNB
211
O-Cloud
290
CU
210
DU
230
DU
230
Midhaul link
Midhaul link
Fronthaul link
RU
240
RU
240
RU
240
UE
104
UE
104
UE
104
UE
104
Access link

FIG. 2

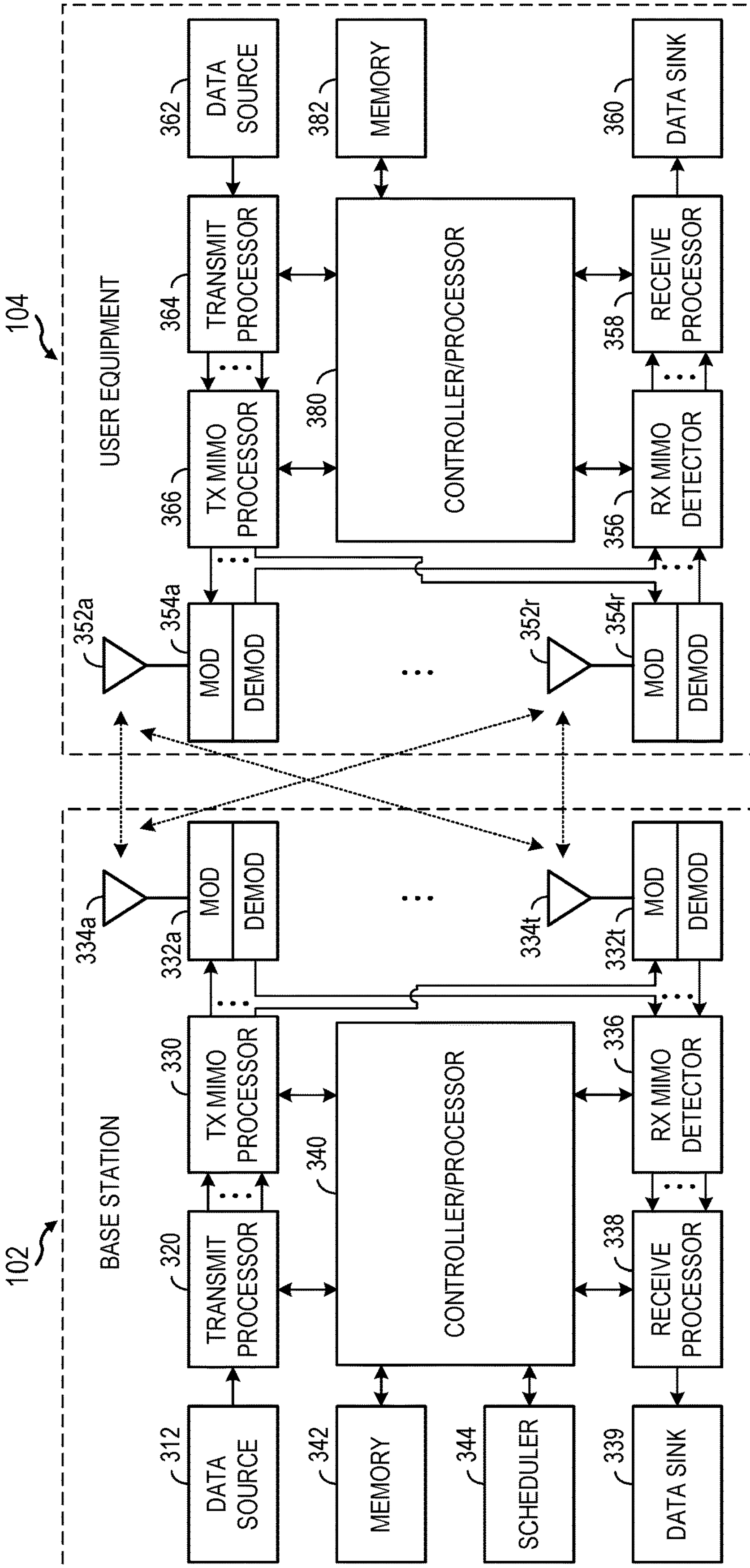

104
USER EQUIPMENT
362
DATA SOURCE
382
MEMORY
360
DATA SINK
364
TRANSMIT PROCESSOR
380
CONTROLLER/PROCESSOR
358
RECEIVE PROCESSOR
366
TX MIMO PROCESSOR
356
RX MIMO DETECTOR
352a
354a
MOD
DEMOD
352r
354r
MOD
DEMOD
102
BASE STATION
334a
332a
MOD
DEMOD
334t
332t
MOD
DEMOD
330
TX MIMO PROCESSOR
336
RX MIMO DETECTOR
340
CONTROLLER/PROCESSOR
320
TRANSMIT PROCESSOR
338
RECEIVE PROCESSOR
312
DATA SOURCE
342
MEMORY
344
SCHEDULER
339
DATA SINK

FIG. 3

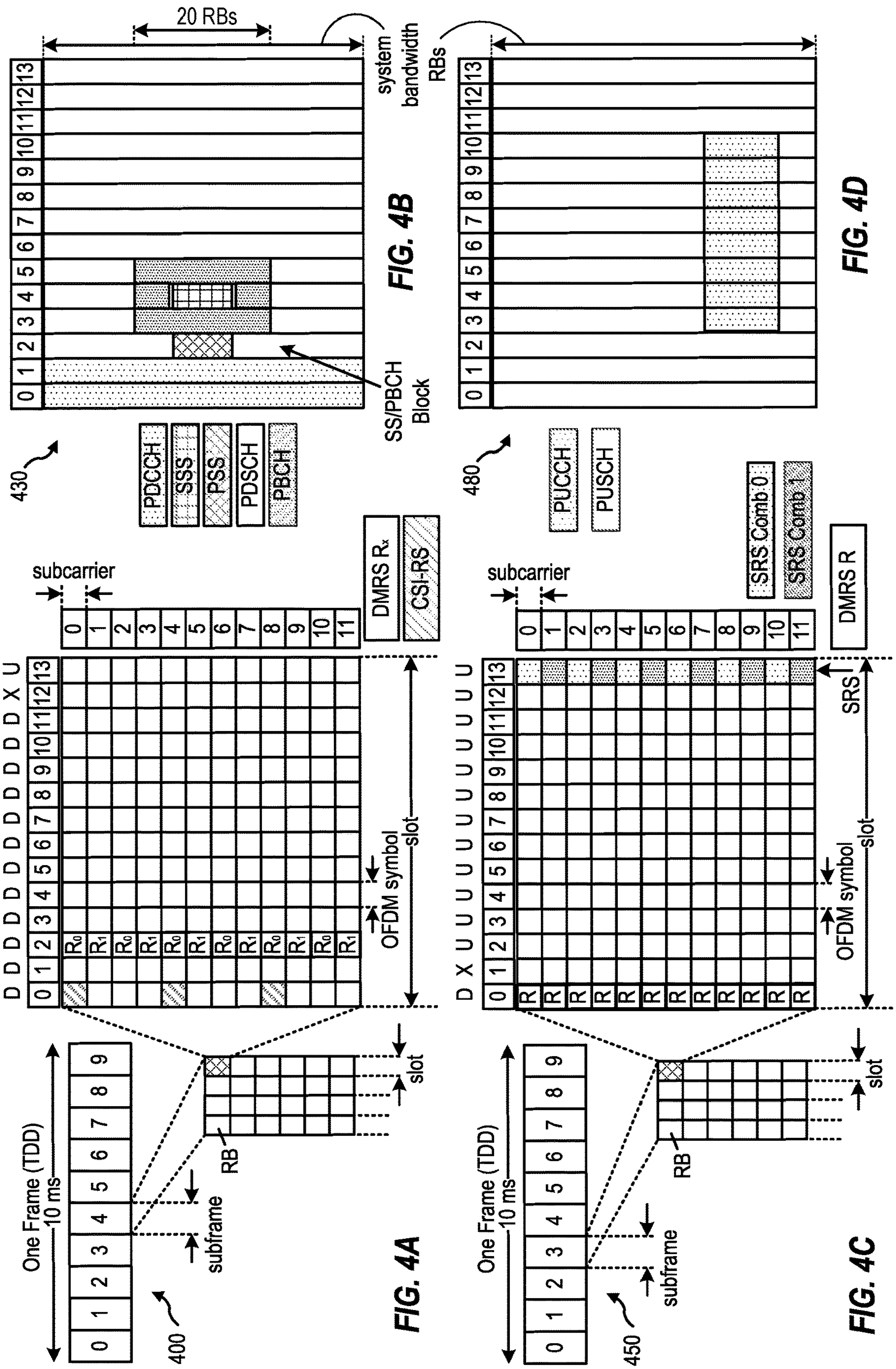


FIG. 4A

FIG. 4B

FIG. 4C

FIG. 4D

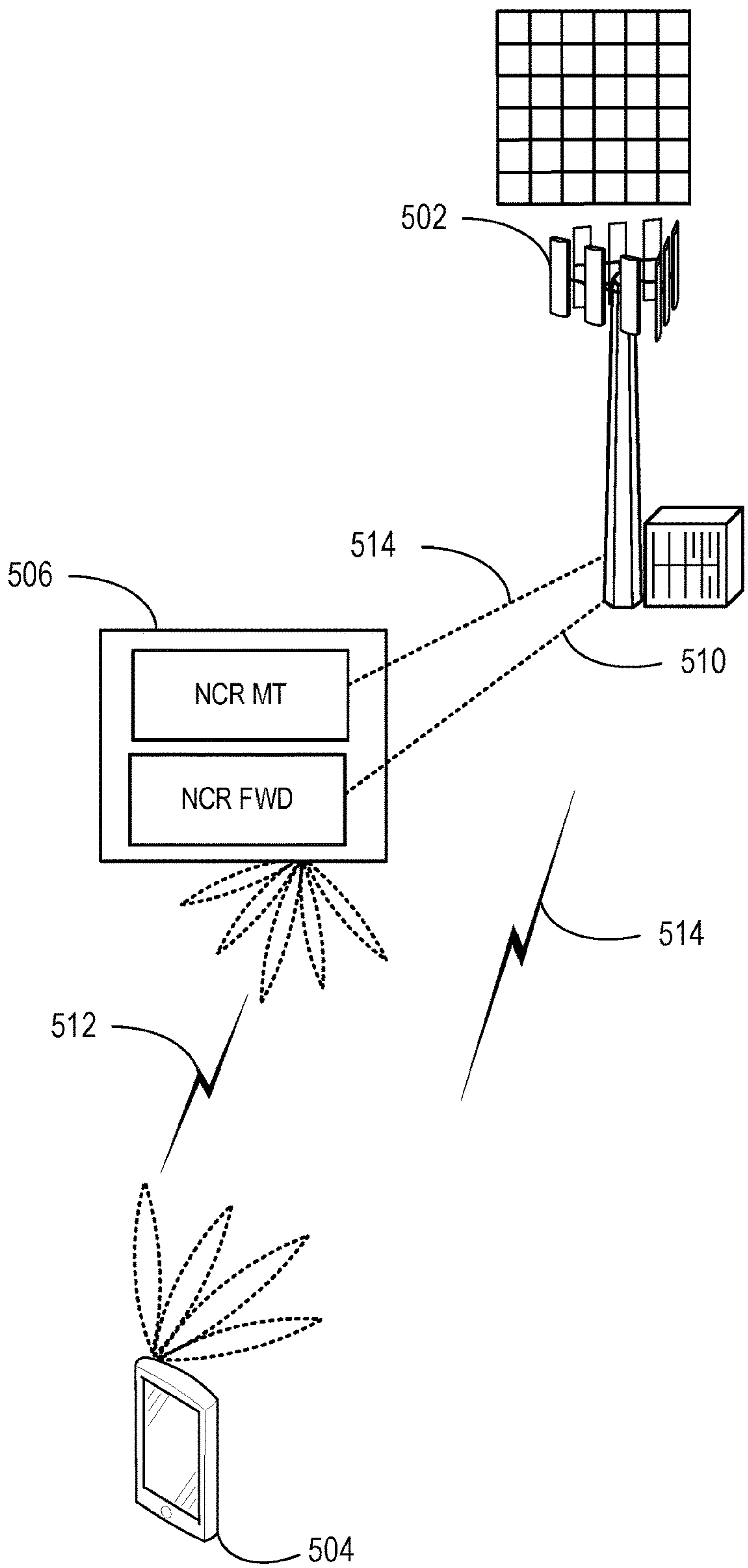


FIG. 5

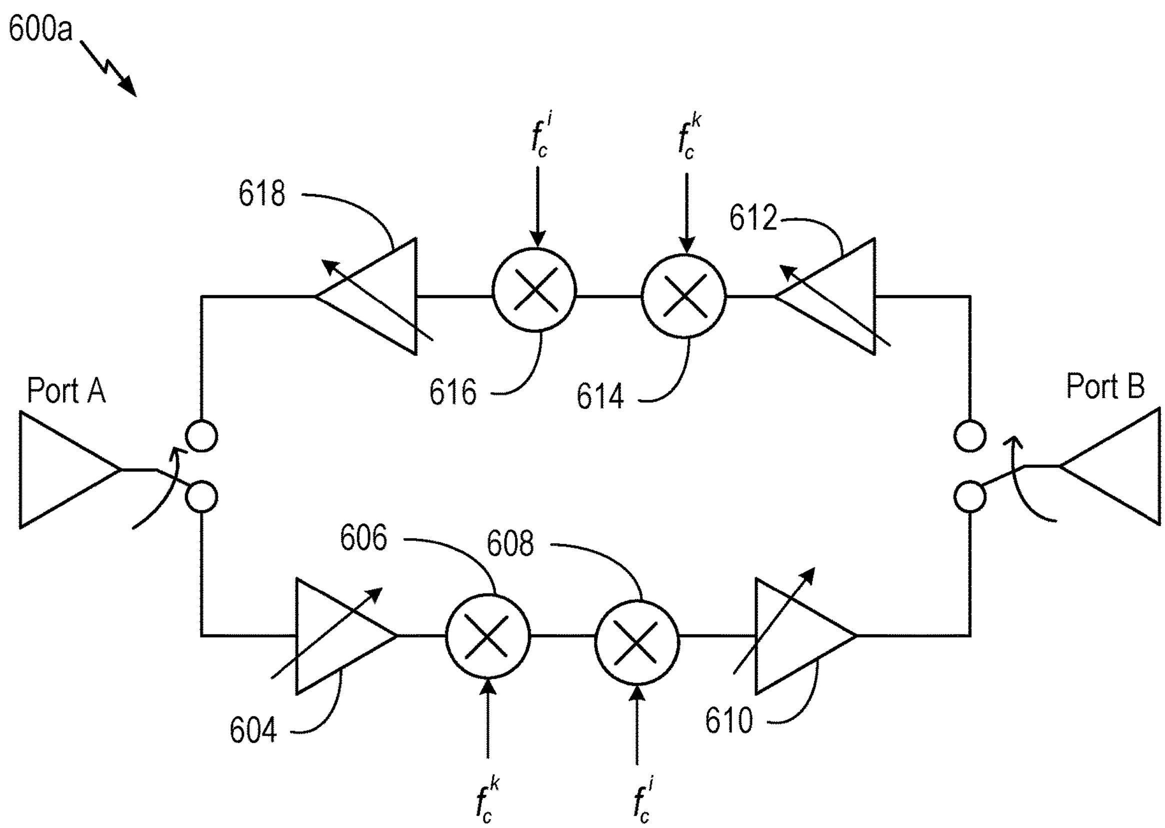

600a
f_c^i
f_c^k
618
612
616
614
Port A
Port B
606
608
604
610
f_c^k
f_c^i

FIG. 6A

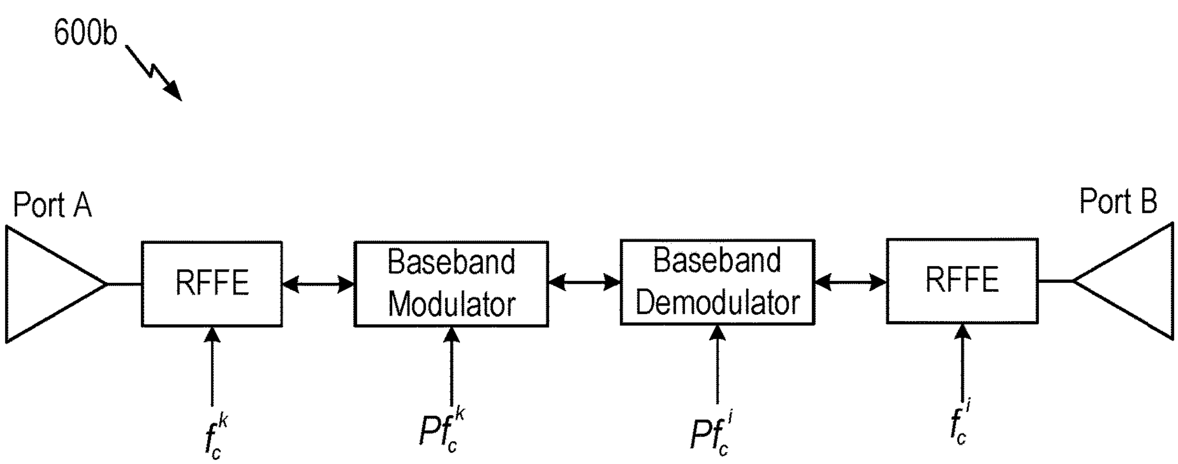

600b
Port A
Port B
RFFE
Baseband Modulator
Baseband Demodulator
RFFE
f_c^k
Pf_c^k
Pf_c^i
f_c^i

FIG. 6B

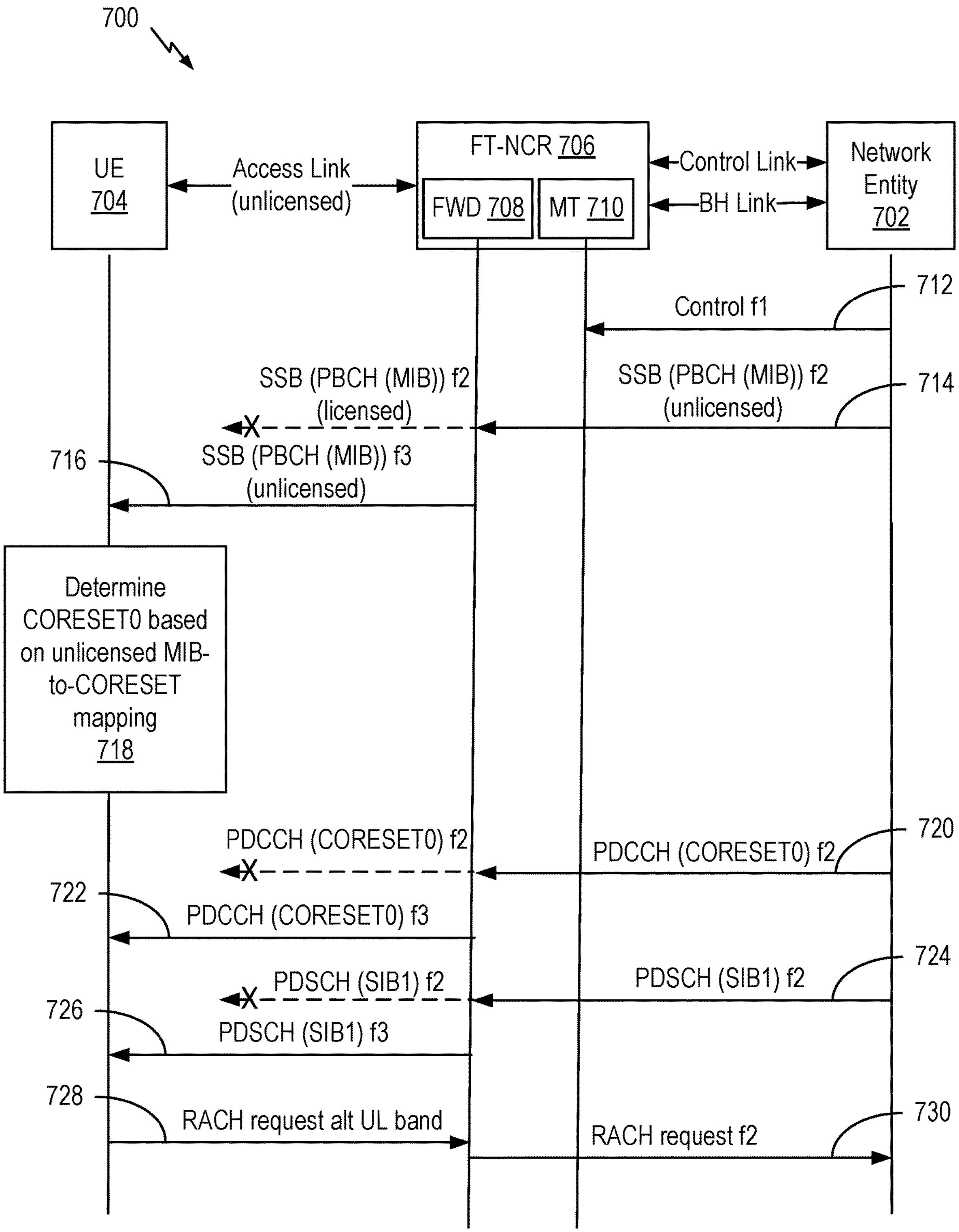

700
UE 704
Access Link (unlicensed)
FT-NCR 706
FWD 708
MT 710
Control Link
BH Link
Network Entity 702
712
Control f1
SSB (PBCH (MIB)) f2 (licensed)
SSB (PBCH (MIB)) f2 (unlicensed)
714
716
SSB (PBCH (MIB)) f3 (unlicensed)
Determine CORESET0 based on unlicensed MIB-to-CORESET mapping 718
720
PDCCH (CORESET0) f2
PDCCH (CORESET0) f2
722
PDCCH (CORESET0) f3
724
PDSCH (SIB1) f2
PDSCH (SIB1) f2
726
PDSCH (SIB1) f3
728
RACH request alt UL band
RACH request f2
730

FIG. 7

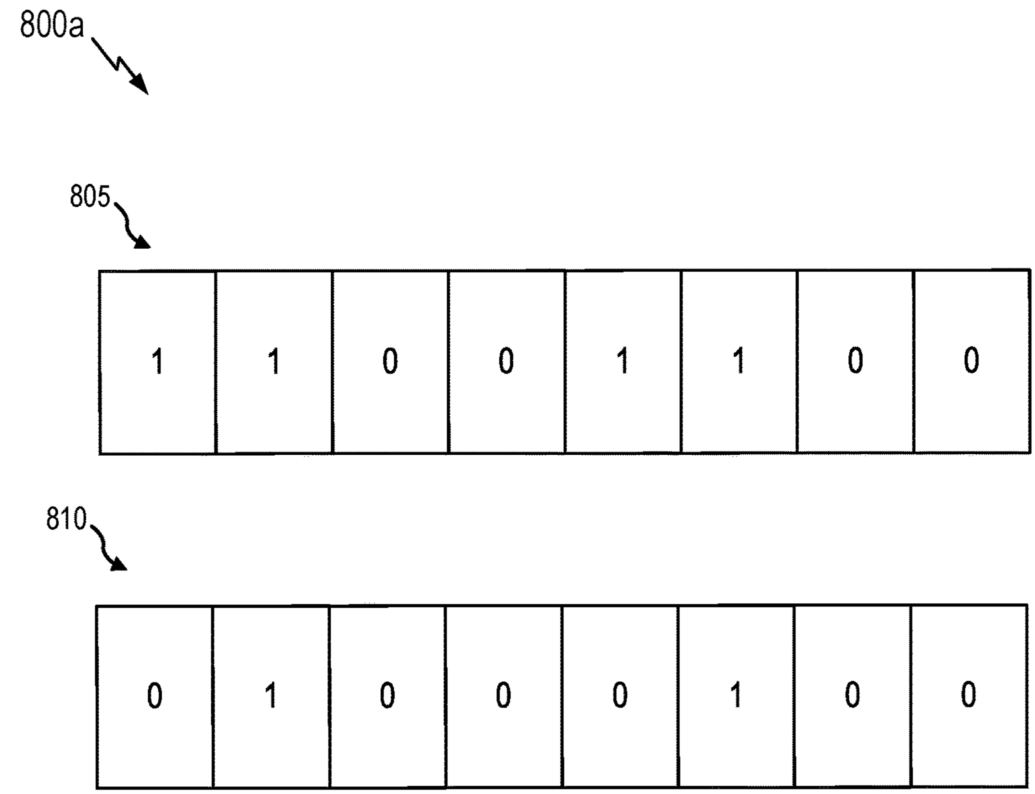

800a
805
1
1
0
0
1
1
0
0
810
0
1
0
0
0
1
0
0

FIG. 8A

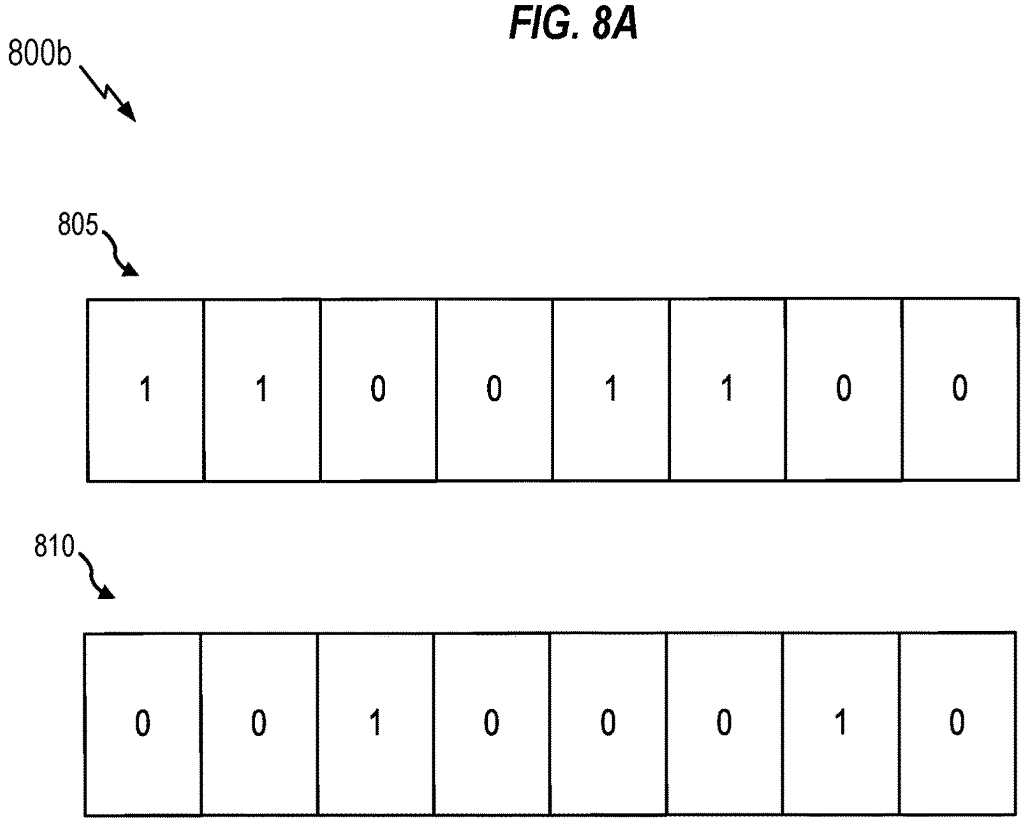

800b
805
1
1
0
0
1
1
0
0
810
0
0
1
0
0
0
1
0

FIG. 8B

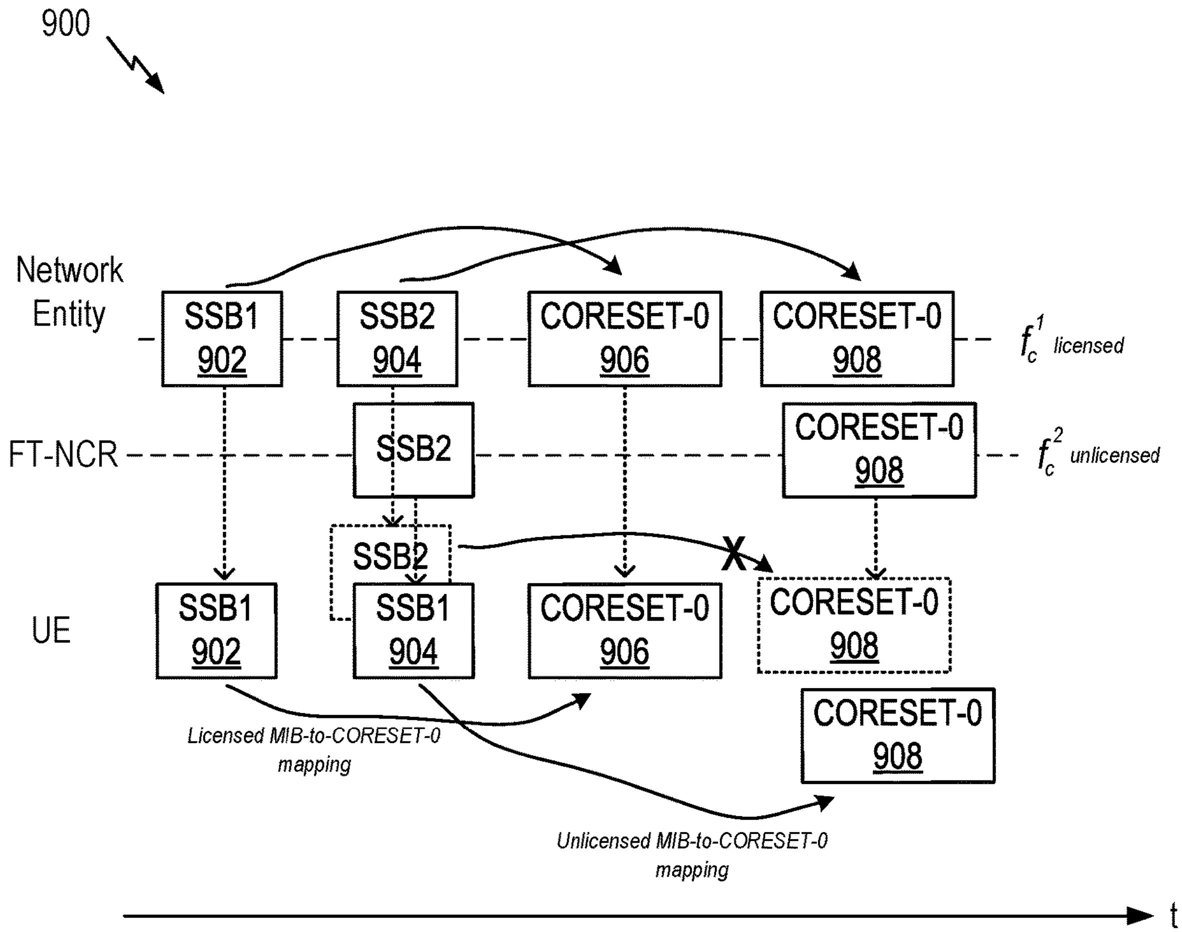

900
Network Entity
SSB1 902
SSB2 904
CORESET-0 906
CORESET-0 908
f_c^1 licensed
FT-NCR
SSB2
CORESET-0 908
f_c^2 unlicensed
UE
SSB1 902
SSB2
SSB1 904
CORESET-0 906
X
CORESET-0 908
CORESET-0 908
Licensed MIB-to-CORESET-0 mapping
Unlicensed MIB-to-CORESET-0 mapping
t

FIG. 9

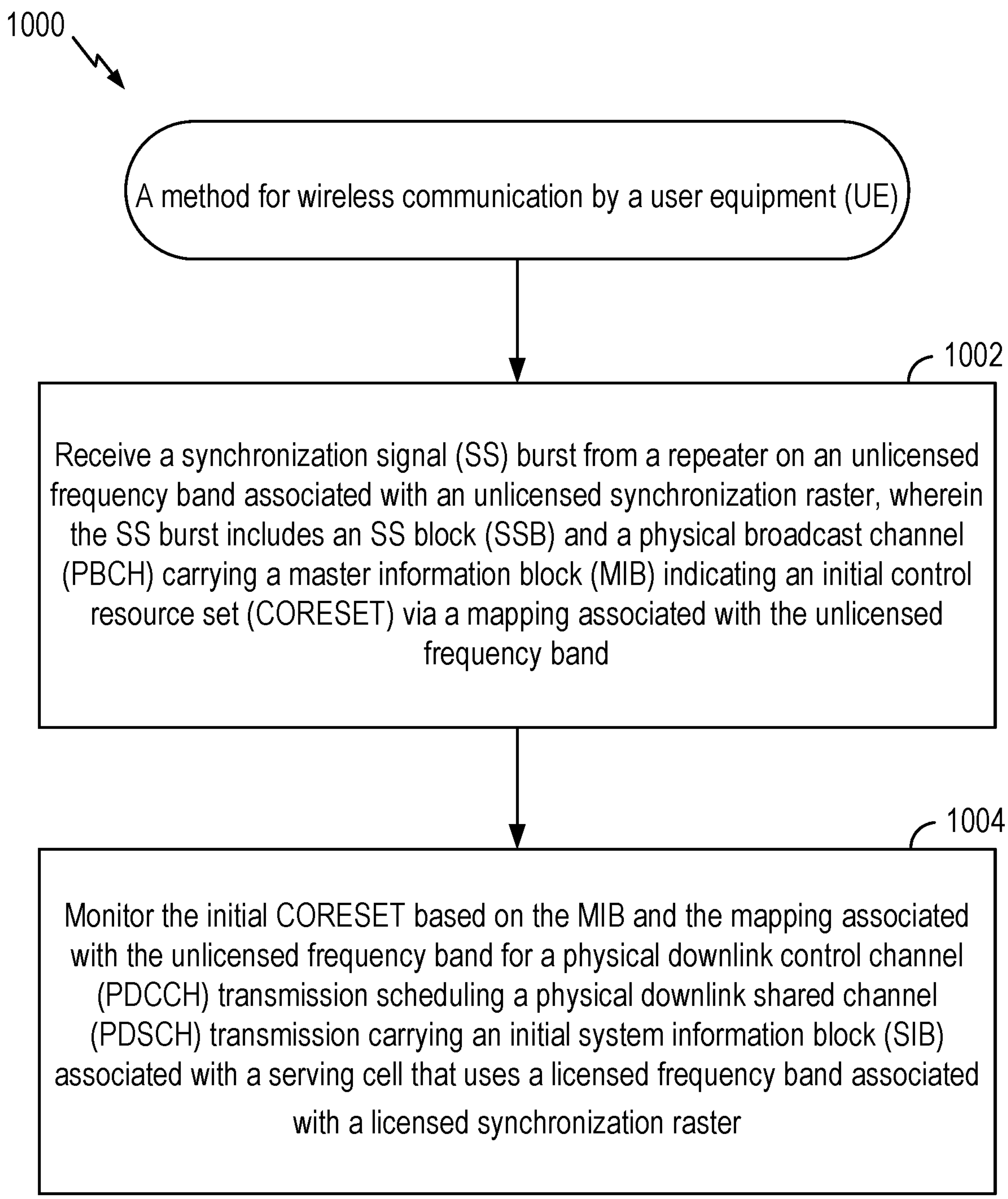

1000
A method for wireless communication by a user equipment (UE)
1002
Receive a synchronization signal (SS) burst from a repeater on an unlicensed frequency band associated with an unlicensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with the unlicensed frequency band
1004
Monitor the initial CORESET based on the MIB and the mapping associated with the unlicensed frequency band for a physical downlink control channel (PDCCH) transmission scheduling a physical downlink shared channel (PDSCH) transmission carrying an initial system information block (SIB) associated with a serving cell that uses a licensed frequency band associated with a licensed synchronization raster

FIG. 10

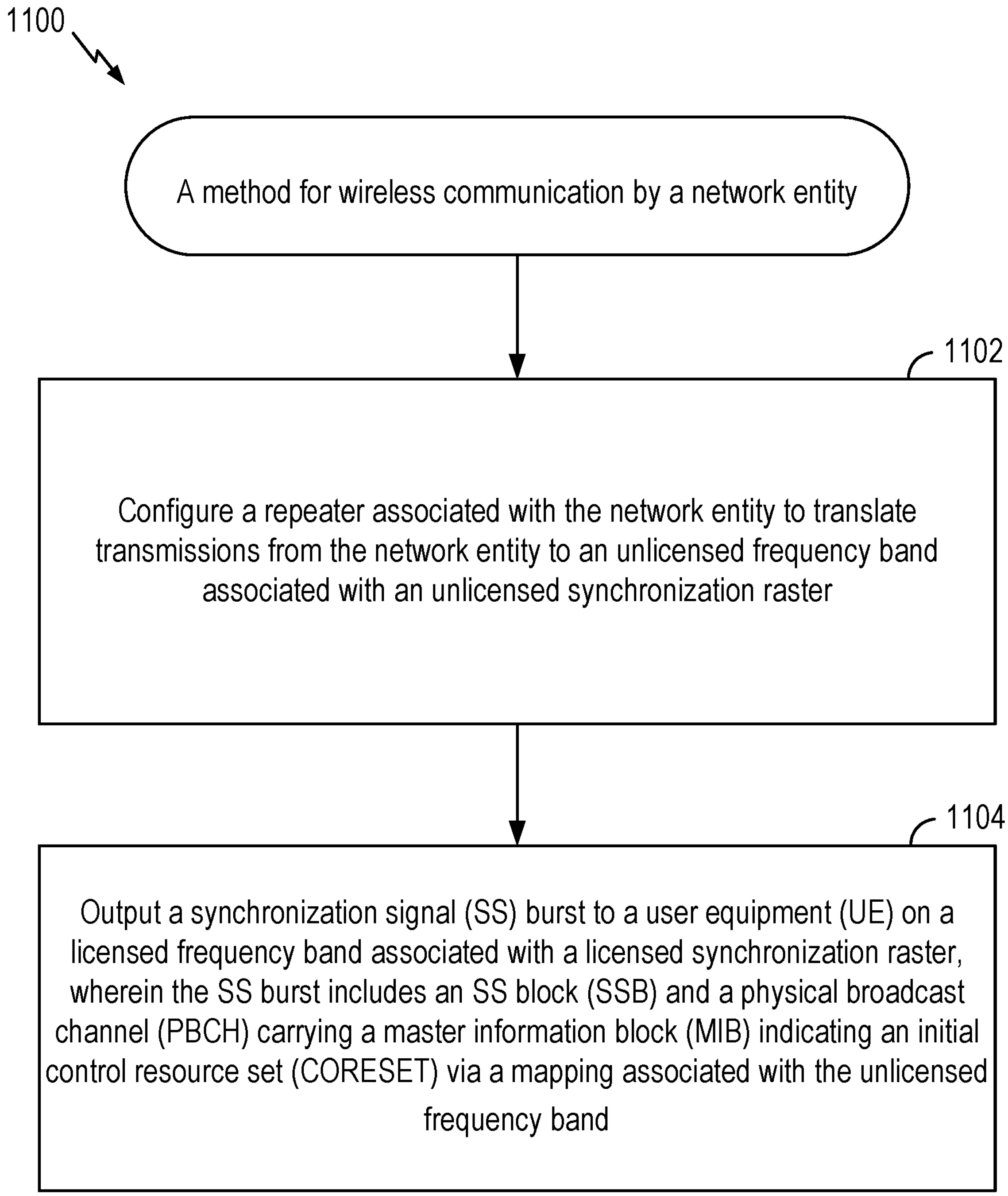

1100
A method for wireless communication by a network entity
1102
Configure a repeater associated with the network entity to translate transmissions from the network entity to an unlicensed frequency band associated with an unlicensed synchronization raster
1104
Output a synchronization signal (SS) burst to a user equipment (UE) on a licensed frequency band associated with a licensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with the unlicensed frequency band

FIG. 11

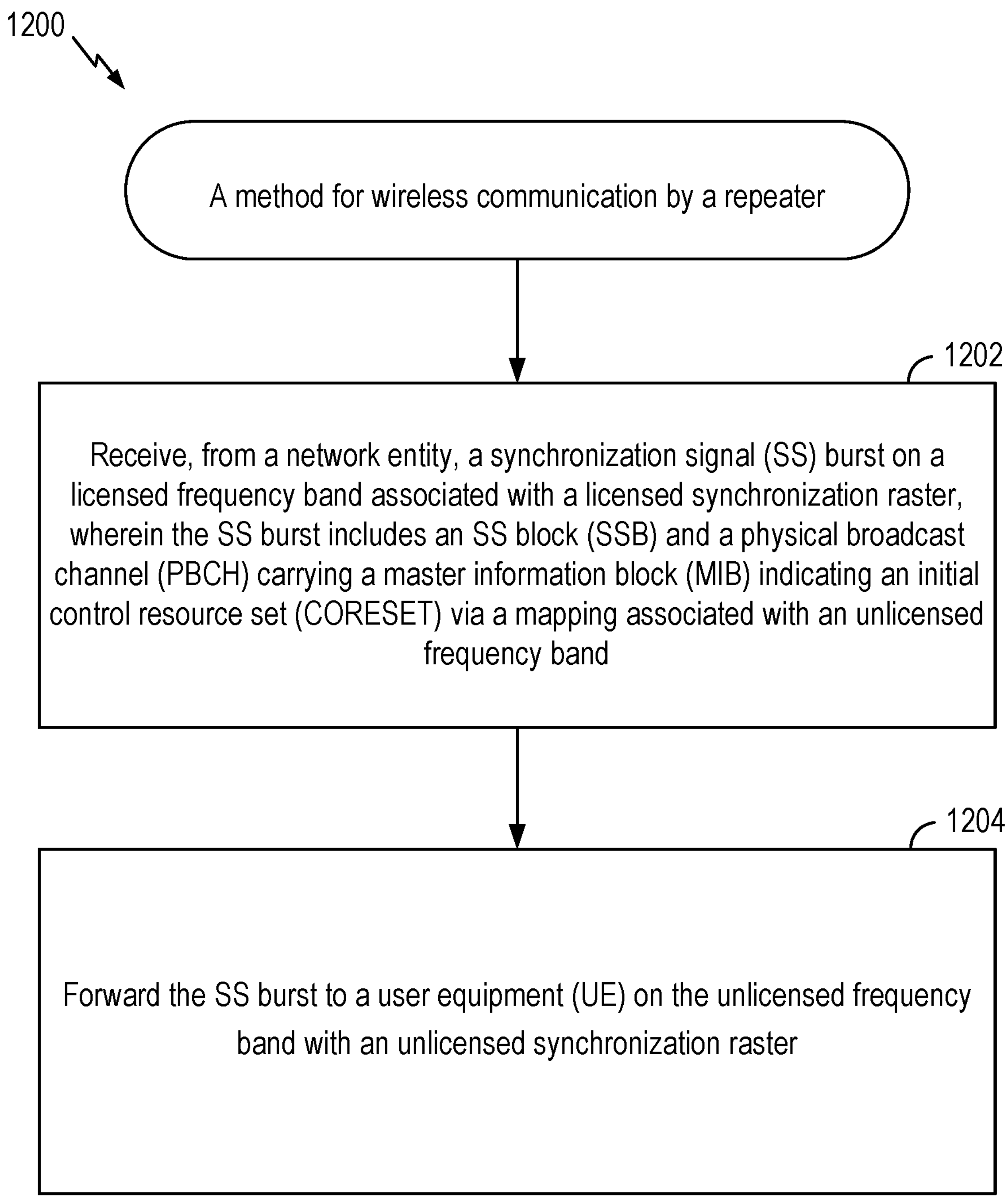

1200
A method for wireless communication by a repeater
1202
Receive, from a network entity, a synchronization signal (SS) burst on a licensed frequency band associated with a licensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with an unlicensed frequency band
1204
Forward the SS burst to a user equipment (UE) on the unlicensed frequency band with an unlicensed synchronization raster

FIG. 12

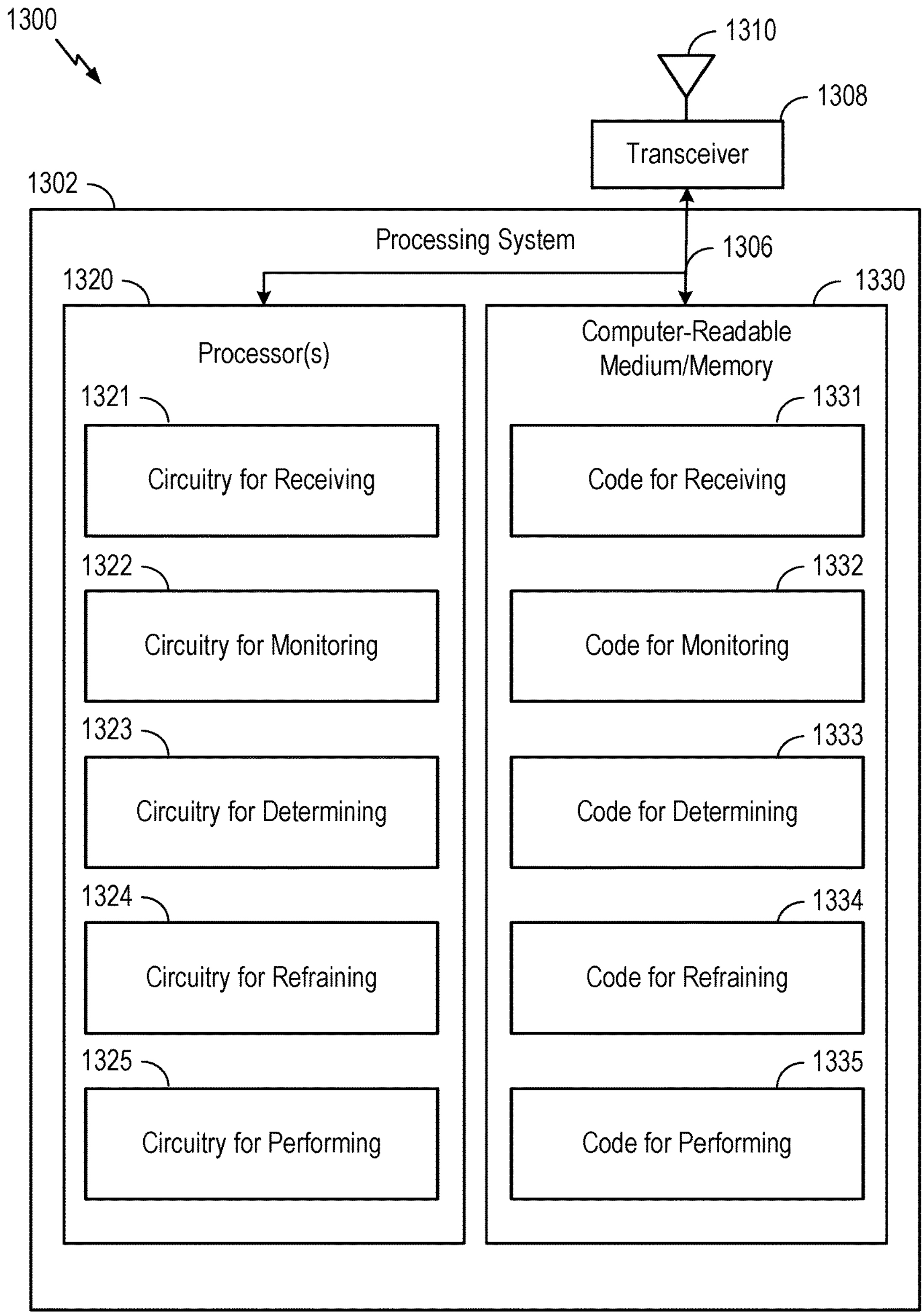

1300
1310
1308
Transceiver
1302
Processing System
1306
1320
1330
Processor(s)
Computer-Readable
Medium/Memory
1321
Circuitry for Receiving
1331
Code for Receiving
1322
Circuitry for Monitoring
1332
Code for Monitoring
1323
Circuitry for Determining
1333
Code for Determining
1324
Circuitry for Refraining
1334
Code for Refraining
1325
Circuitry for Performing
1335
Code for Performing

FIG. 13

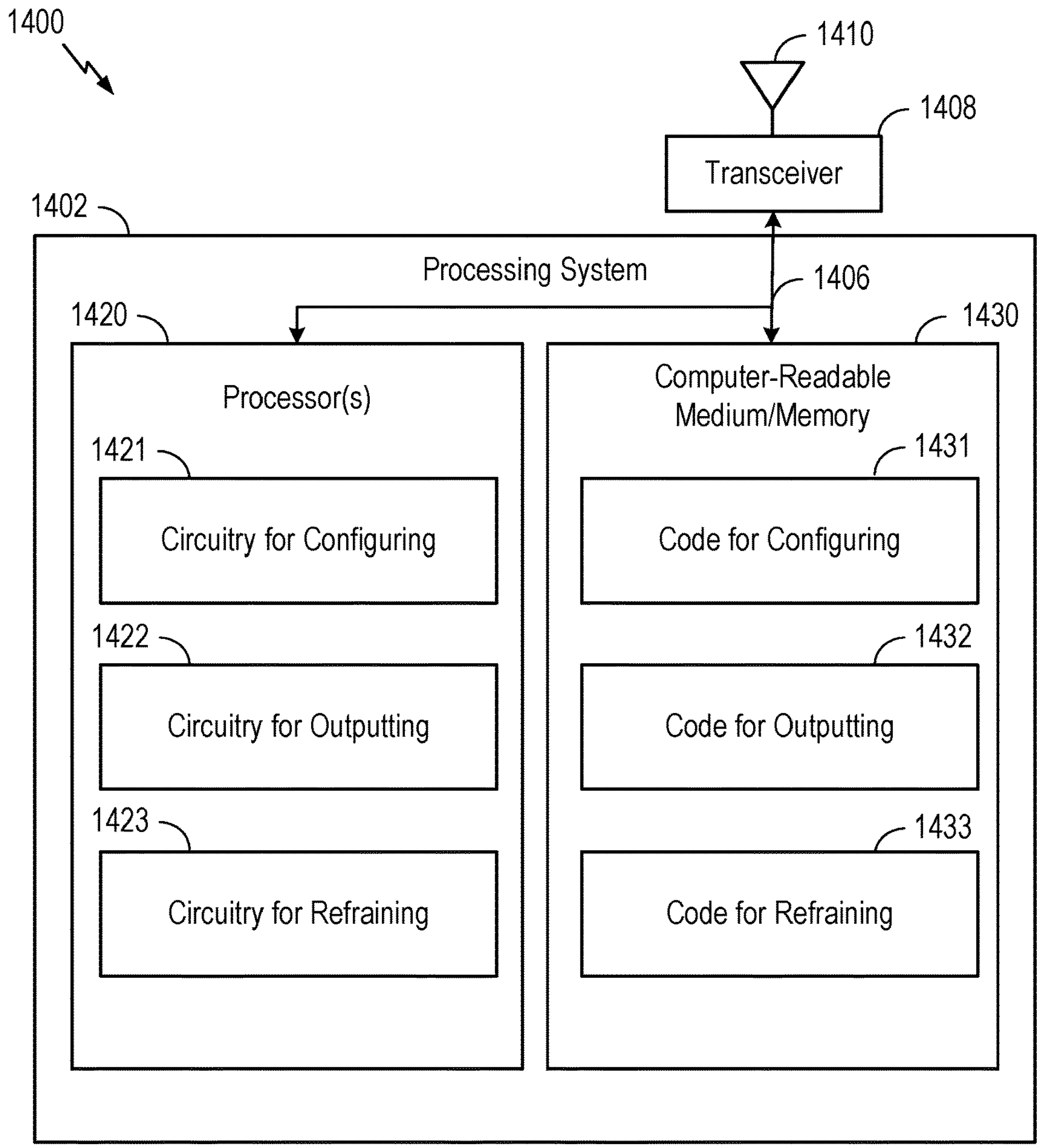

1400
1410
1408
Transceiver
1402
Processing System
1406
1420
1430
Processor(s)
Computer-Readable Medium/Memory
1421
1431
Circuitry for Configuring
Code for Configuring
1422
1432
Circuitry for Outputting
Code for Outputting
1423
1433
Circuitry for Refraining
Code for Refraining

FIG. 14

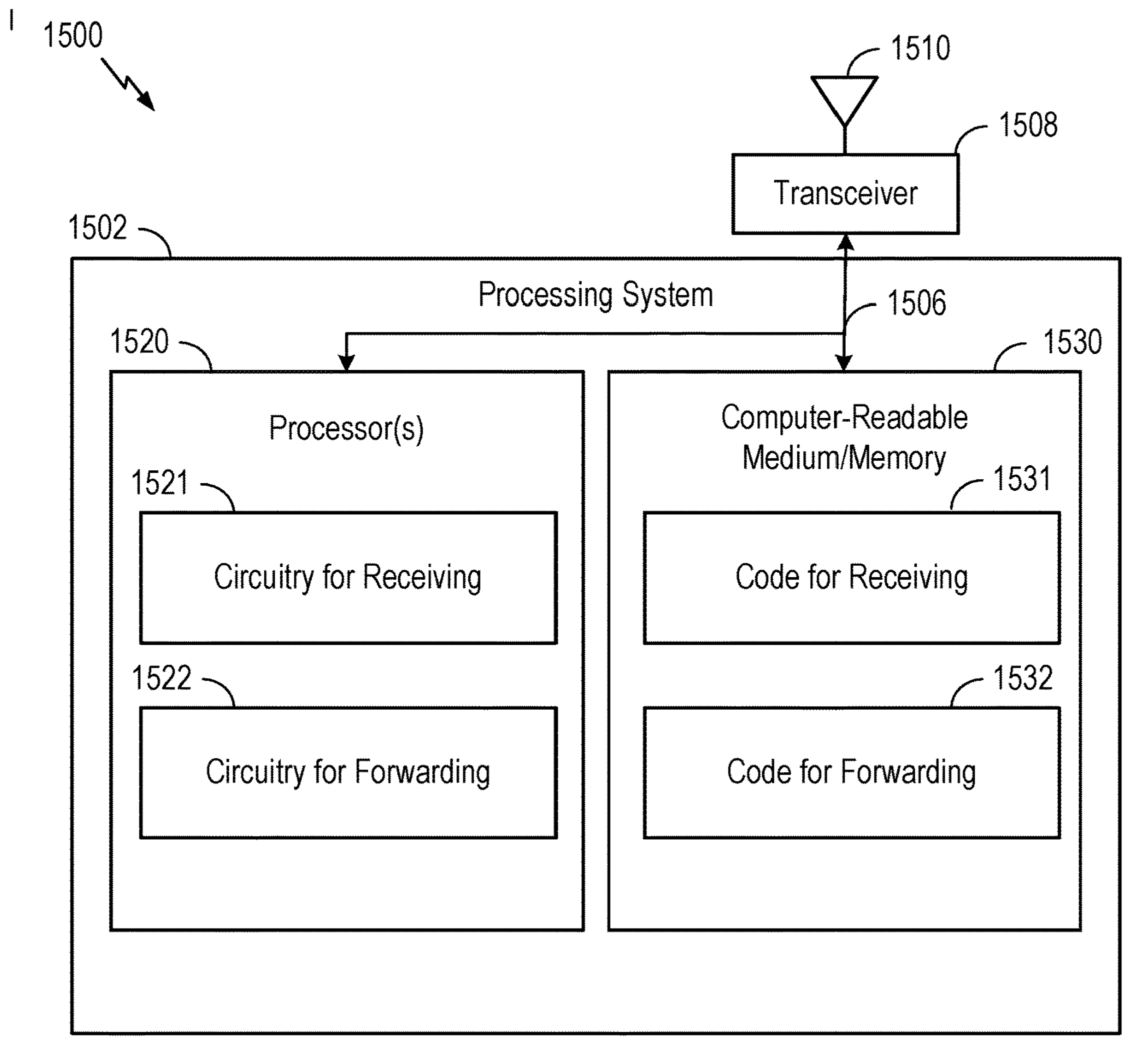

1500
1510
1508
Transceiver
1502
Processing System
1506
1520
1530
Processor(s)
Computer-Readable Medium/Memory
1521
1531
Circuitry for Receiving
Code for Receiving
1522
1532
Circuitry for Forwarding
Code for Forwarding

FIG. 15

INITIAL ACCESS WITH A LICENSED-TO-UNLICENSED FREQUENCY-TRANSLATING NETWORK CONTROLLED REPEATER

FIELD OF THE DISCLOSURE

[0001] Aspects of the present disclosure relate to wireless communications, and more particularly, to techniques for initial access procedures in a wireless communication network with licensed-to-unlicensed frequency-translating network-controlled repeaters (FT-NCRs).

DESCRIPTION OF RELATED ART

[0002] Wireless communications systems are widely deployed to provide various telecommunication services such as telephony, video, data, messaging, broadcasts, or other similar types of services. These wireless communications systems may employ multiple-access technologies capable of supporting communications with multiple users by sharing available wireless communications system resources with those users.

[0003] Although wireless communications systems have made great technological advancements over many years, challenges still exist. For example, complex and dynamic environments can still attenuate or block signals between wireless transmitters and wireless receivers. Accordingly, there is a continuous desire to improve the technical performance of wireless communications systems, including, for example: improving speed and data carrying capacity of communications, improving efficiency of the use of shared communications mediums, reducing power used by transmitters and receivers while performing communications, improving reliability of wireless communications, avoiding redundant transmissions and/or receptions and related processing, improving the coverage area of wireless communications, increasing the number and types of devices that can access wireless communications systems, increasing the ability for different types of devices to intercommunicate, increasing the number and type of wireless communications mediums available for use, and the like. Consequently, there exists a need for further improvements in wireless communications systems to overcome the aforementioned technical challenges and others.

SUMMARY

[0004] One aspect provides a method for wireless communication by a user equipment (UE). The method includes receiving a synchronization signal (SS) burst from a repeater on an unlicensed frequency band associated with an unlicensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with the unlicensed frequency band; and monitoring the initial CORESET based on the MIB and the mapping associated with the unlicensed frequency band for a physical downlink control channel (PDCCH) transmission scheduling a physical downlink shared channel (PDSCH) transmission carrying an initial system information block (SIB) associated with a serving cell that uses a licensed frequency band associated with a licensed synchronization raster.

[0005] Another aspect provides a method for wireless communication by a network entity. The method includes configuring a repeater associated with the network entity to translate transmissions from the network entity to an unlicensed frequency band associated with an unlicensed synchronization raster; and outputting a synchronization signal (SS) burst to a user equipment (UE) on a licensed frequency band associated with a licensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with the unlicensed frequency band.

[0006] Another aspect provides a method for wireless communication by a repeater. The method includes receiving, from a network entity, a synchronization signal (SS) burst on a licensed frequency band associated with a licensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with an unlicensed frequency band; and forwarding the SS burst to a user equipment (UE) on the unlicensed frequency band with an unlicensed synchronization raster.

[0007] Other aspects provide: an apparatus operable, configured, or otherwise adapted to perform any one or more of the aforementioned methods and/or those described elsewhere herein; a non-transitory, computer-readable media comprising instructions that, when executed (e.g., directly, indirectly, after pre-processing, without pre-processing) by one or more processors of an apparatus, cause the apparatus to perform the aforementioned methods as well as those described elsewhere herein; a computer program product embodied on a computer-readable storage medium comprising code for performing the aforementioned methods as well as those described elsewhere herein; and/or an apparatus comprising means for performing the aforementioned methods as well as those described elsewhere herein. By way of example, an apparatus may comprise a processing system, a device with a processing system, or processing systems cooperating over one or more networks.

[0008] The following description and the appended figures set forth certain features for purposes of illustration.

BRIEF DESCRIPTION OF DRAWINGS

[0009] The appended figures depict certain features of the various aspects described herein and are not to be considered limiting of the scope of this disclosure.

[0010] FIG. **1** depicts an example wireless communications network.

[0011] FIG. **2** depicts an example disaggregated BS architecture.

[0012] FIG. **3** depicts aspects of an example base station and an example UE.

[0013] FIGS. **4**A, **4**B, **4**C, and **4**D depict various example aspects of data structures for a wireless communications network.

[0014] FIG. **5** depicts an example NCF serving a UE for a BS.

[0015] FIG. **6**A depicts an example analog FT-NCR.

[0016] FIG. **6**B depicts an example digital FT-NCR.

[0017] FIG. **7** is a call flow diagram illustrating example operations between a UE, a network entity, and an FT-NCR for licensed-to-unlicensed FT-NCR operations.

[0018] FIG. **8**A illustrates an example FT-NCR synchronization signal block (SSB) burst location bitmap indicating FT-NCR SSB burst locations from a set of serving cell SSB burst locations.

[0019] FIG. **8**B illustrates an example FT-NCR SSB burst location bitmap indicating FT-NCR SSB burst locations additional to a set of serving cell SSB burst locations.

[0020] FIG. **9** illustrates example licensed-to-unlicensed FT-NCR operations.

[0021] FIG. **10** depicts a method for wireless communications at a UE.

[0022] FIG. **11** depicts a method for wireless communications at a network entity.

[0023] FIG. **12** depicts a method for wireless communications at an FT-NCR.

[0024] FIG. **13** depicts aspects of an example communications device.

[0025] FIG. **14** depicts aspects of an example communications device.

[0026] FIG. **15** depicts aspects of an example communications device.

DETAILED DESCRIPTION

[0027] Aspects of the present disclosure provide apparatuses, methods, processing systems, and computer-readable mediums for initial access with a licensed-to-unlicensed frequency translating network controlled repeater (FT-NCR).

[0028] The FT-NCR has a control link and backhaul link with a network entity (e.g., a base station (BS)) and one or more access links with a user equipment (UE). The network entity receives control information from the network entity over the control link to control the amplify, frequency translation, and forwarding operations of the FT-NCR.

[0029] According to certain aspects, the FT-NCR receives synchronization signal (SS) bursts from the network entity over a licensed frequency band (e.g., via the backhaul link or Uu interface), translates the SS bursts to an unlicensed frequency band (e.g., associated with the access link) and forwards the translated SS bursts to the UE over the access link on the unlicensed frequency band. In some aspects, the network entity sends additional SS bursts for the FT-NCR operation. In some cases, the additional SS bursts are transmitted on a non-legacy synchronization raster detectable by the FT-NCR.

[0030] The network entity provides system information in a master information block (MIB) of a physical broadcast channel (PBCH) of the SS burst indicating an associated initial control resource set (CORESET). According to certain aspects, for SS bursts over the unlicensed frequency bands, the system information indicating the initial CORESET is based on a MIB-to-CORESET-0 mapping associated with the unlicensed frequency band.

[0031] In some aspects, the network entity configures the UE to refrain from decoding physical downlink control channel (PDCCH) resources in the initial CORESET associated with a MIB when the MIB is based on the MIB-to-CORESET-0 mapping associated with the unlicensed frequency band but the UE receives the MIB in the licensed frequency band.

[0032] According to certain aspects, the initial system information further provides information for the UE to perform random access in response to SS bursts received over the access link.

Introduction to Wireless Communications Networks

[0033] The techniques and methods described herein may be used for various wireless communications networks. While aspects may be described herein using terminology commonly associated with 3G, 4G, and/or 5G wireless technologies, aspects of the present disclosure may likewise be applicable to other communications systems and standards not explicitly mentioned herein.

[0034] FIG. **1** depicts an example of a wireless communications network **100**, in which aspects described herein may be implemented.

[0035] Generally, wireless communications network **100** includes various network entities (alternatively, network elements or network nodes). A network entity is generally a communications device and/or a communications function performed by a communications device (e.g., a user equipment (UE), a base station (BS), a component of a BS, a server, etc.). For example, various functions of a network as well as various devices associated with and interacting with a network may be considered network entities. Further, wireless communications network **100** includes terrestrial aspects, such as ground-based network entities (e.g., BSs **102**), and non-terrestrial aspects, such as satellite **140** and aircraft **145**, which may include network entities on-board (e.g., one or more BSs) capable of communicating with other network elements (e.g., terrestrial BSs) and user equipments.

[0036] In the depicted example, wireless communications network **100** includes BSs **102**, UEs **104**, and one or more core networks, such as an Evolved Packet Core (EPC) **160** and 5G Core (5GC) network **190**, which interoperate to provide communications services over various communications links, including wired and wireless links.

[0037] FIG. **1** depicts various example UEs **104**, which may more generally include: a cellular phone, smart phone, session initiation protocol (SIP) phone, laptop, personal digital assistant (PDA), satellite radio, global positioning system, multimedia device, video device, digital audio player, camera, game console, tablet, smart device, wearable device, vehicle, electric meter, gas pump, large or small kitchen appliance, healthcare device, implant, sensor/actuator, display, internet of things (IoT) devices, always on (AON) devices, edge processing devices, or other similar devices. UEs **104** may also be referred to more generally as a mobile device, a wireless device, a wireless communications device, a station, a mobile station, a subscriber station, a mobile subscriber station, a mobile unit, a subscriber unit, a wireless unit, a remote unit, a remote device, an access terminal, a mobile terminal, a wireless terminal, a remote terminal, a handset, and others.

[0038] BSs **102** wirelessly communicate with (e.g., transmit signals to or receive signals from) UEs **104** via communications links **120**. The communications links **120** between BSs **102** and UEs **104** may include uplink (UL) (also referred to as reverse link) transmissions from a UE **104** to a BS **102** and/or downlink (DL) (also referred to as forward link) transmissions from a BS **102** to a UE **104**. The communications links **120** may use multiple-input and multiple-output (MIMO) antenna technology, including spatial multiplexing, beamforming, and/or transmit diversity in various aspects.

[0039] BSs **102** may generally include: a NodeB, enhanced NodeB (CNB), next generation enhanced NodeB (ng-eNB), next generation NodeB (gNB or gNodeB), access point, base transceiver station, radio base station, radio transceiver, transceiver function, transmission reception point, and/or others. Each of BSs **102** may provide communications coverage for a respective geographic coverage area **110**, which may sometimes be referred to as a cell, and which may overlap in some cases (e.g., small cell **102'** may have a coverage area **110'** that overlaps the coverage area **110** of a macro cell). A BS may, for example, provide communications coverage for a macro cell (covering relatively large geographic area), a pico cell (covering relatively smaller geographic area, such as a sports stadium), a femto cell (relatively smaller geographic area (e.g., a home)), and/or other types of cells.

[0040] While BSs **102** are depicted in various aspects as unitary communications devices, BSs **102** may be implemented in various configurations. For example, one or more components of a base station may be disaggregated, including a central unit (CU), one or more distributed units (DUs), one or more radio units (RUs), a Near-Real Time (Near-RT) RAN Intelligent Controller (RIC), or a Non-Real Time (Non-RT) RIC, to name a few examples. In another example, various aspects of a base station may be virtualized. More generally, a base station (e.g., BS **102**) may include components that are located at a single physical location or components located at various physical locations. In examples in which a base station includes components that are located at various physical locations, the various components may each perform functions such that, collectively, the various components achieve functionality that is similar to a base station that is located at a single physical location. In some aspects, a base station including components that are located at various physical locations may be referred to as a disaggregated radio access network architecture, such as an Open RAN (O-RAN) or Virtualized RAN (VRAN) architecture. FIG. **2** depicts and describes an example disaggregated base station architecture.

[0041] Different BSs **102** within wireless communications network **100** may also be configured to support different radio access technologies, such as 3G, 4G, and/or 5G. For example, BSs **102** configured for 4G LTE (collectively referred to as Evolved Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access Network (E-UTRAN)) may interface with the EPC **160** through first backhaul links **132** (e.g., an S1 interface). BSs **102** configured for 5G (e.g., 5G NR or Next Generation RAN (NG-RAN)) may interface with 5GC **190** through second backhaul links **184**. BSs **102** may communicate directly or indirectly (e.g., through the EPC **160** or 5GC **190**) with each other over third backhaul links **134** (e.g., X2 interface), which may be wired or wireless.

[0042] Wireless communications network **100** may subdivide the electromagnetic spectrum into various classes, bands, channels, or other features. In some aspects, the subdivision is provided based on wavelength and frequency, where frequency may also be referred to as a carrier, a subcarrier, a frequency channel, a tone, or a subband. For example, 3GPP currently defines Frequency Range 1 (FR1) as including 410 MHZ-7125 MHz, which is often referred to (interchangeably) as "Sub-6 GHz". Similarly, 3GPP currently defines Frequency Range 2 (FR2) as including 24,250 MHZ-71,000 MHZ, which is sometimes referred to (interchangeably) as a "millimeter wave" ("mmW" or "mm Wave"). In some cases, FR2 may be further defined in terms of sub-ranges, such as a first sub-range FR2-1 including 24,250 MHz-52,600 MHz and a second sub-range FR2-2 including 52,600 MHz-71,000 MHz. A base station configured to communicate using mm Wave/near mm Wave radio frequency bands (e.g., a mm Wave base station such as BS **180**) may utilize beamforming (e.g., **182**) with a UE (e.g., **104**) to improve path loss and range.

[0043] The communications links **120** between BSs **102** and, for example, UEs **104**, may be through one or more carriers, which may have different bandwidths (e.g., 5, 10, 15, 20, 100, 400, and/or other MHz), and which may be aggregated in various aspects. Carriers may or may not be adjacent to each other. Allocation of carriers may be asymmetric with respect to DL and UL (e.g., more or fewer carriers may be allocated for DL than for UL).

[0044] Communications using higher frequency bands may have higher path loss and a shorter range compared to lower frequency communications. Accordingly, certain base stations (e.g., **180** in FIG. **1**) may utilize beamforming **182** with a UE **104** to improve path loss and range. For example, BS **180** and the UE **104** may each include a plurality of antennas, such as antenna elements, antenna panels, and/or antenna arrays to facilitate the beamforming. In some cases, BS **180** may transmit a beamformed signal to UE **104** in one or more transmit directions **182'**. UE **104** may receive the beamformed signal from the BS **180** in one or more receive directions **182"**. UE **104** may also transmit a beamformed signal to the BS **180** in one or more transmit directions **182"**. BS **180** may also receive the beamformed signal from UE **104** in one or more receive directions **182'**. BS **180** and UE **104** may then perform beam training to determine the best receive and transmit directions for each of BS **180** and UE **104**. Notably, the transmit and receive directions for BS **180** may or may not be the same. Similarly, the transmit and receive directions for UE **104** may or may not be the same.

[0045] Wireless communications network **100** further includes a Wi-Fi AP **150** in communication with Wi-Fi stations (STAs) **152** via communications links **154** in, for example, a 2.4 GHz and/or 5 GHz unlicensed frequency spectrum.

[0046] Certain UEs **104** may communicate with each other using device-to-device (D2D) communications link **158**. D2D communications link **158** may use one or more sidelink channels, such as a physical sidelink broadcast channel (PSBCH), a physical sidelink discovery channel (PSDCH), a physical sidelink shared channel (PSSCH), a physical sidelink control channel (PSCCH), and/or a physical sidelink feedback channel (PSFCH).

[0047] EPC **160** may include various functional components, including: a Mobility Management Entity (MME) **162**, other MMEs **164**, a Serving Gateway **166**, a Multimedia Broadcast Multicast Service (MBMS) Gateway **168**, a Broadcast Multicast Service Center (BM-SC) **170**, and/or a Packet Data Network (PDN) Gateway **172**, such as in the depicted example. MME **162** may be in communication with a Home Subscriber Server (HSS) **174**. MME **162** is the control node that processes the signaling between the UEs **104** and the EPC **160**. Generally, MME **162** provides bearer and connection management.

[0048] Generally, user Internet protocol (IP) packets are transferred through Serving Gateway **166**, which itself is connected to PDN Gateway **172**. PDN Gateway **172** provides UE IP address allocation as well as other functions. PDN Gateway **172** and the BM-SC **170** are connected to IP Services **176**, which may include, for example, the Internet, an intranet, an IP Multimedia Subsystem (IMS), a Packet Switched (PS) streaming service, and/or other IP services.

[0049] BM-SC **170** may provide functions for MBMS user service provisioning and delivery. BM-SC **170** may serve as an entry point for content provider MBMS transmission, may be used to authorize and initiate MBMS Bearer Services within a public land mobile network (PLMN), and/or may be used to schedule MBMS transmissions. MBMS Gateway **168** may be used to distribute MBMS traffic to the BSs **102** belonging to a Multicast Broadcast Single Frequency Network (MBSFN) area broadcasting a particular service, and/or may be responsible for session management (start/stop) and for collecting eMBMS related charging information.

[0050] 5GC **190** may include various functional components, including: an Access and Mobility Management Function (AMF) **192**, other AMFs **193**, a Session Management Function (SMF) **194**, and a User Plane Function (UPF) **195**. AMF **192** may be in communication with Unified Data Management (UDM) **196**.

[0051] AMF **192** is a control node that processes signaling between UEs **104** and 5GC **190**. AMF **192** provides, for example, quality of service (QOS) flow and session management.

[0052] Internet protocol (IP) packets are transferred through UPF **195**, which is connected to the IP Services **197**, and which provides UE IP address allocation as well as other functions for 5GC **190**. IP Services **197** may include, for example, the Internet, an intranet, an IMS, a PS streaming service, and/or other IP services.

[0053] In various aspects, a network entity or network node can be implemented as an aggregated base station, as a disaggregated base station, a component of a base station, an integrated access and backhaul (IAB) node, a relay node, a sidelink node, to name a few examples.

[0054] FIG. **2** depicts an example disaggregated base station **200** architecture. The disaggregated base station **200** architecture may include one or more central units (CUs) **210** that can communicate directly with a core network **220** via a backhaul link, or indirectly with the core network **220** through one or more disaggregated base station units (such as a Near-Real Time (Near-RT) RAN Intelligent Controller (RIC) **225** via an E2 link, or a Non-Real Time (Non-RT) RIC **215** associated with a Service Management and Orchestration (SMO) Framework **205**, or both). A CU **210** may communicate with one or more distributed units (DUs) **230** via respective midhaul links, such as an F1 interface. The DUs **230** may communicate with one or more radio units (RUs) **240** via respective fronthaul links. The RUs **240** may communicate with respective UEs **104** via one or more radio frequency (RF) access links. In some implementations, the UE **104** may be simultaneously served by multiple RUs **240**.

[0055] Each of the units, e.g., the CUs **210**, the DUs **230**, the RUs **240**, as well as the Near-RT RICs **225**, the Non-RT RICs **215** and the SMO Framework **205**, may include one or more interfaces or be coupled to one or more interfaces configured to receive or transmit signals, data, or information (collectively, signals) via a wired or wireless transmission medium. Each of the units, or an associated processor or controller providing instructions to the communications interfaces of the units, can be configured to communicate with one or more of the other units via the transmission medium. For example, the units can include a wired interface configured to receive or transmit signals over a wired transmission medium to one or more of the other units. Additionally or alternatively, the units can include a wireless interface, which may include a receiver, a transmitter or transceiver (such as a radio frequency (RF) transceiver), configured to receive or transmit signals, or both, over a wireless transmission medium to one or more of the other units.

[0056] In some aspects, the CU **210** may host one or more higher layer control functions. Such control functions can include radio resource control (RRC), packet data convergence protocol (PDCP), service data adaptation protocol (SDAP), or the like. Each control function can be implemented with an interface configured to communicate signals with other control functions hosted by the CU **210**. The CU **210** may be configured to handle user plane functionality (e.g., Central Unit-User Plane (CU-UP)), control plane functionality (e.g., Central Unit-Control Plane (CU-CP)), or a combination thereof. In some implementations, the CU **210** can be logically split into one or more CU-UP units and one or more CU-CP units. The CU-UP unit can communicate bidirectionally with the CU-CP unit via an interface, such as the E1 interface when implemented in an O-RAN configuration. The CU **210** can be implemented to communicate with the DU **230**, as necessary, for network control and signaling.

[0057] The DU **230** may correspond to a logical unit that includes one or more base station functions to control the operation of one or more RUs **240**. In some aspects, the DU **230** may host one or more of a radio link control (RLC) layer, a medium access control (MAC) layer, and one or more high physical (PHY) layers (such as modules for forward error correction (FEC) encoding and decoding, scrambling, modulation and demodulation, or the like) depending, at least in part, on a functional split, such as those defined by the 3rd Generation Partnership Project (3GPP). In some aspects, the DU **230** may further host one or more low PHY layers. Each layer (or module) can be implemented with an interface configured to communicate signals with other layers (and modules) hosted by the DU **230**, or with the control functions hosted by the CU **210**.

[0058] Lower-layer functionality can be implemented by one or more RUs **240**. In some deployments, an RU **240**, controlled by a DU **230**, may correspond to a logical node that hosts RF processing functions, or low-PHY layer functions (such as performing fast Fourier transform (FFT), inverse FFT (IFFT), digital beamforming, physical random access channel (PRACH) extraction and filtering, or the like), or both, based at least in part on the functional split, such as a lower layer functional split. In such an architecture, the RU(s) **240** can be implemented to handle over the air (OTA) communications with one or more UEs **104**. In some implementations, real-time and non-real-time aspects of control and user plane communications with the RU(s) **240** can be controlled by the corresponding DU **230**. In some scenarios, this configuration can enable the DU(s) **230** and the CU **210** to be implemented in a cloud-based RAN architecture, such as a vRAN architecture.

[0059] The SMO Framework **205** may be configured to support RAN deployment and provisioning of non-virtualized and virtualized network elements. For non-virtualized network elements, the SMO Framework **205** may be configured to support the deployment of dedicated physical resources for RAN coverage requirements which may be managed via an operations and maintenance interface (such as an O1 interface). For virtualized network elements, the SMO Framework **205** may be configured to interact with a cloud computing platform (such as an open cloud (O-Cloud) **290**) to perform network element life cycle management (such as to instantiate virtualized network elements) via a cloud computing platform interface (such as an O2 interface). Such virtualized network elements can include, but are not limited to, CUs **210**, DUs **230**, RUs **240** and Near-RT RICs **225**. In some implementations, the SMO Framework **205** can communicate with a hardware aspect of a 4G RAN, such as an open eNB (O-cNB) **211**, via an O1 interface. Additionally, in some implementations, the SMO Framework **205** can communicate directly with one or more RUs **240** via an O1 interface. The SMO Framework **205** also may include a Non-RT RIC **215** configured to support functionality of the SMO Framework **205**.

[0060] The Non-RT RIC **215** may be configured to include a logical function that enables non-real-time control and optimization of RAN elements and resources, Artificial Intelligence/Machine Learning (AI/ML) workflows including model training and updates, or policy-based guidance of applications/features in the Near-RT RIC **225**. The Non-RT RIC **215** may be coupled to or communicate with (such as via an A1 interface) the Near-RT RIC **225**. The Near-RT RIC **225** may be configured to include a logical function that enables near-real-time control and optimization of RAN elements and resources via data collection and actions over an interface (such as via an E2 interface) connecting one or more CUs **210**, one or more DUs **230**, or both, as well as an O-cNB, with the Near-RT RIC **225**.

[0061] In some implementations, to generate AI/ML models to be deployed in the Near-RT RIC **225**, the Non-RT RIC **215** may receive parameters or external enrichment information from external servers. Such information may be utilized by the Near-RT RIC **225** and may be received at the SMO Framework **205** or the Non-RT RIC **215** from non-network data sources or from network functions. In some examples, the Non-RT RIC **215** or the Near-RT RIC **225** may be configured to tune RAN behavior or performance. For example, the Non-RT RIC **215** may monitor long-term trends and patterns for performance and employ AI/ML models to perform corrective actions through the SMO Framework **205** (such as reconfiguration via **01**) or via creation of RAN management policies (such as A1 policies).

[0062] FIG. **3** depicts aspects of an example BS **102** and a UE **104**.

[0063] Generally, BS **102** includes various processors (e.g., **320**, **330**, **338**, and **340**), antennas **334***a-t* (collectively **334**), transceivers **332***a-t* (collectively **332**), which include modulators and demodulators, and other aspects, which enable wireless transmission of data (e.g., data source **312**) and wireless reception of data (e.g., data sink **339**). For example, BS **102** may send and receive data between BS **102** and UE **104**. BS **102** includes controller/processor **340**, which may be configured to implement various functions described herein related to wireless communications.

[0064] Generally, UE **104** includes various processors (e.g., **358**, **364**, **366**, and **380**), antennas **352***a-r* (collectively **352**), transceivers **354***a-r* (collectively **354**), which include modulators and demodulators, and other aspects, which enable wireless transmission of data (e.g., retrieved from data source **362**) and wireless reception of data (e.g., provided to data sink **360**). UE **104** includes controller/processor **380**, which may be configured to implement various functions described herein related to wireless communications.

[0065] In regards to an example downlink transmission, BS **102** includes a transmit processor **320** that may receive data from a data source **312** and control information from a controller/processor **340**. The control information may be for the physical broadcast channel (PBCH), physical control format indicator channel (PCFICH), physical HARQ indicator channel (PHICH), physical downlink control channel (PDCCH), group common PDCCH (GC PDCCH), and/or others. The data may be for the physical downlink shared channel (PDSCH), in some examples.

[0066] Transmit processor **320** may process (e.g., encode and symbol map) the data and control information to obtain data symbols and control symbols, respectively. Transmit processor **320** may also generate reference symbols, such as for the primary synchronization signal (PSS), secondary synchronization signal (SSS), PBCH demodulation reference signal (DMRS), and channel state information reference signal (CSI-RS).

[0067] Transmit (TX) multiple-input multiple-output (MIMO) processor **330** may perform spatial processing (e.g., precoding) on the data symbols, the control symbols, and/or the reference symbols, if applicable, and may provide output symbol streams to the modulators (MODs) in transceivers **332***a*-**332***t*. Each modulator in transceivers **332***a*-**332***t* may process a respective output symbol stream to obtain an output sample stream. Each modulator may further process (e.g., convert to analog, amplify, filter, and upconvert) the output sample stream to obtain a downlink signal. Downlink signals from the modulators in transceivers **332***a*-**332***t* may be transmitted via the antennas **334***a*-**334***t*, respectively.

[0068] In order to receive the downlink transmission, UE **104** includes antennas **352***a*-**352***r* that may receive the downlink signals from the BS **102** and may provide received signals to the demodulators (DEMODs) in transceivers **354***a*-**354***r*, respectively. Each demodulator in transceivers **354***a*-**354***r* may condition (e.g., filter, amplify, downconvert, and digitize) a respective received signal to obtain input samples. Each demodulator may further process the input samples to obtain received symbols.

[0069] MIMO detector **356** may obtain received symbols from all the demodulators in transceivers **354***a*-**354***r*, perform MIMO detection on the received symbols if applicable, and provide detected symbols. Receive processor **358** may process (e.g., demodulate, deinterleave, and decode) the detected symbols, provide decoded data for the UE **104** to a data sink **360**, and provide decoded control information to a controller/processor **380**.

[0070] In regards to an example uplink transmission, UE **104** further includes a transmit processor **364** that may receive and process data (e.g., for the PUSCH) from a data source **362** and control information (e.g., for the physical uplink control channel (PUCCH)) from the controller/processor **380**. Transmit processor **364** may also generate reference symbols for a reference signal (e.g., for the sounding reference signal (SRS)). The symbols from the transmit processor **364** may be precoded by a TX MIMO processor **366** if applicable, further processed by the modulators in transceivers **354***a*-**354***r* (e.g., for SC-FDM), and transmitted to BS **102**.

[0071] At BS **102**, the uplink signals from UE **104** may be received by antennas **334***a-t*, processed by the demodulators in transceivers **332***a*-**332***t*, detected by a MIMO detector **336** if applicable, and further processed by a receive processor **338** to obtain decoded data and control information sent by UE **104**. Receive processor **338** may provide the decoded data to a data sink **339** and the decoded control information to the controller/processor **340**.

[0072] Memories **342** and **382** may store data and program codes for BS **102** and UE **104**, respectively.

[0073] Scheduler **344** may schedule UEs for data transmission on the downlink and/or uplink.

[0074] In various aspects, BS **102** may be described as transmitting and receiving various types of data associated with the methods described herein. In these contexts, "transmitting" may refer to various mechanisms of outputting data, such as outputting data from data source **312**, scheduler **344**, memory **342**, transmit processor **320**, controller/processor **340**, TX MIMO processor **330**, transceivers **332***a-t*, antenna **334***a-t*, and/or other aspects described herein. Similarly, "receiving" may refer to various mechanisms of obtaining data, such as obtaining data from antennas **334***a-t*, transceivers **332***a-t*, RX MIMO detector **336**, controller/processor **340**, receive processor **338**, scheduler **344**, memory **342**, and/or other aspects described herein.

[0075] In various aspects, UE **104** may likewise be described as transmitting and receiving various types of data associated with the methods described herein. In these contexts, "transmitting" may refer to various mechanisms of outputting data, such as outputting data from data source **362**, memory **382**, transmit processor **364**, controller/processor **380**, TX MIMO processor **366**, transceivers **354***a-t*, antenna **352***a-t*, and/or other aspects described herein. Similarly, "receiving" may refer to various mechanisms of obtaining data, such as obtaining data from antennas **352***a-t*, transceivers **354***a-t*, RX MIMO detector **356**, controller/processor **380**, receive processor **358**, memory **382**, and/or other aspects described herein.

[0076] In some aspects, one or more processors may be configured to perform various operations, such as those associated with the methods described herein, and transmit (output) to or receive (obtain) data from another interface that is configured to transmit or receive, respectively, the data.

[0077] FIGS. **4**A, **4**B, **4**C, and **4**D depict aspects of data structures for a wireless communications network, such as wireless communications network **100** of FIG. **1**.

[0078] In particular, FIG. **4**A is a diagram **400** illustrating an example of a first subframe within a 5G (e.g., 5G NR) frame structure, FIG. **4**B is a diagram **430** illustrating an example of DL channels within a 5G subframe, FIG. **4**C is a diagram **450** illustrating an example of a second subframe within a 5G frame structure, and FIG. **4**D is a diagram **480** illustrating an example of UL channels within a 5G subframe.

[0079] Wireless communications systems may utilize orthogonal frequency division multiplexing (OFDM) with a cyclic prefix (CP) on the uplink and downlink. Such systems may also support half-duplex operation using time division duplexing (TDD). OFDM and single-carrier frequency division multiplexing (SC-FDM) partition the system bandwidth (e.g., as depicted in FIGS. **4**B and **4**D) into multiple orthogonal subcarriers. Each subcarrier may be modulated with data. Modulation symbols may be sent in the frequency domain with OFDM and/or in the time domain with SC-FDM.

[0080] A wireless communications frame structure may be frequency division duplex (FDD), in which, for a particular set of subcarriers, subframes within the set of subcarriers are dedicated for either DL or UL. Wireless communications frame structures may also be time division duplex (TDD), in which, for a particular set of subcarriers, subframes within the set of subcarriers are dedicated for both DL and UL.

[0081] In FIGS. **4**A and **4**C, the wireless communications frame structure is TDD where Dis DL, U is UL, and X is flexible for use between DL/UL. UEs may be configured with a slot format through a received slot format indicator (SFI) (dynamically through DL control information (DCI), or semi-statically/statically through radio resource control (RRC) signaling). In the depicted examples, a 10 ms frame is divided into 10 equally sized 1 ms subframes. Each subframe may include one or more time slots. In some examples, each slot may include 7 or 14 symbols, depending on the slot format. Subframes may also include mini-slots, which generally have fewer symbols than an entire slot. Other wireless communications technologies may have a different frame structure and/or different channels.

[0082] In certain aspects, the number of slots within a subframe is based on a slot configuration and a numerology. For example, for slot configuration 0, different numerologics (μ) 0 to 6 allow for 1, 2, 4, 8, 16, 32, and 64 slots, respectively, per subframe. For slot configuration 1, different numerologies 0 to 2 allow for 2, 4, and 8 slots, respectively, per subframe. Accordingly, for slot configuration 0 and numerology μ, there are 14 symbols/slot and 2μ slots/subframe. The subcarrier spacing and symbol length/duration are a function of the numerology. The subcarrier spacing may be equal to $2^{\mu}\times 15$ kHz, where u is the numerology 0 to 6. As such, the numerology $\mu=0$ has a subcarrier spacing of 15 kHz and the numerology $\mu=6$ has a subcarrier spacing of 960 kHz. The symbol length/duration is inversely related to the subcarrier spacing. FIGS. **4**A, **4**B, **4**C, and **4**D provide an example of slot configuration 0 with 14 symbols per slot and numerology $\mu=2$ with 4 slots per subframe. The slot duration is 0.25 ms, the subcarrier spacing is 60 kHz, and the symbol duration is approximately 16.67 μs.

[0083] As depicted in FIGS. **4**A, **4**B, **4**C, and **4**D, a resource grid may be used to represent the frame structure. Each time slot includes a resource block (RB) (also referred to as physical RBs (PRBs)) that extends, for example, 12 consecutive subcarriers. The resource grid is divided into multiple resource elements (REs). The number of bits carried by each RE depends on the modulation scheme.

[0084] As illustrated in FIG. **4**A, some of the REs carry reference (pilot) signals (RS) for a UE (e.g., UE **104** of FIGS. **1** and **3**). The RS may include demodulation RS (DMRS) and/or channel state information reference signals (CSI-RS) for channel estimation at the UE. The RS may also include beam measurement RS (BRS), beam refinement RS (BRRS), and/or phase tracking RS (PT-RS).

[0085] FIG. **4**B illustrates an example of various DL channels within a subframe of a frame. The physical downlink control channel (PDCCH) carries DCI within one or more control channel elements (CCEs), each CCE including, for example, nine RE groups (REGs), each REG including, for example, four consecutive REs in an OFDM symbol.

[0086] A primary synchronization signal (PSS) may be within symbol **2** of particular subframes of a frame. The PSS is used by a UE (e.g., **104** of FIGS. **1** and **3**) to determine subframe/symbol timing and a physical layer identity.

[0087] A secondary synchronization signal (SSS) may be within symbol **4** of particular subframes of a frame. The SSS is used by a UE to determine a physical layer cell identity group number and radio frame timing.

[0088] Based on the physical layer identity and the physical layer cell identity group number, the UE can determine a physical cell identifier (PCI). Based on the PCI, the UE can determine the locations of the aforementioned DMRS. The physical broadcast channel (PBCH), which carries a master information block (MIB), may be logically grouped with the PSS and SSS to form a synchronization signal (SS)/PBCH block. The MIB provides a number of RBs in the system bandwidth and a system frame number (SFN). The physical downlink shared channel (PDSCH) carries user data, broadcast system information not transmitted through the PBCH such as system information blocks (SIBs), and/or paging messages.

[0089] As illustrated in FIG. **4**C, some of the REs carry DMRS (indicated as R for one particular configuration, but other DMRS configurations are possible) for channel estimation at the base station. The UE may transmit DMRS for the PUCCH and DMRS for the PUSCH. The PUSCH DMRS may be transmitted, for example, in the first one or two symbols of the PUSCH. The PUCCH DMRS may be transmitted in different configurations depending on whether short or long PUCCHs are transmitted and depending on the particular PUCCH format used. UE **104** may transmit sounding reference signals (SRS). The SRS may be transmitted, for example, in the last symbol of a subframe. The SRS may have a comb structure, and a UE may transmit SRS on one of the combs. The SRS may be used by a base station for channel quality estimation to enable frequency-dependent scheduling on the UL.

[0090] FIG. **4**D illustrates an example of various UL channels within a subframe of a frame. The PUCCH may be located as indicated in one configuration. The PUCCH carries uplink control information (UCI), such as scheduling requests, a channel quality indicator (CQI), a precoding matrix indicator (PMI), a rank indicator (RI), and HARQ ACK/NACK feedback. The PUSCH carries data, and may additionally be used to carry a buffer status report (BSR), a power headroom report (PHR), and/or UCI.

Aspects Related to Synchronization Raster

[0091] In some systems, a channel raster defines radio frequency (RF) reference frequencies. The RF reference frequencies are mapped to resource elements (REs) and resource blocks (RBs) to identify channel positions. The system bandwidth may be partitioned into a number of operating bands in which uplink channels, downlink channels, or both uplink and downlink channels can be used for communications between user equipments (UEs) and network entities (e.g., base stations (BSs)). The channels can be configured with different channel bandwidths. Different UE channel bandwidths support different total numbers of RBs (e.g., the maximum transmission bandwidth configuration), N_{RB}. For example, Table 5.3.2-1 of 3GPP TS 38.101-1 v17.7.0 illustrates an example of different N_{RB} dependent on SCS and channel bandwidth in NR.

[0092] A global frequency channel raster defines a set of RF reference frequencies, F_{REF}. The RF reference frequency is used in signaling to identify the frequency position of RF channels, SSBs, other elements. In 5G NR, the global frequency raster is defined for all frequencies from 0 GHz to 100 GHz. The granularity of the global frequency raster, ΔF_{Global}, defines the frequency step size between the RF reference frequencies. The RF reference frequencies are designated by an NR Absolute Radio Frequency Channel Number (NR-ARFCN), N_{REF}. The NR-ARFCN may be in the range (0, 1, . . . , 2016666) on the global frequency raster. The NR-ARFCN can be used to determine an associated RF reference frequency in MHz. For example, $F_{REF}=F_{REF\text{-}Offs}+\Delta F_{Global}(N_{REF}-N_{REF\text{-}Offs})$, where $F_{REF\text{-}Offs}$ and $N_{Ref\text{-}Offs}$ are offset values.

[0093] The channel raster defines a subset of the RF reference frequencies that can be used to identify the RF channel position in the uplink and downlink. Each subset of RF reference frequencies are associated with different operating bands. The RF reference frequency for an RF channel maps to a resource element on the carrier. For each operating band, a subset of frequencies from the global frequency raster are applicable for that band and forms a channel raster with a granularity ΔF_{Raster}, which may be equal to or larger than ΔF_{Global}. For example, Table 5.4.2.3-1 of 3GPP TS 38.101-1 v17.7.0 illustrates example NR operating bands mapped to RF reference frequency ranges.

[0094] The synchronization raster indicates the frequency positions of the SSB that can be used by the UE for system acquisition when explicit signaling of the synchronization block position is not present.

[0095] The frequency position of the SS block, SS_{REF}, is defined with a corresponding GSCN. Table 5.4.3.1-1 of 3GPP TS 38.101-1 v17.7.0 illustrates an example of parameters defining the SS_{REF} and GSCN for different frequency ranges. The synchronization raster and the SCS of the SSB may be defined separately for each band. An example of the resource element corresponding to the SS_{REF} is given in clause 5.4.3.2 of 3GPP TS 38.101-1 v17.7.0. An example of a synchronization raster for each band is given in Table 5.4.3.3-1 of 3GPP TS 38.101-1 v17.7.0 with reference to the example SS/PBCH block patterns Cases A-G in Section 4.1 of 3GPP TS 38.213 v17.7.0.

Aspects Related to Licensed-to-Unlicensed Frequency-Translating Network Controlled Repeaters (FT-NCRS)

[0096] To improve the coverage and support the increasing number of user equipments (UEs), different methods are considered, among which network densification and millimeter wave (mmw) communications are considered important contributions. Network densification refers to the deployment of multiple access points of different types (e.g., in metropolitan areas. Small nodes, such as relays, integrated access and backhaul (IAB), reconfigurable intelligent surfaces (RIS), and repeaters, may be deployed to assist the communications.

[0097] In certain systems, such as 3GPP 5G NR Release 16 and Release 17 systems, IAB nodes are specified as the main relaying nodes. While IAB nodes extend coverage, IAB node are, however, relatively complex.

[0098] A RIS may be an electromagnetically active artificial structures with low beamforming capabilities, and hence low accuracy, that can be used to reshape the propagation environment such as to improve capacity, coverage and energy efficiency. A RIS may control electromagnetic properties of the radio frequency (RF) waves by performing an intelligent adaptation of the phase shift (e.g., adapting a phase matrix) towards the desired direction, without performing any decoding.

[0099] Repeaters (e.g., RF repeaters) enhance coverage, but are low complexity devices, significantly reducing operator costs. FIG. **5** depicts an example repeater **506** serving a user equipment **504** (e.g., such as a UE **104** of FIG. **1**) for a base station **502** (e.g., such as a BS **102** of FIG. **1**).

[0100] The repeater **506** may communicate data with the base station **502** over a backhaul link **510**, for example, via the NCR forwarding (FWD) function.

[0101] The repeater **506** may receive control information from the base station **502** over a control link **514**, for example, via the NCR mobile termination (MT). The control information may control the forwarding operation of the repeater **502**. In some aspects, the control link **514** is over a Uu interface.

[0102] The repeater **506** may forward data from the base station **502** to a UE **504** and/or from the UE **504** to the base station **502** via access link **512**. The NCR FWD of the repeater **506** may perform the amplify-and-forwarding operation of uplink and downlink RF signals between the base station **502** and the UE **504**. In some aspects, the repeater **506** can maintain the base station-repeater link **510** simultaneously with the repeater-user equipment link **512**.

[0103] Currently, such repeaters may be fully network-controlled. An NCR may amplify-and-forward signals that the NCR receives without performing any decoding. The NCR may use transmit and receive beamforming to control interference. The NCR can be logically a part of the base station for management purposes.

[0104] In some aspects, NCRs are in-band RF repeaters used for extension of network coverage in the FR1 and FR2 bands and may operate transparently to the UE. After power amplification and with beamforming, the NCR forwards a received RF signal in the uplink or downlink. Since the NCR-forward only amplifies and beamforms the RF signal, the NCR may not use any advanced digital receiver or transmitter chains. In some examples, the NCR is transparent to the UE.

[0105] In some aspects, an NCR may be frequency translating NCR (FT-NCR). The FT-NCR, in addition to the amplify and forward operations, translates the signal received on a first frequency band and outputs the signal on a second frequency band. For example, the FT-NCR may output the signal on a band with low load for last-mile connectivity to UEs in the cell edge. In some cases, the FT-NCR may output the signal on another licensed band or on an unlicensed band. Use of an unlicensed band may mitigate interference to other UEs.

[0106] In the illustrative example discussed herein, the base station transmits the control information to the FT-NCR over the Uu interface on the control link on a first frequency band f_c^1 (a licensed frequency band). The base station communicates data with a UE by transmitting towards the FT-NCR over the backhaul link on a second frequency band f_c^2 (a licensed frequency band). The FT-NCR forwards the data from the base station with the UE over the access link is on a third frequency band f_c^3 (an unlicensed frequency band). In some cases, the first frequency band for the control link is the same frequency band as the second frequency band for the backhaul and a different frequency band than the third frequency band for the access link. In some cases, the base station also transmits to the UE using the first frequency band or the second frequency band.

[0107] FIG. **6**A depicts an example analog FT-NCR **600***a*. The analog FT-NCR **600***a* receives a signal over antenna port A. The analog Ft-NCR **600***a* amplifies the signal, for example, using low noise amplifier (LNA) **604**, translates the received signal frequency band f_c^k to baseband or intermediate frequency (IF) at frequency converter **606**, up-converts the signal to output signal frequency band f_c^i at frequency converter **608**, amplifies the signal using LNA **610**, and outputs the signal over the antenna port B. For a signal in the other direction, the analog FT-NCR **600***a* receives a signal over antenna port B, amplifies the signal, for example, using LNA **612**, translates the received signal frequency band f_c^k to baseband (or IR) at frequency converter **614**, up-converts the signal to output signal frequency band f_c^i at frequency converter **616**, amplifies the signal using LNA **618**, and outputs the signal over the antenna port A.

[0108] FIG. **6**B depicts an example digital FT-NCR **600***b*. After the digital FT-NCR **600***b* RF front-end (RFFE) receives the input signal over antenna port A on the received signal frequency band f_c^k, the digital FT-NCR **600***b* digitally translates the frequency though the baseband modulator modulating the signal with modulation parameters Pf_c^k and the baseband demodulator demodulating the signal with demodulation parameters Pf_c^i. The RFFE outputs the signal on the output signal frequency band f_c^i.

[0109] While FT-NCRs allow for coverage extension, because the FT-NCR may be transparent to the UE, the UE needs to be aware that signals being repeated by the FT-NCR are from the same cell as the original signal transmissions from the base station in order to distinguish the signals associated with the cell from signals transmitted by other neighbor cells. For example, the UE may need to identify synchronization signal block (SSB) transmissions received from the FT-NCR as associated with the cell, even though they are received on a different frequency band, in order to perform a random access channel (RACH) procedure with the correct cell.

[0110] As mentioned, translation to an unlicensed frequency band may be useful to avoid interference. For example, licensed-to-unlicensed FT-NCRs may be deployed on cars, buses, or other vehicles. Based on the position of the UEs inside the vehicle, the UEs may experience a large variation in signal strength from a base station (BS). For example, a UE on the dashboard inside a car may receive a stronger signal from the BS than a UE in the center console. The FT-NCRs may receive a signal from a base station (BS) using licensed frequency bands and may communicate repeat the signal to nearby UEs using unlicensed frequency band(s). The communication with the UEs using the unlicensed frequency band(s) will not interference with the other nearby UEs that have a good signal with the BS using the licensed frequency band. Further, as licensed spectrum may be expensive, use of the unlicensed frequency band(s) may be more cost effective than performing repetition on the licensed band to improve coverage.

[0111] However, while translation to an unlicensed frequency band may improve coverage and avoid interference to the licensed frequency band, enhancements may be needed to initial access and to system information. For example, the SS burst includes the physical broadcast channel (PBCH) carrying the master information block (MIB). The MIB includes information that maps to a control resource set (CORESET) in which the network transmits downlink control information (DCI) in a physical downlink control channel (PDCCH) search space to schedule a physical downlink shared channel (PDSCH) with the initial system information. The UE needs to be able to identify that the SS burst and the initial system information, received on the unlicensed frequency band over the access link, is associated with a particular cell (e.g., associated with the serving cell). For example, the UE may distinguish the translated SS burst and initial system information as part of extended licensed operation through licensed-to-unlicensed FT-NCR rather than NR unlicensed (NR-U) operation. For example, the mapping of the MIB to the initial CORESET (CORESET-0) is different for the licensed and unlicensed operation. Accordingly, if the UE, receiving the MIB over the unlicensed frequency band, uses the unlicensed mapping to determine a CORESET to monitor, the UE will not find the CORESET because the MIB carries information mapping to the CORESET in the licensed spectrum.

[0112] Thus, enhancements are needed to allow the UE to receive system information over the unlicensed frequency band. In addition, as NCR operation may be transparent to the UE, it may be desirable that the enhancements allow the UE to receive the system information over the unlicensed frequency band without prior knowledge of the frequency translation operation.

Aspects Related to Enhanced Initial Access with FT-NCRs

[0113] According to certain aspects, the network configures a frequency translating network controlled repeater (FT-NCR) to translate synchronization signal (SS) burst transmissions received on a licensed frequency band from a network entity to an access link unlicensed frequency band and forwards the translated SS burst transmissions to a user equipment (UE) over the access link. In some aspects, the FT-NCR translates the SS burst transmission to a synchronization raster associated with the unlicensed frequency band. In some aspects, the synchronization raster is a non-legacy synchronization raster defined for the licensed-to-unlicensed FT-NCR operation. The non-legacy synchronization raster may be monitored for SS bursts only by non-legacy UEs.

[0114] In some aspects, the FT-NCR forwards the SS bursts in one or more SSB locations of SSB locations used by the network entity. In some aspects, the network entity transmits additional separate SS bursts for the FT-NCR operation. In some aspects, the FT-NCR forwards the SS bursts in one or more SSB additional SSB locations separate from SSB locations used by the network entity.

[0115] The SS burst transmissions include the physical broadcast channel (PBCH) carrying system information including the master information block (MIB). The MIB includes information mapping to a time and frequency location (e.g., in a Type0 PDCCH search space) of an initial control resource set (CORESET-0). According to certain aspects, for one or more SS bursts for the FT-NCR operation, the network entity includes information in the MIB pointing to the CORESET-0 based on the MIB-to-CORESET-0 mapping of the unlicensed spectrum mapping. For example, the index for the CORESET-0 may be based on the indices for the unlicensed SIB-1. Thus, the UE receiving MIB over the access link from the FT-NCR in the unlicensed frequency band will find the CORESET-0 when the UE monitors the CORESET-0 based on the unlicensed spectrum MIB-to-CORESET-0 mapping. The network entity may transmit one or more other SSBs over the direct link (e.g., a Uu link with the UEs over the licensed frequency band) that include MIB with information pointing to the CORESET-0 based on the MIB-to-CORESET-0 mapping of the licensed spectrum mapping.

[0116] In some aspects, the system information carried in the PBCH of additional SS bursts, for the FT-NCR operation, includes system information indicating for UEs not to use the SS burst if received over the licensed frequency band and licensed synchronization raster. In some aspects, a UE receiving the SS burst, with the system information indicating not to use the SS burst, will not attempt to monitor and/or decode in the associated initial CORESET indicated by the MIB. This may prevent the UEs from receiving the MIB in the licensed frequency band and determining the CORESET-0 to monitor based on the MIB-to-CORESET-0 mapping of the licensed spectrum mapping, while the MIB information is based on the unlicensed spectrum MIB-to-CORESET-0 mapping, in which case the UE will not find the CORSET-0. In some aspects, the network entity does not transmit the PDCCH and/or the associated SIB-1 in the CORESET-0 location based on the licensed MIB-to-CORESET-0 mapping.

[0117] In some aspects, the network entity may prevent the UEs the receiving the MIB in the licensed frequency band with the MIB information based on the unlicensed spectrum MIB-to-CORESET-0 mapping from attempting to monitor and/or decode in the associated initial CORESET indicated by the MIB by transmitting a system information block (SIB) in the associated CORESET indicating that the UEs are barred from using the CORESET.

[0118] In some aspects, the network entity sets a flag (e.g., a cellReservedForFutureUse flag) to prevent legacy UEs from attempting to decode PDCCH resources in the initial CORESET.

[0119] In some aspects, the network entity configures the FT-NCR with a listen-before-talk (LBT) type of procedure to use before transmitting on the access link. For example, the network entity may configure no LBT to be used or a short Type 2 LBT procedure for the FT-NCR to use before transmitting on the access link.

[0120] In some aspects, the network entity configures the FT-NCR with a transmit power reduction to use for transmission on the access link.

[0121] The network entity transmits downlink control information (DCI) in a physical downlink control channel (PDCCH) in the initial CORESET. The DCI schedules a physical downlink shared channel (PDSCH) transmission including an initial system information block (SIB1).

[0122] The UE receiving the SS burst with the MIB, determines the location to monitor the initial CORESET to monitor based on a mapping of information in the MIB to the initial CORESET. The UE receiving the SS burst in the licensed frequency band determines the location to monitor the initial CORESET to monitor based on a first mapping of information in the MIB to the initial CORESET associated with the licensed spectrum. The UE receiving the SS burst in the unlicensed frequency band determines the location to monitor the initial CORESET to monitor based on a second mapping of information in the MIB to the initial CORESET, different than the first mapping, associated with the unlicensed spectrum. In some aspects, where the UE receives the SS burst on the licensed frequency spectrum, the UE may refrain monitoring the associated CORESET for PDCCH. For example, the UE may receive system information in the SS burst indicating not to monitor the associated CORESET if received over the licensed frequency band or the UE may receive a SIB in the CORESET indicating not to decode the PDCCH in the CORESET.

[0123] In some aspects, the initial SIB includes information for the UE to use the access link for the FT-NCR operation.

[0124] In some aspects, the initial SIB contains information for a UE to perform RACH in response to SS bursts received over the access link frequency band. For example, the initial SIB may include first information for the UE to perform RACH in response to SS bursts received over the direct link on the licensed frequency band and second information for the UE to perform RACH in response to SS bursts received over the access link on the unlicensed frequency band. In some aspects, the initial SIB may indicate additional RACH resources to account for in an LBT procedure for the unlicensed link. In some examples, the initial SIB may indicate a maximum RACH LBT failure threshold parameter for the access link. In some examples, if the UE is unable to send a RACH request on the access link within the maximum RACH LBT failure threshold due to persistent LBT failures, the UE may stop trying to transmit the RACH request for a fixed period. In some examples, the initial SIB may indicate for the UE to refrain from power boosting on one or more RACH occasions. In some examples, the initial SIB may indicate for the UE to refrain from perform LBT for RACH on the access link or for the UE to perform a short (e.g., Type2) LBT procedure for RACH on the access link. In some examples, the initial SIB may indicate a maximum transmit power for RACH on the access link. In some aspects, the initial SIB indicates an unlicensed frequency band for the UE to use for uplink and/or downlink communication on the access link. For example, the initial SIB may indicate an additional downlink only path, the UE may use the access link to decode DCI and downlink traffic but the UE does not perform RACH on the access link. If the initial SIB indicates an additional uplink only path, the UE may conditionally use the access link to perform RACH, for example, if RACH with the cell has failed, or if the cell signal quality (e.g., reference signal receive power (RSRP)) is below a threshold.

[0125] FIG. **7** depicts a process flow **700** for communications in a network between a network entity **702**, a UE **704**, and a FT-NCR **706**. In some aspects, the network entity **702** may be an example of the BS **102** depicted and described with respect to FIGS. **1** and **3** or a disaggregated base station depicted and described with respect to FIG. **2**. Similarly, the UE **704** may be an example of UE **104** depicted and described with respect to FIGS. **1** and **3**. In some aspects, the FT-NCR **706** may be an example of the NCR **506** depicted and described with respect to FIG. **5**, the analog NCR **600***a* depicted and described with respect to FIG. **6**A, or the digital NCR **600***b* depicted and described with respect to FIG. **6**B. However, in other aspects, UE **704** may be another type of wireless communications device, network entity **702** may be another type of network entity or network node, and FT-NCR **706** may be another type of repeater, such as those described herein.

[0126] As shown in FIG. **7**, the FT-NCR **706** may include a mobile termination (MT) **710** and forwarding **708** logical entities. The MT **710** may receive control information from the network entity **702** over a control link, which may use a first frequency band f1 (e.g., f_c^1). The FWD **708** may receive data from the network entity **702** over a backhaul link, which uses a second frequency band (e.g., f_c^2). The network entity **702** may also communicate with the UE **704** via the Uu interface over a licensed frequency band. In some examples, the licensed frequency band is the first frequency band (e.g., f_c^1) or the second frequency band (e.g., f_c^2). However, the UE **704** may not be able to receive signals from the network entity **702**. For example, UE **704** may be a cell edge UE or due to signal interference or the presence of blockers in the network environment. The FWD **708** may repeat the signals received from the network entity **702** to the UE **704** over an access link, which may use a third unlicensed frequency band (e.g., f_c^3).

[0127] At **712**, the network entity **702** may configured the FT-NCR **706** with control information over the control link. The control information may configure the FT-NCR **706** for the licensed-to-unlicensed frequency translation, amplify, and forwarding operations. In some aspects, the network entity **702** configures the FT-NCR **706** with an LBT type of procedure to use before transmitting on the access link. For example, the network entity **702** may configure no LBT to be used or a short Type 2 LBT procedure for the FT-NCR **706** to use before transmitting on the access link. In some aspects, the network entity **702** configures the FT-NCR **706** with a transmit power reduction to use for transmission on the access link.

[0128] At **714**, the network entity **702** sends a SS burst for the UE **704**. The SS burst may be sent via the Uu interface on the second frequency band (e.g., f_c^2) with a first synchronization raster. As shown, the SS burst may not reach the UE **704**, but the SS burst may be received by the FT-NCR **706** over the backhaul link.

[0129] In some aspects, SS bursts are transmitted periodically. The transmission pattern may be depend on the subcarrier spacing (SCS) and frequency range. Within a window, a set of SS bursts may be transmitted (e.g., up to 64 SSBs transmitted with beam sweeping). The SS burst may include an SSB and a physical broadcast channel (PBCH) carrying a MIB indicating an initial CORESET (e.g., CORESET0). For example, the MIB may include a parameter pdcch-ConfigSIB1 that maps to an initial CORESET, a common search space, and some PDCCH parameters. A CORESET may be a set of physical resources (e.g., a specific area on the downlink resource grid), localized to specific search space regions in the frequency domain, and a set of parameters that is used to carry PDCCH.

[0130] According to certain aspects, for one or more SS bursts for the FT-NCR operation, the network entity **702** includes information in the MIB pointing to the CORESET-0 based on the MIB-to-CORESET-0 mapping of the unlicensed spectrum mapping. For example, the index for the CORESET-0 may be based on the indices for the unlicensed SIB-1.

[0131] In some aspects, the network entity **702** may transmit one or more other SSBs over the direct link (e.g., a Uu link with the UEs over the licensed frequency band) that include MIB with information pointing to the CORESET-0 based on the MIB-to-CORESET-0 mapping of the licensed spectrum mapping.

[0132] In some aspects, the system information carried in the PBCH of additional SS bursts, for the FT-NCR **706** operation, includes system information indicating for UE **704** not to use the SS burst if received over the licensed frequency band and licensed synchronization raster. In some aspects, the network entity **702** does not transmit the PDCCH and/or the associated SIB-1 in the CORESET-0 location based on the licensed MIB-to-CORESET-0 mapping.

[0133] In some aspects, the network entity **702** transmits a system information block (SIB) in the CORESET associated with the MIB based on the licensed MIB-to-CORESET-0 mapping indicating that the UE **704** is barred from using the CORESET. In some aspects, the network entity **702** sets a flag (e.g., a cellReservedForFutureUse flag) to prevent legacy UEs from attempting to decode PDCCH resources in the initial CORESET.

[0134] When the FT-NCR **706** receives the SS burst over the backhaul link on the licensed second frequency band (e.g., f_c^2), the FWD **708** amplifies the SS burst transmission and translates the SS burst transmission to the third unlicensed frequency band (e.g., f_c^3) for repeating the SS burst to the UE **704** over the access link at **716**. In some aspects, the FT-NCR **706** translates the SS burst transmission to a synchronization raster associated with the unlicensed third frequency band. In some aspects, the synchronization raster is a non-legacy synchronization raster defined for the licensed-to-unlicensed FT-NCR operation. The non-legacy synchronization raster may be monitored for SS bursts only by non-legacy UEs.

[0135] In some aspects, the FT-NCR **706** forwards the SS bursts in one or more SSB locations of SSB locations **810** of SSB locations **805** used by the network entity **702** as shown in FIG. **8**A. In some aspects, the network entity **702** transmits separate SS burst locations **810** for the FT-NCR **706** operation additionally to the SSB locations **805** used by the network entity **702** as shown in FIG. **8**B. In some aspects, the FT-NCR **706** forwards the SS bursts in one or more SSB additional SSB locations separate from SSB locations used by the network entity **702**.

[0136] Once the UE **704** receives the SS burst with the MIB from the FT-NCR **706** over the access link on the third unlicensed frequency band, the UE **704** can determine the initial CORESET, at **718**, and knows where to monitor for a PDCCH based on the MIB-to-CORESET-0 mapping associated with the unlicensed frequency band.

[0137] In some cases, where the UE **704** receives a MIB over the direct link from the network entity **702** in the licensed frequency band with the information indicating not to decode the associated CORESET-0, the UE **704** refrains from monitoring PDCCH in the CORESET-0 indicated by the MIB and the MIB-to-CORESET-0 mapping associated with the licensed frequency band. Alternatively, the UE **704** monitors in the CORESET-0 indicated by the MIB and the MIB-to-CORESET-0 mapping associated with the licensed frequency band and receives a SIB indicating not to decode the associated CORESET-0, the UE **704** refrains from monitoring PDCCH in the CORESET-0.

[0138] At **720**, the network entity **702** transmits a PDCCH transmission in the CORESET indicated in the MIB. The PDCCH transmission includes DCI scheduling a PDSCH transmission carrying an initial SIB. The PDCCH transmissions may be sent via the Uu interface on the second frequency band (e.g., f_c^2) with the first synchronization raster. As shown, the PDCCH transmission may not reach the UE **704**, but the PDCCH transmission may be received by the FT-NCR **706** over the backhaul link. The FWD **708** amplifies the PDCCH transmission and translates the PDCCH transmission to the third unlicensed frequency band (e.g., f_c^3) for repeating the PDCCH transmission to the UE **704** over the access link at **722**.

[0139] At **724**, the network entity **702** transmits the PDSCH transmission indicated in the DCI. As shown, the PDSCH transmission may not reach the UE **704**, but the PDSCH transmission may be received by the FT-NCR **706** over the backhaul link. The FWD **708** amplifies the PDSCH transmission and translates the PDSCH transmission to the third unlicensed frequency band (e.g., f_c^3) for repeating the PDSCH transmission to the UE **704** over the access link at **726**. The PDSCH transmission may include an initial SIB (e.g., SIB1).

[0140] The initial SIB may carry information about SSBs. For example, the initial SIB may include a parameter (e.g., ssb-PositionInBurst in ServingCellConfigCommonSIB IE) that configures a time domain transmission pattern of SSBs by the serving cell. In some aspects, the initial SIB further includes a parameter (e.g., downlinkConfigCommonSIB) that configures a list of downlink frequency bands (e.g., frequencyInfoDL IE) and a parameter (e.g., uplinkConfigCommonSIB) that configures a list of uplink frequency bands (e.g., frequencyInfoUL IE). In some aspects, the initial SIB further includes a parameter (e.g., supplementaryUplink IE) that configures one or more supplement uplink SUL) frequency bands.

[0141] In some aspects, the initial SIB includes information for the UE **704** to use the access link for the FT-NCR operation. In some aspects, the initial SIB contains information for the UE **704** to perform RACH in response to SS bursts received over the access link frequency band. For example, the initial SIB may include first information for the UE **704** to perform RACH in response to SS bursts received over the direct link on the licensed frequency band and second information for the UE **704** to perform RACH in response to SS bursts received over the access link on the unlicensed frequency band. In some aspects, the initial SIB may indicate additional RACH resources to account for an LBT procedure for the unlicensed link. In some examples, the initial SIB may indicate a maximum RACH LBT failure threshold parameter for the access link. In some examples, the initial SIB may indicate for the UE **704** to refrain from power boosting on one or more RACH occasions. In some examples, the initial SIB may indicate for the UE **704** to refrain from performing LBT for RACH on the access link or for the UE to perform a short (e.g., Type2) LBT procedure for RACH on the access link. In some examples, the initial SIB may indicate a maximum transmit power for RACH on the access link. In some aspects, the initial SIB indicates an unlicensed frequency band for the UE **704** to use for uplink and/or downlink communication on the access link.

[0142] At **728**, the UE **704** sends a RACH request, in response to the SS burst, to the serving cell (e.g., network entity **702**) based on determining the SS burst, received from the FT-NCR **706**, is associated with the same serving cell (e.g., network entity **702**). For example, the UE **704** may send the RACH request to the network entity **702** via the

FT-NCR **706**. The RACH request may be received by the FT-NCR **706** over the access link. The FWD **708** amplifies the RACH request transmission and translates the RACH request transmission to the second frequency band (e.g., f_c^2) for repeating the RACH request transmission to the network entity **702** over the backhaul link at **730**. In some examples, if the UE **704** is unable to send a RACH request on the access link within the maximum RACH LBT failure threshold due to persistent LBT failures, the UE **704** may stop trying to transmit the RACH request for a fixed period.

[0143] If the initial SIB indicated an additional downlink only path, the UE **704** may use the access link to decode DCI and downlink traffic but the UE **704** does not perform RACH on the access link. If the initial SIB indicates an additional uplink only path, the UE **704** may conditionally use the access link to perform the RACH, for example, if RACH with the cell has failed, or if the cell signal quality (e.g., RSRP) is below a threshold. If the initial SIB indicates both an additional downlink path and an additional uplink path, the UE **704** may use the access link to decode DCI and downlink traffic and also use the access link to perform RACH.

[0144] FIG. **9** illustrates example licensed-to-unlicensed FT-NCR operations **900**. As shown, the network entity transmits a first SS burst **902** over the licensed frequency band. The first SS burst **902** is received by the UE on the direct link over the licensed frequency band. The first SS burst **902** includes a MIB with system information based on the licensed frequency band MIB-to-CORESET-0 mapping. Accordingly, the UE can correctly determine the CORESET-0 **906** to decode PDCCH based on the MIB and the licensed frequency band MIB-to-CORESET-0 mapping.

[0145] As shown, the network entity transmits a second SS burst **904** over the licensed frequency band. The second SS burst **904** includes a MIB with system information based on the unlicensed frequency band MIB-to-CORESET-0 mapping. If the second SS burst **904** is received by the UE on the direct link over the licensed frequency band, the UE will determine an invalid CORESET-0 **908** to decode PDCCH based on the MIB and the licensed frequency band MIB-to-CORESET-0 mapping. However, if the second SS burst **904** is received by the UE on the access link over the unlicensed frequency band, the UE will determine the correct CORESET-0 **908** to decode PDCCH based on the MIB and the unlicensed frequency band MIB-to-CORESET-0 mapping.

Example Operations

[0146] FIG. **10** shows an example of a method **1000** of wireless communication by a user equipment (UE), such as a UE **104** of FIGS. **1** and **3**.

[0147] Method **1000** begins at step **1005** with receiving a synchronization signal (SS) burst from a repeater on an unlicensed frequency band associated with an unlicensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with the unlicensed frequency band. In some cases, the operations of this step refer to, or may be performed by, circuitry for receiving and/or code for receiving as described with reference to FIG. **13**.

[0148] Method **1000** then proceeds to step **1010** with monitoring the initial CORESET based on the MIB and the mapping associated with the unlicensed frequency band for a physical downlink control channel (PDCCH) transmission scheduling a physical downlink shared channel (PDSCH) transmission carrying an initial system information block (SIB) associated with a serving cell that uses a licensed frequency band associated with a licensed synchronization raster. In some cases, the operations of this step refer to, or may be performed by, circuitry for monitoring and/or code for monitoring as described with reference to FIG. **13**.

[0149] In some aspects, the method **1000** further includes determining the SS burst is associated with the serving cell based on the unlicensed synchronization raster. In some cases, the operations of this step refer to, or may be performed by, circuitry for determining and/or code for determining as described with reference to FIG. **13**.

[0150] In some aspects, the unlicensed frequency band and the unlicensed synchronization raster are associated with an access link between the UE and the repeater and the licensed frequency band and the licensed synchronization raster are associated with a direct link between the UE and the serving cell.

[0151] In some aspects, the method **1000** further includes receiving a SS burst from the serving cell on the licensed frequency band, wherein the SS burst includes an SSB and a PBCH carrying a MIB indicating an initial CORESET via a mapping associated with the unlicensed frequency band, wherein the SS burst includes an indication to refrain from decoding PDCCH resources in the initial CORESET if the SS burst is received on the licensed frequency band. In some cases, the operations of this step refer to, or may be performed by, circuitry for receiving and/or code for receiving as described with reference to FIG. **13**.

[0152] In some aspects, the method **1000** further includes refraining from monitoring in the initial CORESET based on the indication and based on receiving the MIB in the licensed frequency band. In some cases, the operations of this step refer to, or may be performed by, circuitry for refraining and/or code for refraining as described with reference to FIG. **13**.

[0153] In some aspects, the method **1000** further includes receiving a SS burst from the serving cell on the licensed frequency band, wherein the SS burst includes an SSB and a PBCH carrying a MIB indicating an initial CORESET via a mapping associated with the unlicensed frequency band. In some cases, the operations of this step refer to, or may be performed by, circuitry for receiving and/or code for receiving as described with reference to FIG. **13**.

[0154] In some aspects, the method **1000** further includes receiving a SIB in the initial CORESET indicated in the MIB and the mapping associated with the licensed frequency band, wherein the SIB indicates the UE is barred from decoding PDCCH resources in the initial CORESET. In some cases, the operations of this step refer to, or may be performed by, circuitry for receiving and/or code for receiving as described with reference to FIG. **13**.

[0155] In some aspects, the method **1000** further includes refraining from monitoring in the initial CORESET based on the indication. In some cases, the operations of this step refer to, or may be performed by, circuitry for refraining and/or code for refraining as described with reference to FIG. **13**.

[0156] In some aspects, the initial SIB indicates a first random access channel (RACH) configuration associated with the licensed frequency band and with the licensed synchronization raster and a second RACH configuration associated with the unlicensed frequency band and with the unlicensed synchronization raster.

[0157] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes a maximum RACH listen-before-talk (LBT) failure threshold parameter.

[0158] In some aspects, the method **1000** further includes determining to send a RACH request message for the serving cell via the unlicensed frequency band. In some cases, the operations of this step refer to, or may be performed by, circuitry for determining and/or code for determining as described with reference to FIG. **13**.

[0159] In some aspects, the method **1000** further includes performing an LBT procedure in response to the determination to send the RACH request message. In some cases, the operations of this step refer to, or may be performed by, circuitry for performing and/or code for performing as described with reference to FIG. **13**.

[0160] In some aspects, the method **1000** further includes refraining from sending the RACH request message in response to a number of LBT failures reaching the maximum RACH LBT failure threshold. In some cases, the operations of this step refer to, or may be performed by, circuitry for refraining and/or code for refraining as described with reference to FIG. **13**.

[0161] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes an indication to refrain from performing power boosting when sending a RACH request message for the serving cell via the unlicensed frequency band.

[0162] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes an indication to skip performing a listen-before-talk (LBT) procedure when sending a RACH request message for the serving cell via the unlicensed frequency band.

[0163] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes an indication to perform a short listen-before-talk (LBT) procedure when sending a RACH request message for the serving cell via the unlicensed frequency band.

[0164] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes a maximum transmit power for sending a RACH request message for the serving cell via the unlicensed frequency band.

[0165] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes a maximum number of repetitions for sending a RACH request message for the serving cell via the unlicensed frequency band.

[0166] In some aspects, the initial SIB indicates for the UE to use the unlicensed frequency band only for uplink transmission to the serving cell.

[0167] In some aspects, the initial SIB indicates for the UE to use the unlicensed frequency band only for downlink reception from the serving cell.

[0168] In some aspects, the initial SIB indicates for the UE to use the unlicensed frequency band for both uplink transmission to the serving cell and downlink reception from the serving cell.

[0169] In one aspect, method **1000**, or any aspect related to it, may be performed by an apparatus, such as communications device **1300** of FIG. **13**, which includes various components operable, configured, or adapted to perform the method **1000**. Communications device **1300** is described below in further detail.

[0170] Note that FIG. **10** is just one example of a method, and other methods including fewer, additional, or alternative steps are possible consistent with this disclosure.

[0171] FIG. **11** shows an example of a method **1100** of wireless communication by a network entity, such as a BS **102** of FIGS. **1** and **3**, or a disaggregated base station as discussed with respect to FIG. **2**.

[0172] Method **1100** begins at step **1105** with configuring a repeater associated with the network entity to translate transmissions from the network entity to an unlicensed frequency band associated with an unlicensed synchronization raster. In some cases, the operations of this step refer to, or may be performed by, circuitry for configuring and/or code for configuring as described with reference to FIG. **14**.

[0173] Method **1100** then proceeds to step **1110** with outputting a synchronization signal (SS) burst to a user equipment (UE) on a licensed frequency band associated with a licensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with the unlicensed frequency band. In some cases, the operations of this step refer to, or may be performed by, circuitry for outputting and/or code for outputting as described with reference to FIG. **14**.

[0174] In some aspects, the unlicensed frequency band and the unlicensed synchronization raster are associated with an access link between the UE and the repeater and the licensed frequency band and the licensed synchronization raster are associated with a direct link between the UE and a serving cell.

[0175] In some aspects, the method **1100** further includes outputting, on the initial CORESET based on the MIB and the mapping associated with the unlicensed frequency band and with the unlicensed synchronization raster, a physical downlink control channel (PDCCH) transmission scheduling a physical downlink shared channel (PDSCH) transmission carrying an initial system information block (SIB). In some cases, the operations of this step refer to, or may be performed by, circuitry for outputting and/or code for outputting as described with reference to FIG. **14**.

[0176] In some aspects, the SS burst includes an indication to refrain from decoding PDCCH resources in the initial CORESET if the SS burst is received on the licensed frequency band.

[0177] In some aspects, the method **1100** further includes refraining from outputting in an initial CORESET indicated by the MIB via a mapping associated with the licensed frequency band. In some cases, the operations of this step refer to, or may be performed by, circuitry for refraining and/or code for refraining as described with reference to FIG. **14**.

[0178] In some aspects, the method **1100** further includes outputting a SIB in an initial CORESET indicated by the MIB via a mapping associated with the licensed frequency band, wherein the SIB indicates the UE is barred from decoding PDCCH resources in the initial CORESET. In some cases, the operations of this step refer to, or may be performed by, circuitry for outputting and/or code for outputting as described with reference to FIG. **14**.

[0179] In some aspects, the initial SIB indicates a first random access channel (RACH) configuration associated with the licensed frequency band and with the licensed synchronization raster and a second RACH configuration associated with the unlicensed frequency band and with the unlicensed synchronization raster.

[0180] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes a maximum RACH listen-before-talk (LBT) failure threshold parameter.

[0181] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes an indication to refrain from performing power boosting when sending a RACH request message for a serving cell via the unlicensed frequency band.

[0182] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes an indication to skip performing a listen-before-talk (LBT) procedure when sending a RACH request message for a serving cell via the unlicensed frequency band.

[0183] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes an indication to perform a short listen-before-talk (LBT) procedure when sending a RACH request message for a serving cell via the unlicensed frequency band.

[0184] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes a maximum transmit power for sending a RACH request message for a serving cell via the unlicensed frequency band.

[0185] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes a maximum number of repetitions for sending a RACH request message for a serving cell via the unlicensed frequency band.

[0186] In some aspects, the initial SIB indicates for the UE to use the unlicensed frequency band only for uplink transmission to a serving cell.

[0187] In some aspects, the initial SIB indicates for the UE to use the unlicensed frequency band only for downlink reception from a serving cell.

[0188] In some aspects, the initial SIB indicates for the UE to use the unlicensed frequency band for both uplink transmission to a serving cell and downlink reception from a serving cell.

[0189] In one aspect, method **1100**, or any aspect related to it, may be performed by an apparatus, such as communications device **1400** of FIG. **14**, which includes various components operable, configured, or adapted to perform the method **1100**. Communications device **1400** is described below in further detail.

[0190] Note that FIG. **11** is just one example of a method, and other methods including fewer, additional, or alternative steps are possible consistent with this disclosure.

[0191] FIG. **12** shows an example of a method **1200** of wireless communication by a repeater. In some examples, the repeater is a user equipment, such as a UE **104** of FIGS. **1** and **3**. In some examples, the repeater is a network entity, such as a BS **102** of FIGS. **1** and **3**, or a disaggregated base station as discussed with respect to FIG. **2**.

[0192] Method **1200** begins at step **1205** with receiving, from a network entity, a synchronization signal (SS) burst on a licensed frequency band associated with a licensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with an unlicensed frequency band. In some cases, the operations of this step refer to, or may be performed by, circuitry for receiving and/or code for receiving as described with reference to FIG. **15**.

[0193] Method **1200** then proceeds to step **1210** with forwarding the SS burst to a user equipment (UE) on the unlicensed frequency band with an unlicensed synchronization raster. In some cases, the operations of this step refer to, or may be performed by, circuitry for forwarding and/or code for forwarding as described with reference to FIG. **15**.

[0194] In some aspects, the unlicensed frequency band and the unlicensed synchronization raster are associated with an access link between the UE and the repeater and the licensed frequency band and the licensed synchronization raster are associated with a direct link between the UE and the network entity.

[0195] In some aspects, the initial SIB indicates a first random access channel (RACH) configuration associated with the licensed frequency band and with the licensed synchronization raster and a second RACH configuration associated with the unlicensed frequency band and with the unlicensed synchronization raster.

[0196] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes a maximum RACH listen-before-talk (LBT) failure threshold parameter.

[0197] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes an indication to refrain from performing power boosting when sending a RACH request message for a serving cell via the unlicensed frequency band.

[0198] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes an indication to skip performing a listen-before-talk (LBT) procedure when sending a RACH request message for a serving cell via the unlicensed frequency band.

[0199] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes an indication to perform a short listen-before-talk (LBT) procedure when sending a RACH request message for a serving cell via the unlicensed frequency band.

[0200] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes a maximum transmit power for sending a RACH request message for a serving cell via the unlicensed frequency band.

[0201] In some aspects, the first RACH configuration associated with the unlicensed synchronization raster includes a maximum number of repetitions for sending a RACH request message for a serving cell via the unlicensed frequency band.

[0202] In some aspects, the initial SIB indicates for the UE to use the unlicensed frequency band only for uplink transmission to a serving cell.

[0203] In some aspects, the initial SIB indicates for the UE to use the unlicensed frequency band only for downlink reception from a serving cell.

[0204] In some aspects, the initial SIB indicates for the UE to use the unlicensed frequency band for both uplink transmission to a serving cell and downlink reception from a serving cell.

[0205] In some aspects, the method **1200** further includes receiving control information configuring the repeater to translate transmissions from the network entity on the licensed frequency to the unlicensed frequency band and to forward the translated transmissions to the UE. In some cases, the operations of this step refer to, or may be performed by, circuitry for receiving and/or code for receiving as described with reference to FIG. **15**.

[0206] In some aspects, the control information is received from the network entity over a control link.

[0207] In one aspect, method **1200**, or any aspect related to it, may be performed by an apparatus, such as communications device **1500** of FIG. **15**, which includes various components operable, configured, or adapted to perform the method **1200**. Communications device **1500** is described below in further detail.

[0208] Note that FIG. **12** is just one example of a method, and other methods including fewer, additional, or alternative steps are possible consistent with this disclosure.

Example Communications Device(s)

[0209] FIG. **13** depicts aspects of an example communications device **1300**. In some aspects, communications device **1300** is a user equipment, such as UE **104** described above with respect to FIGS. **1** and **3**.

[0210] The communications device **1300** includes a processing system **1305** coupled to the transceiver **1375** (e.g., a transmitter and/or a receiver). The transceiver **1375** is configured to transmit and receive signals for the communications device **1300** via the antenna **1380**, such as the various signals as described herein. The processing system **1305** may be configured to perform processing functions for the communications device **1300**, including processing signals received and/or to be transmitted by the communications device **1300**.

[0211] The processing system **1305** includes one or more processors **1310**. In various aspects, the one or more processors **1310** may be representative of one or more of receive processor **358**, transmit processor **364**, TX MIMO processor **366**, and/or controller/processor **380**, as described with respect to FIG. **3**. The one or more processors **1310** are coupled to a computer-readable medium/memory **1340** via a bus **1370**. In certain aspects, the computer-readable medium/memory **1340** is configured to store instructions (e.g., computer-executable code) that when executed by the one or more processors **1310**, cause the one or more processors **1310** to perform the method **1000** described with respect to FIG. **10**, or any aspect related to it. Note that reference to a processor performing a function of communications device **1300** may include one or more processors **1310** performing that function of communications device **1300**.

[0212] In the depicted example, computer-readable medium/memory **1340** stores code (e.g., executable instructions), such as code for receiving **1345**, code for monitoring **1350**, code for determining **1355**, code for refraining **1360**, and code for performing **1365**. Processing of the code for receiving **1345**, code for monitoring **1350**, code for determining **1355**, code for refraining **1360**, and code for performing **1365** may cause the communications device **1300** to perform the method **1000** described with respect to FIG. **10**, or any aspect related to it.

[0213] The one or more processors **1310** include circuitry configured to implement (e.g., execute) the code stored in the computer-readable medium/memory **1340**, including circuitry such as circuitry for receiving **1315**, circuitry for monitoring **1320**, circuitry for determining **1325**, circuitry for refraining **1330**, and circuitry for performing **1335**. Processing with circuitry for receiving **1315**, circuitry for monitoring **1320**, circuitry for determining **1325**, circuitry for refraining **1330**, and circuitry for performing **1335** may cause the communications device **1300** to perform the method **1000** described with respect to FIG. **10**, or any aspect related to it.

[0214] Various components of the communications device **1300** may provide means for performing the method **1000** described with respect to FIG. **10**, or any aspect related to it. For example, means for transmitting, sending or outputting for transmission may include transceivers **354** and/or antenna(s) **352** of the UE **104** illustrated in FIG. **3** and/or the transceiver **1375** and the antenna **1380** of the communications device **1300** in FIG. **13**. Means for receiving or obtaining may include transceivers **354** and/or antenna(s) **352** of the UE **104** illustrated in FIG. **3** and/or the transceiver **1375** and the antenna **1380** of the communications device **1300** in FIG. **13**.

[0215] FIG. **14** depicts aspects of an example communications device **1400**. In some aspects, communications device **1400** is a network entity, such as BS **102** of FIGS. **1** and **3**, or a disaggregated base station as discussed with respect to FIG. **2**.

[0216] The communications device **1400** includes a processing system **1405** coupled to the transceiver **1455** (e.g., a transmitter and/or a receiver) and/or a network interface **1465**. The transceiver **1455** is configured to transmit and receive signals for the communications device **1400** via the antenna **1460**, such as the various signals as described herein. The network interface **1465** is configured to obtain and send signals for the communications device **1400** via communication link(s), such as a backhaul link, midhaul link, and/or fronthaul link as described herein, such as with respect to FIG. **2**. The processing system **1405** may be configured to perform processing functions for the communications device **1400**, including processing signals received and/or to be transmitted by the communications device **1400**.

[0217] The processing system **1405** includes one or more processors **1410**. In various aspects, one or more processors **1410** may be representative of one or more of receive processor **338**, transmit processor **320**, TX MIMO processor **330**, and/or controller/processor **340**, as described with respect to FIG. **3**. The one or more processors **1410** are coupled to a computer-readable medium/memory **1430** via a bus **1450**. In certain aspects, the computer-readable medium/memory **1430** is configured to store instructions (e.g., computer-executable code) that when executed by the one or more processors **1410**, cause the one or more processors **1410** to perform the method **1100** described with respect to FIG. **11**, or any aspect related to it. Note that reference to a processor of communications device **1400** performing a function may include one or more processors **1410** of communications device **1400** performing that function.

[0218] In the depicted example, the computer-readable medium/memory **1430** stores code (e.g., executable instructions), such as code for configuring **1435**, code for outputting **1440**, and code for refraining **1445**. Processing of the code for configuring **1435**, code for outputting **1440**, and code for refraining **1445** may cause the communications device **1400** to perform the method **1100** described with respect to FIG. **11**, or any aspect related to it.

[0219] The one or more processors **1410** include circuitry configured to implement (e.g., execute) the code stored in the computer-readable medium/memory **1430**, including circuitry such as circuitry for configuring **1415**, circuitry for outputting **1420**, and circuitry for refraining **1425**. Processing with circuitry for configuring **1415**, circuitry for outputting **1420**, and circuitry for refraining **1425** may cause the communications device **1400** to perform the method **1100** described with respect to FIG. **11**, or any aspect related to it.

[0220] Various components of the communications device **1400** may provide means for performing the method **1100** described with respect to FIG. **11**, or any aspect related to it. Means for transmitting, sending or outputting for transmission may include transceivers **332** and/or antenna(s) **334** of the BS **102** illustrated in FIG. **3** and/or the transceiver **1455** and the antenna **1460** of the communications device **1400** in FIG. **14**. Means for receiving or obtaining may include transceivers **332** and/or antenna(s) **334** of the BS **102** illustrated in FIG. **3** and/or the transceiver **1455** and the antenna **1460** of the communications device **1400** in FIG. **14**.

[0221] FIG. **15** depicts aspects of an example communications device **1500**. In some aspects, communications device **1500** is a user equipment, such as UE **104** described above with respect to FIGS. **1** and **3**. In some aspects, communications device **1500** is a network entity, such as BS **102** of FIGS. **1** and **3**, or a disaggregated base station as discussed with respect to FIG. **2**.

[0222] The communications device **1500** includes a processing system **1505** coupled to the transceiver **1545** (e.g., a transmitter and/or a receiver). In some aspects (e.g., when communications device **1500** is a network entity), processing system **1505** may be coupled to a network interface **1555** that is configured to obtain and send signals for the communications device **1500** via communication link(s), such as a backhaul link, midhaul link, and/or fronthaul link as described herein, such as with respect to FIG. **2**. The transceiver **1545** is configured to transmit and receive signals for the communications device **1500** via the antenna **1550**, such as the various signals as described herein. The processing system **1505** may be configured to perform processing functions for the communications device **1500**, including processing signals received and/or to be transmitted by the communications device **1500**.

[0223] The processing system **1505** includes one or more processors **1510**. In various aspects, the one or more processors **1510** may be representative of one or more of receive processor **358**, transmit processor **364**, TX MIMO processor **366**, and/or controller/processor **380**, as described with respect to FIG. **3**. In various aspects, one or more processors **1510** may be representative of one or more of receive processor **338**, transmit processor **320**, TX MIMO processor **330**, and/or controller/processor **340**, as described with respect to FIG. **3**. The one or more processors **1510** are coupled to a computer-readable medium/memory **1525** via a bus **1540**. In certain aspects, the computer-readable medium/memory **1525** is configured to store instructions (e.g., computer-executable code) that when executed by the one or more processors **1510**, cause the one or more processors **1510** to perform the method **1200** described with respect to FIG. **12**, or any aspect related to it. Note that reference to a processor performing a function of communications device **1500** may include one or more processors **1510** performing that function of communications device **1500**.

[0224] In the depicted example, computer-readable medium/memory **1525** stores code (e.g., executable instructions), such as code for receiving **1530** and code for forwarding **1535**. Processing of the code for receiving **1530** and code for forwarding **1535** may cause the communications device **1500** to perform the method **1200** described with respect to FIG. **12**, or any aspect related to it.

[0225] The one or more processors **1510** include circuitry configured to implement (e.g., execute) the code stored in the computer-readable medium/memory **1525**, including circuitry for receiving **1515** and circuitry for forwarding **1520**. Processing with circuitry for receiving **1515** and circuitry for forwarding **1520** may cause the communications device **1500** to perform the method **1200** described with respect to FIG. **12**, or any aspect related to it.

[0226] Various components of the communications device **1500** may provide means for performing the method **1200** described with respect to FIG. **12**, or any aspect related to it. For example, means for transmitting, sending or outputting for transmission may include transceivers **354** and/or antenna(s) **352** of the UE **104** illustrated in FIG. **3**, transceivers **332** and/or antenna(s) **334** of the BS **102** illustrated in FIG. **3**, and/or the transceiver **1545** and the antenna **1550** of the communications device **1500** in FIG. **15**. Means for receiving or obtaining may include transceivers **354** and/or antenna(s) **352** of the UE **104** illustrated in FIG. **3**, transceivers **332** and/or antenna(s) **334** of the BS **102** illustrated in FIG. **3**, and/or the transceiver **1545** and the antenna **1550** of the communications device **1500** in FIG. **15**.

EXAMPLE CLAUSES

[0227] Implementation examples are described in the following numbered clauses:

[0228] Clause 1: A method for wireless communication by a user equipment (UE), comprising: receiving a synchronization signal (SS) burst from a repeater on an unlicensed frequency band associated with an unlicensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with the unlicensed frequency band; and monitoring the initial CORESET based on the MIB and the mapping associated with the unlicensed frequency band for a physical downlink control channel (PDCCH) transmission scheduling a physical downlink shared channel (PDSCH) transmission carrying an initial system information block (SIB) associated with a serving cell that uses a licensed frequency band associated with a licensed synchronization raster.

[0229] Clause 2: The method of Clause 1, further comprising determining the SS burst is associated with the serving cell based on the unlicensed synchronization raster.

[0230] Clause 3: The method of combination one of Clauses 1-2, wherein the unlicensed frequency band and the unlicensed synchronization raster are associated with an access link between the UE and the repeater and the licensed frequency band and the licensed synchronization raster are associated with a direct link between the UE and the serving cell.

[0231] Clause 4: The method of any combination of Clauses 1-3, further comprising: receiving a SS burst from the serving cell on the licensed frequency band, wherein the

SS burst includes an SSB and a PBCH carrying a MIB indicating an initial CORESET via a mapping associated with the unlicensed frequency band, wherein the SS burst includes an indication to refrain from decoding PDCCH resources in the initial CORESET if the SS burst is received on the licensed frequency band; and refraining from monitoring in the initial CORESET based on the indication and based on receiving the MIB in the licensed frequency band.

[0232] Clause 5: The method of any combination of Clauses 1-4, further comprising: receiving a SS burst from the serving cell on the licensed frequency band, wherein the SS burst includes an SSB and a PBCH carrying a MIB indicating an initial CORESET via a mapping associated with the unlicensed frequency band; receiving a SIB in the initial CORESET indicated in the MIB and the mapping associated with the licensed frequency band, wherein the SIB indicates the UE is barred from decoding PDCCH resources in the initial CORESET; and refraining from monitoring in the initial CORESET based on the indication.

[0233] Clause 6: The method of any combination of Clauses 1-5, wherein the initial SIB indicates a first random access channel (RACH) configuration associated with the licensed frequency band and with the licensed synchronization raster and a second RACH configuration associated with the unlicensed frequency band and with the unlicensed synchronization raster.

[0234] Clause 7: The method of Clause 6, wherein the first RACH configuration associated with the unlicensed synchronization raster includes a maximum RACH listen-before-talk (LBT) failure threshold parameter.

[0235] Clause 8: The method of Clause 7, further comprising: determining to send a RACH request message for the serving cell via the unlicensed frequency band; performing an LBT procedure in response to the determination to send the RACH request message; and refraining from sending the RACH request message in response to a number of LBT failures reaching the maximum RACH LBT failure threshold.

[0236] Clause 9: The method of any combination of Clauses 6-7, wherein the first RACH configuration associated with the unlicensed synchronization raster includes an indication to refrain from performing power boosting when sending a RACH request message for the serving cell via the unlicensed frequency band.

[0237] Clause 10: The method of any combination of Clauses 6-9, wherein the first RACH configuration associated with the unlicensed synchronization raster includes an indication to skip performing a listen-before-talk (LBT) procedure when sending a RACH request message for the serving cell via the unlicensed frequency band.

[0238] Clause 11: The method of any combination of Clauses 6-10, wherein the first RACH configuration associated with the unlicensed synchronization raster includes an indication to perform a short listen-before-talk (LBT) procedure when sending a RACH request message for the serving cell via the unlicensed frequency band.

[0239] Clause 12: The method of any combination of Clauses 6-11, wherein the first RACH configuration associated with the unlicensed synchronization raster includes a maximum transmit power for sending a RACH request message for the serving cell via the unlicensed frequency band.

[0240] Clause 13: The method of any combination of Clauses 6-12, wherein the first RACH configuration associated with the unlicensed synchronization raster includes a maximum number of repetitions for sending a RACH request message for the serving cell via the unlicensed frequency band.

[0241] Clause 14: The method of any combination of Clauses 6-13, wherein the initial SIB indicates for the UE to use the unlicensed frequency band only for uplink transmission to the serving cell.

[0242] Clause 15: The method of any combination of Clauses 6-14, wherein the initial SIB indicates for the UE to use the unlicensed frequency band only for downlink reception from the serving cell.

[0243] Clause 16: The method of any combination of Clauses 6-15, wherein the initial SIB indicates for the UE to use the unlicensed frequency band for both uplink transmission to the serving cell and downlink reception from the serving cell.

[0244] Clause 17: A method for wireless communication by a network entity, comprising: configuring a repeater associated with the network entity to translate transmissions from the network entity to an unlicensed frequency band associated with an unlicensed synchronization raster; and outputting a synchronization signal (SS) burst to a user equipment (UE) on a licensed frequency band associated with a licensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with the unlicensed frequency band.

[0245] Clause 18: The method of Clause 17, wherein the unlicensed frequency band and the unlicensed synchronization raster are associated with an access link between the UE and the repeater and the licensed frequency band and the licensed synchronization raster are associated with a direct link between the UE and a serving cell.

[0246] Clause 19: The method of any combination of Clauses 17-18, further comprising outputting, on the initial CORESET based on the MIB and the mapping associated with the unlicensed frequency band and with the unlicensed synchronization raster, a physical downlink control channel (PDCCH) transmission scheduling a physical downlink shared channel (PDSCH) transmission carrying an initial system information block (SIB).

[0247] Clause 20: The method of any combination of Clauses 17-19, wherein the SS burst includes an indication to refrain from decoding PDCCH resources in the initial CORESET if the SS burst is received on the licensed frequency band.

[0248] Clause 21: The method of any combination of Clauses 17-20, further comprising refraining from outputting in an initial CORESET indicated by the MIB via a mapping associated with the licensed frequency band.

[0249] Clause 22: The method of any combination of Clauses 17-21, further comprising outputting a SIB in an initial CORESET indicated by the MIB via a mapping associated with the licensed frequency band, wherein the SIB indicates the UE is barred from decoding PDCCH resources in the initial CORESET.

[0250] Clause 23: The method of any combination of Clauses 17-22, wherein the initial SIB indicates a first random access channel (RACH) configuration associated with the licensed frequency band and with the licensed synchronization raster and a second RACH configuration associated with the unlicensed frequency band and with the unlicensed synchronization raster.

[0251] Clause 24: The method of Clause 23, wherein the first RACH configuration associated with the unlicensed synchronization raster includes a maximum RACH listen-before-talk (LBT) failure threshold parameter.

[0252] Clause 25: The method of any combination of Clauses 23-24, wherein the first RACH configuration associated with the unlicensed synchronization raster includes an indication to refrain from performing power boosting when sending a RACH request message for a serving cell via the unlicensed frequency band.

[0253] Clause 26: The method of any combination of Clauses 23-25, wherein the first RACH configuration associated with the unlicensed synchronization raster includes an indication to skip performing a listen-before-talk (LBT) procedure when sending a RACH request message for a serving cell via the unlicensed frequency band.

[0254] Clause 27: The method of any combination of Clauses 23-26, wherein the first RACH configuration associated with the unlicensed synchronization raster includes an indication to perform a short listen-before-talk (LBT) procedure when sending a RACH request message for a serving cell via the unlicensed frequency band.

[0255] Clause 28: The method of any combination of Clauses 23-27, wherein the first RACH configuration associated with the unlicensed synchronization raster includes a maximum transmit power for sending a RACH request message for a serving cell via the unlicensed frequency band.

[0256] Clause 29: The method of any combination of Clauses 23-28, wherein the first RACH configuration associated with the unlicensed synchronization raster includes a maximum number of repetitions for sending a RACH request message for a serving cell via the unlicensed frequency band.

[0257] Clause 30: The method of any combination of Clauses 23-29, wherein the initial SIB indicates for the UE to use the unlicensed frequency band only for uplink transmission to a serving cell.

[0258] Clause 31: The method of any combination of Clauses 23-30, wherein the initial SIB indicates for the UE to use the unlicensed frequency band only for downlink reception from a serving cell.

[0259] Clause 32: The method of any combination of Clauses 23-31, wherein the initial SIB indicates for the UE to use the unlicensed frequency band for both uplink transmission to a serving cell and downlink reception from a serving cell.

[0260] Clause 33: A method for wireless communication by a repeater, comprising: receiving, from a network entity, a synchronization signal (SS) burst on a licensed frequency band associated with a licensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with an unlicensed frequency band; and forwarding the SS burst to a user equipment (UE) on the unlicensed frequency band with an unlicensed synchronization raster.

[0261] Clause 34: The method of Clause 33, wherein the unlicensed frequency band and the unlicensed synchronization raster are associated with an access link between the UE and the repeater and the licensed frequency band and the licensed synchronization raster are associated with a direct link between the UE and the network entity.

[0262] Clause 35: The method of any combination of Clauses 33-34, wherein the initial SIB indicates a first random access channel (RACH) configuration associated with the licensed frequency band and with the licensed synchronization raster and a second RACH configuration associated with the unlicensed frequency band and with the unlicensed synchronization raster.

[0263] Clause 36: The method of Clause 35, wherein the first RACH configuration associated with the unlicensed synchronization raster includes a maximum RACH listen-before-talk (LBT) failure threshold parameter.

[0264] Clause 37: The method of any combination of Clauses 35-36, wherein the first RACH configuration associated with the unlicensed synchronization raster includes an indication to refrain from performing power boosting when sending a RACH request message for a serving cell via the unlicensed frequency band.

[0265] Clause 38: The method of any combination of Clauses 35-37, wherein the first RACH configuration associated with the unlicensed synchronization raster includes an indication to skip performing a listen-before-talk (LBT) procedure when sending a RACH request message for a serving cell via the unlicensed frequency band.

[0266] Clause 39: The method of any combination of Clauses 35-38, wherein the first RACH configuration associated with the unlicensed synchronization raster includes an indication to perform a short listen-before-talk (LBT) procedure when sending a RACH request message for a serving cell via the unlicensed frequency band.

[0267] Clause 40: The method of any combination of Clauses 35-39, wherein the first RACH configuration associated with the unlicensed synchronization raster includes a maximum transmit power for sending a RACH request message for a serving cell via the unlicensed frequency band.

[0268] Clause 41: The method of any combination of Clauses 35-40, wherein the first RACH configuration associated with the unlicensed synchronization raster includes a maximum number of repetitions for sending a RACH request message for a serving cell via the unlicensed frequency band.

[0269] Clause 42: The method of any combination of Clauses 35-41, wherein the initial SIB indicates for the UE to use the unlicensed frequency band only for uplink transmission to a serving cell.

[0270] Clause 43: The method of any combination of Clauses 35-42, wherein the initial SIB indicates for the UE to use the unlicensed frequency band only for downlink reception from a serving cell.

[0271] Clause 44: The method of any combination of Clauses 35-43, wherein the initial SIB indicates for the UE to use the unlicensed frequency band for both uplink transmission to a serving cell and downlink reception from a serving cell.

[0272] Clause 45: The method of any combination of Clauses 35-44, further comprising receiving control information configuring the repeater to translate transmissions from the network entity on the licensed frequency to the unlicensed frequency band and to forward the translated transmissions to the UE.

[0273] Clause 46: The method of any combination of Clauses 35-45, wherein the control information is received from the network entity over a control link.

[0274] Clause 47: An apparatus, comprising: at least one memory comprising executable instructions; and at least one processor configured to execute the executable instructions and cause the apparatus to perform a method in accordance with any one of Clauses 1-46.

[0275] Clause 48: An apparatus, comprising means for performing a method in accordance with any one of Clauses 1-46.

[0276] Clause 49: A non-transitory computer-readable medium comprising executable instructions that, when executed by at least one processor of an apparatus, cause the apparatus to perform a method in accordance with any one of Clauses 1-46.

[0277] Clause 50: A computer program product embodied on a computer-readable storage medium comprising code for performing a method in accordance with any one of Clauses 1-46.

ADDITIONAL CONSIDERATIONS

[0278] The preceding description is provided to enable any person skilled in the art to practice the various aspects described herein. The examples discussed herein are not limiting of the scope, applicability, or aspects set forth in the claims. Various modifications to these aspects will be readily apparent to those skilled in the art, and the general principles defined herein may be applied to other aspects. For example, changes may be made in the function and arrangement of elements discussed without departing from the scope of the disclosure. Various examples may omit, substitute, or add various procedures or components as appropriate. For instance, the methods described may be performed in an order different from that described, and various actions may be added, omitted, or combined. Also, features described with respect to some examples may be combined in some other examples. For example, an apparatus may be implemented or a method may be practiced using any number of the aspects set forth herein. In addition, the scope of the disclosure is intended to cover such an apparatus or method that is practiced using other structure, functionality, or structure and functionality in addition to, or other than, the various aspects of the disclosure set forth herein. It should be understood that any aspect of the disclosure disclosed herein may be embodied by one or more elements of a claim.

[0279] The various illustrative logical blocks, modules and circuits described in connection with the present disclosure may be implemented or performed with a general purpose processor, a graphics processing unit (GPU), a neural processing unit (NPU), a digital signal processor (DSP), an ASIC, a field programmable gate array (FPGA) or other programmable logic device (PLD), 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 commercially available 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, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, a system on a chip (SoC), or any other such configuration.

[0280] As used herein, "a processor," "at least one processor" or "one or more processors" generally refers to a single processor configured to perform one or multiple operations or multiple processors configured to collectively perform one or more operations. In the case of multiple processors, performance of the one or more operations could be divided amongst different processors, though one processor may perform multiple operations, and multiple processors could collectively perform a single operation. Similarly, "a memory," "at least one memory" or "one or more memories" generally refers to a single memory configured to store data and/or instructions, multiple memories configured to collectively store data and/or instructions.

[0281] Means for receiving, means for monitoring, means for determining, means for refraining, means for configuring, means for outputting, and means for forwarding may comprise one or more processors, such as one or more of the processors described above with reference to FIG. **13**, FIG. **14**, and FIG. **15**.

[0282] As used herein, a phrase referring to "at least one of" a list of items refers to any combination of those items, including single members. As an example, "at least one of: a, b, or c" is intended to cover a, b, c, a-b, a-c, b-c, and a-b-c, as well as any combination with multiples of the same element (e.g., a-a, a-a-a, a-a-b, a-a-c, a-b-b, a-c-c, b-b, b-b-b, b-b-c, c-c, and c-c-c or any other ordering of a, b, and c).

[0283] As used herein, the term "determining" encompasses a wide variety of actions. For example, "determining" may include calculating, computing, processing, deriving, investigating, looking up (e.g., looking up in a table, a database or another data structure), ascertaining and the like. Also, "determining" may include receiving (e.g., receiving information), accessing (e.g., accessing data in a memory) and the like. Also, "determining" may include resolving, selecting, choosing, establishing and the like.

[0284] The methods disclosed herein comprise one or more actions for achieving the methods. The method actions may be interchanged with one another without departing from the scope of the claims. In other words, unless a specific order of actions is specified, the order and/or use of specific actions may be modified without departing from the scope of the claims. Further, the various operations of methods described above may be performed by any suitable means capable of performing the corresponding functions. The means may include various hardware and/or software component(s) and/or module(s), including, but not limited to a circuit, an application specific integrated circuit (ASIC), or processor. Software shall be construed broadly to mean instructions, instruction sets, code, code segments, program code, programs, subprograms, software modules, applications, software applications, software packages, routines, subroutines, objects, executables, threads of execution, procedures, or functions, whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise.

[0285] The following claims are not intended to be limited to the aspects shown herein, but are to be accorded the full scope consistent with the language of the claims. Within a claim, reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." Unless specifically stated otherwise, the term "some" refers to one or more. No claim element is to be construed under the provisions of 35 U.S.C. § 112(f) unless the element is expressly recited using the phrase "means for". All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims.

What is claimed is:

1. A user equipment (UE) comprising:

memory storing computer executable code; and

at least one processor coupled with the memory configured to the execute computer executable code and cause the UE to:

receive a synchronization signal (SS) burst from a repeater on an unlicensed frequency band associated with an unlicensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with the unlicensed frequency band; and

monitor the initial CORESET based on the MIB and the mapping associated with the unlicensed frequency band for a physical downlink control channel (PDCCH) transmission scheduling a physical downlink shared channel (PDSCH) transmission carrying an initial system information block (SIB) associated with a serving cell that uses a licensed frequency band associated with a licensed synchronization raster.

2. The UE of claim **1**, wherein the at least one processor is further configured to cause the UE to determine the SS burst is associated with the serving cell based on the unlicensed synchronization raster.

3. The UE of claim **1**, wherein the unlicensed frequency band and the unlicensed synchronization raster are associated with an access link between the UE and the repeater and the licensed frequency band and the licensed synchronization raster are associated with a direct link between the UE and the serving cell.

4. The UE of claim **1**, wherein the at least one processor is further configured to cause the UE to:

receive a SS burst from the serving cell on the licensed frequency band, wherein the SS burst includes an SSB and a PBCH carrying a MIB indicating an initial CORESET via a mapping associated with the unlicensed frequency band, wherein the SS burst includes an indication to refrain from decoding PDCCH resources in the initial CORESET if the SS burst is received on the licensed frequency band; and

refrain from monitoring in the initial CORESET based on the indication and based on receiving the MIB in the licensed frequency band.

5. The UE of claim **1**, wherein the at least one processor is further configured to cause the UE to:

receive a SS burst from the serving cell on the licensed frequency band, wherein the SS burst includes an SSB and a PBCH carrying a MIB indicating an initial CORESET via a mapping associated with the unlicensed frequency band;

receive a SIB in the initial CORESET indicated in the MIB and the mapping associated with the licensed frequency band, wherein the SIB indicates the UE is barred from decoding PDCCH resources in the initial CORESET; and

refrain from monitoring in the initial CORESET based on the indication.

6. The UE of claim **1**, wherein the initial SIB indicates a first random access channel (RACH) configuration associated with the licensed frequency band and with the licensed synchronization raster and a second RACH configuration associated with the unlicensed frequency band and with the unlicensed synchronization raster.

7. The UE of claim **6**, wherein the first RACH configuration associated with the unlicensed synchronization raster includes a maximum RACH listen-before-talk (LBT) failure threshold parameter.

8. The UE of claim **7**, wherein the at least one processor is further configured to cause the UE to:

determine to send a RACH request message for the serving cell via the unlicensed frequency band;

perform an LBT procedure in response to the determination to send the RACH request message; and

refrain from sending the RACH request message in response to a number of LBT failures reaching the maximum RACH LBT failure threshold.

9. The UE of claim **6**, wherein the first RACH configuration associated with the unlicensed synchronization raster includes an indication to refrain from performing power boosting when sending a RACH request message for the serving cell via the unlicensed frequency band.

10. The UE of claim **6**, wherein the first RACH configuration associated with the unlicensed synchronization raster includes an indication to skip performing a listen-before-talk (LBT) procedure when sending a RACH request message for the serving cell via the unlicensed frequency band.

11. The UE of claim **6**, wherein the first RACH configuration associated with the unlicensed synchronization raster includes an indication to perform a short listen-before-talk (LBT) procedure when sending a RACH request message for the serving cell via the unlicensed frequency band.

12. The UE of claim **6**, wherein the first RACH configuration associated with the unlicensed synchronization raster includes a maximum transmit power for sending a RACH request message for the serving cell via the unlicensed frequency band.

13. The UE of claim **6**, wherein the first RACH configuration associated with the unlicensed synchronization raster includes a maximum number of repetitions for sending a RACH request message for the serving cell via the unlicensed frequency band.

14. The UE of claim **6**, wherein the initial SIB indicates for the UE to use the unlicensed frequency band only for uplink transmission to the serving cell.

15. The UE of claim **6**, wherein the initial SIB indicates for the UE to use the unlicensed frequency band only for downlink reception from the serving cell.

16. The UE of claim **6**, wherein the initial SIB indicates for the UE to use the unlicensed frequency band for both uplink transmission to the serving cell and downlink reception from the serving cell.

17. A network entity comprising:

memory storing computer executable code; and

at least one processor coupled with the memory configured to the execute computer executable code and cause the network entity to:

configure a repeater associated with the network entity to translate transmissions from the first network entity to an unlicensed frequency band associated with an unlicensed synchronization raster; and

output a synchronization signal (SS) burst on a licensed frequency band associated with a licensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with the unlicensed frequency band.

18. The network entity of claim **17**, wherein the at least one processor is further configured to cause the network entity to output, on the initial CORESET based on the MIB and the mapping associated with the unlicensed frequency band and with the unlicensed synchronization raster, a physical downlink control channel (PDCCH) transmission scheduling a physical downlink shared channel (PDSCH) transmission carrying an initial system information block (SIB).

19. The network entity of claim **17**, wherein the unlicensed frequency band and the unlicensed synchronization raster are associated with an access link between the UE and the repeater and the licensed frequency band and the licensed synchronization raster are associated with a direct link between the UE and the serving cell.

20. A repeater comprising:

memory storing computer executable code; and

at least one processor coupled with the memory configured to the execute computer executable code and cause the repeater to:

receive, from a network entity, a synchronization signal (SS) burst on a licensed frequency band associated with a licensed synchronization raster, wherein the SS burst includes an SS block (SSB) and a physical broadcast channel (PBCH) carrying a master information block (MIB) indicating an initial control resource set (CORESET) via a mapping associated with an unlicensed frequency band; and

forward the SS burst to a user equipment (UE) on the unlicensed frequency band with the unlicensed synchronization raster.

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