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15 February 2019 (15.02.2019) CN(71) Applicant: **QUALCOMM INCORPORATED** [US/US];
ATTN: International IP Administration, 5775 Morehouse
Drive, San Diego, California 92121-1714 (US).

(72) Inventors; and

(71) Applicants (for US only): **REN, Yuwei** [CN/CN]; 5775
Morehouse Drive, San Diego, California 92121-1714 (US).
XU, Huilin [CN/US]; 5775 Morehouse Drive, San Diego,
California 92121-1714 (US). **GAAL, Peter** [US/US];
5775 Morehouse Drive, San Diego, California 92121-1714
(US). **MANOLAKOS, Alexandros** [GR/US]; 5775 More-
house Drive, San Diego, California 92121-1714 (US). **Ji,****Tingfang** [US/US]; 5775 Morehouse Drive, San Diego,
California 92121-1714 (US).(74) Agent: **NTD PATENT & TRADEMARK AGENCY
LTD.**; 10th Floor, Tower C, Beijing Global Trade Center,
36 North Third Ring Road East, Dongcheng District, Bei-
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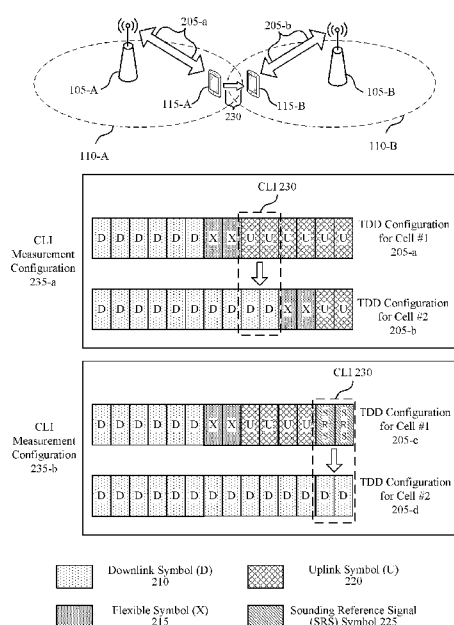


FIG. 2

200

(57) Abstract: Methods, systems, and devices for wireless communications are described. A cross-link interference (CLI) measurement procedure may be employed that utilizes multiple metrics for the CLI in two or more steps to measure the CLI. For example, an aggressor wireless device may transmit a reference signal, and a victim wireless device may measure a signal characteristic of the reference signal to determine a strength of the CLI in a first step of the CLI measurement procedure. A serving cell may compare the signal characteristic against a threshold value, where the serving cell triggers a second step of the CLI measurement procedure based on the signal characteristic and the threshold value. In the second step of the CLI measurement procedure, the aggressor wireless device may transmit a second reference signal, and the victim wireless device may measure a second signal characteristic of the second reference signal to determine the strength of CLI.

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TWO STAGE CROSS-LINK INTERFERENCE TRANSMISSION AND MEASUREMENT

CROSS REFERENCE

[0001] The present Application for Patent claims the benefit of PCT Application
5 No. PCT/CN2019/075253 by REN et al., entitled “TWO STAGE CROSS-LINK
INTERFERENCE TRANSMISSION AND MEASUREMENT,” filed February 15, 2019,
assigned to the assignee hereof.

BACKGROUND

[0002] The following relates generally to wireless communications, and more specifically
10 to two stage cross-link interference (CLI) transmission and measurement.

[0003] Wireless communications systems are widely deployed to provide various types of
communication content such as voice, video, packet data, messaging, broadcast, and so on.
These systems may be capable of supporting communication with multiple users by sharing
the available system resources (e.g., time, frequency, and power). Examples of such multiple-
15 access systems include fourth generation (4G) systems such as Long Term Evolution (LTE)
systems, LTE-Advanced (LTE-A) systems, or LTE-A Pro systems, and fifth generation (5G)
systems which may be referred to as New Radio (NR) systems. These systems may employ
technologies such as code division multiple access (CDMA), time division multiple access
(TDMA), frequency division multiple access (FDMA), orthogonal frequency division
20 multiple access (OFDMA), or discrete Fourier transform spread orthogonal frequency
division multiplexing (DFT-S-OFDM). A wireless multiple-access communications system
may include a number of base stations or network access nodes, each simultaneously
supporting communication for multiple communication devices, which may be otherwise
known as user equipment (UE).

25 [0004] Neighboring cells in a time division duplexing (TDD) system may use different
configurations for TDD communications. In some cases, the different TDD configurations
may lead to overlap for transmissions in opposite directions. For example, an uplink
transmission by a first UE may interfere with downlink reception at a second UE if the uplink
transmission and downlink reception are scheduled for the same time. Interference between

UEs using different TDD configurations may be known as CLI. Current techniques for managing CLI in a TDD system may result in inefficient use of communication resources.

SUMMARY

[0005] The described techniques relate to improved methods, systems, devices, and apparatuses that support two stage CLI transmission and measurement. Generally, the described techniques provide for efficient techniques for a CLI measurement procedure that utilizes both metrics of a reference signal reserved power (RSRP) and a reference signal strength indicator (RSSI) measurement in two or more steps. For example, an aggressor wireless device (e.g., a UE, a base station, or a cell that causes the CLI) may transmit a reference signal for a first signal characteristic of the reference signal (e.g., an RSSI, an RSRP, a signal-to-interference-plus-noise ratio (SINR), etc.) in a first step of the CLI measurement procedure. Subsequently, a victim wireless device (e.g., a UE or a cell that is affected by the CLI) may measure the reference signal to determine the first signal characteristic (e.g., the RSSI, RSRP, SINR, etc.) for the strength of the CLI in the same first step of the CLI measurement procedure. A serving cell for the victim wireless device may then compare the first signal characteristic measurement against a threshold value, where the serving cell triggers a second step of the CLI measurement procedure based on the comparison of the strength measurements with respect to the threshold value. For example, if the first signal characteristic measurement is above or below the threshold value, the serving cell may configure an additional reference signal transmission from the aggressor wireless device and may configure the victim wireless device to receive the additional reference signal and to measure a corresponding signal characteristic of the additional reference signal.

[0006] Accordingly, for example, in the second step of the CLI measurement procedure, the aggressor wireless device may transmit a second reference signal for a second signal characteristic measurement (e.g., the second reference signal is transmitted based on the comparison of the first measurement exceeding the threshold value), and the victim wireless device may measure the second reference signal to determine the second signal characteristic measurement (e.g., RSSI or RSRP) for the strength of CLI. In some cases, the CLI measurement procedure may include an extensible periodicity for performing the reference signal transmission and for performing the CLI measurements. Additionally or alternatively, the serving cell may utilize an event trigger to determine when to initiate the CLI

measurement procedure and the different triggers that enable one or more of the steps of the CLI measurement. For example, the event trigger may include a handover procedure or a signal quality for a wireless connection between the victim wireless device and the serving cell falling below a signal quality threshold or a combination thereof.

5 **[0007]** A method of wireless communications at a first wireless device (e.g., a victim wireless device) associated with a first serving cell is described. The method may include receiving, from the first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure; receiving, from a second wireless device (e.g., an aggressor wireless device), a first reference signal during a first measurement period of the CLI
10 measurement procedure; measuring a first signal characteristic of the first reference signal; receiving, from the second wireless device, a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of the first signal characteristic to a threshold value; measuring a second signal characteristic of the second reference signal, the second signal characteristic different from the first signal
15 characteristic; and determining a CLI value based on the second signal characteristic.

[0008] An apparatus for wireless communications at a first wireless device (e.g., a victim wireless device) associated with a first serving cell is described. The apparatus may include a processor, memory in communication with the processor, and instructions stored in the memory. The instructions may be executable by the processor to cause the apparatus to
20 receive, from the first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure; to receive, from a second wireless device (e.g., an aggressor wireless device), a first reference signal during a first measurement period of the CLI measurement procedure; to measure a first signal characteristic of the first reference signal; to receive, from the second wireless device, a second reference signal during a second
25 measurement period of the CLI measurement procedure based on a comparison of the first signal characteristic to a threshold value; to measure a second signal characteristic of the second reference signal, the second signal characteristic different from the first signal characteristic; and to determine a CLI value based on the second signal characteristic.

[0009] Another apparatus for wireless communications at a first wireless device (e.g., a
30 victim wireless device) associated with a first serving cell is described. The apparatus may include means for receiving, from the first serving cell, a configuration to receive and

measure reference signals of a CLI measurement procedure; means for receiving, from a second wireless device, a first reference signal during a first measurement period of the CLI measurement procedure; means for measuring a first signal characteristic of the first reference signal; means for receiving, from the second wireless device (e.g., an aggressor wireless device), a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of the first signal characteristic to a threshold value; means for measuring a second signal characteristic of the second reference signal, the second signal characteristic different from the first signal characteristic; and means for determining a CLI value based on the second signal characteristic.

[0010] A non-transitory computer-readable medium storing code for wireless communications at a first wireless device (e.g., a victim wireless device) associated with a first serving cell is described. The code may include instructions executable by a processor to receive, from the first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure; to receive, from a second wireless device (e.g., an aggressor wireless device), a first reference signal during a first measurement period of the CLI measurement procedure; to measure a first signal characteristic of the first reference signal; to receive, from the second wireless device, a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of the first signal characteristic to a threshold value; to measure a second signal characteristic of the second reference signal, the second signal characteristic different from the first signal characteristic; and to determine a CLI value based on the second signal characteristic.

[0011] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the configuration to receive and measure reference signals of the CLI measurement procedure may include an indication triggering receiving the first reference signal, measuring the first signal characteristic, receiving the second reference signal, measuring the second signal characteristic, or a combination thereof.

[0012] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the configuration to receive and measure reference signals of the CLI measurement procedure may include a parameter for a measurement metric associated with the measuring the first signal characteristic, the second signal characteristic, or a combination thereof.

[0013] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the configuration to receive and measure reference signals of the CLI measurement procedure may include a parameter for a measurement metric associated with the measuring of the first signal characteristic, the second signal
5 characteristic, or a combination thereof.

[0014] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the configuration to receive and measure reference signals of the CLI measurement procedure may include an indication of a measurement periodicity for the measuring of the first signal characteristic, the second signal characteristic, or a
10 combination thereof.

[0015] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the configuration to receive and measure reference signals of the CLI measurement procedure may include a resource configuration indicating time-domain and frequency-domain resources for the reference signals.

[0016] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the configuration to receive and measure reference signals of the CLI measurement procedure may include a reporting configuration indicating the threshold value, a threshold event, or a combination thereof.

[0017] Some examples of the method, apparatuses, and non-transitory computer-readable
20 medium described herein may further include operations, features, means, or instructions for reporting the first signal characteristic to the first serving cell and receiving, on the first serving cell in response to the reporting, an indication that the first wireless device is to measure the second signal characteristic during the second measurement period.

[0018] In some examples of the method, apparatuses, and non-transitory computer-readable
25 medium described herein, a base station serving the first serving cell may determine that the first signal characteristic exceeds the threshold value.

[0019] Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for receiving, on the first serving cell, a trigger for the first wireless device to measure the first
30 signal characteristic during the first measurement period.

[0020] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first reference signal may be received during the first measurement period according to a first periodicity, and the second reference signal may be received during the second measurement period according to a second periodicity greater than the first periodicity based on the first signal characteristic failing to exceed the threshold value.

[0021] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first reference signal may be received during the first measurement period according to a first periodicity, and the second reference signal may be received during the second measurement period according to a second periodicity less than the first periodicity based on the first signal characteristic exceeding the threshold value.

[0022] Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for receiving, on the first serving cell, a CLI measurement configuration indicating resources for the first wireless device to use to receive the first reference signal during the first measurement period and the second reference signal during the second measurement period.

[0023] Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for receiving, from the second wireless device, the second reference signal based on an event trigger.

[0024] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the event trigger may include an identification of a handover procedure, a signal quality for a wireless connection between the first wireless device and the first serving cell falling below a signal quality threshold, or a combination thereof.

[0025] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the second wireless device may be associated with the first serving cell.

[0026] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the second wireless device may be associated with a second serving cell different from the first serving cell.

[0027] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first serving cell may be served by a base station, and the second serving cell may be served by the base station.

[0028] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first serving cell may be served by a first base station, and the second serving cell may be served by a second base station.

[0029] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first signal characteristic may include an RSSI or an SINR, and the second signal characteristic may include an RSRP.

[0030] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first signal characteristic may include an RSRP, and the second signal characteristic may include an RSSI or an SINR.

[0031] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the comparison of the first signal characteristic to the threshold value may include an RSSI being at or above the threshold value, where the first signal characteristic includes the RSSI; an SINR being at or below the threshold value, where the first signal characteristic includes the SINR; or a combination thereof.

[0032] A method of wireless communications at a second wireless device (e.g., an aggressor wireless device) is described. The method may include receiving a configuration to transmit reference signals of a CLI measurement procedure; transmitting, to a first wireless device (e.g., a victim wireless device) in a first serving cell, a first reference signal during a first measurement period of the CLI measurement procedure; identifying resources to use to transmit a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of a first signal characteristic of the transmitted first reference signal to a threshold value; and transmitting, to the first wireless device using the identified resources, the second reference signal for measurement of a second signal characteristic during the second measurement period.

[0033] An apparatus for wireless communications at a second wireless device (e.g., an aggressor wireless device) is described. The apparatus may include a processor, memory in communication with the processor, and instructions stored in the memory. The instructions may be executable by the processor to cause the apparatus to receive a configuration to
5 transmit reference signals of a CLI measurement procedure; to transmit, to a first wireless device (e.g., a victim wireless device) in a first serving cell, a first reference signal during a first measurement period of the CLI measurement procedure; to identify resources to use to transmit a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of a first signal characteristic of the
10 transmitted first reference signal to a threshold value; and to transmit, to the first wireless device using the identified resources, the second reference signal for measurement of a second signal characteristic during the second measurement period.

[0034] Another apparatus for wireless communications at a second wireless device (e.g., an aggressor wireless device) is described. The apparatus may include means for receiving a
15 configuration to transmit reference signals of a CLI measurement procedure; means for transmitting, to a first wireless device (e.g., a victim wireless device) in a first serving cell, a first reference signal during a first measurement period of the CLI measurement procedure; means for identifying resources to use to transmit a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of a first
20 signal characteristic of the transmitted first reference signal to a threshold value; and means for transmitting, to the first wireless device using the identified resources, the second reference signal for measurement of a second signal characteristic during the second measurement period.

[0035] A non-transitory computer-readable medium storing code for wireless
25 communications at a second wireless device (e.g., an aggressor wireless device) is described. The code may include instructions executable by a processor to receive a configuration to transmit reference signals of a CLI measurement procedure; to transmit, to a first wireless device (e.g., a victim wireless device) in a first serving cell, a first reference signal during a first measurement period of the CLI measurement procedure; to identify resources to use to
30 transmit a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of a first signal characteristic of the transmitted first reference signal to a threshold value; and to transmit, to the first wireless

device using the identified resources, the second reference signal for measurement of a second signal characteristic during the second measurement period.

[0036] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the configuration to transmit reference signals of the CLI measurement procedure may include an indication triggering transmitting the first reference signal, transmitting the second reference signal, or a combination thereof.

[0037] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the configuration to transmit reference signals of the CLI measurement procedure may include an indication of a transmission periodicity for the reference signals.

[0038] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the configuration to transmit reference signals of the CLI measurement procedure may include a resource configuration indicating time-domain and frequency-domain resources for the reference signals.

[0039] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, a base station serving the first serving cell may determine that the first signal characteristic exceeds the threshold value.

[0040] Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for receiving a trigger for the second wireless device to transmit the first reference signal during the first measurement period, the second reference signal during the second measurement period, or a combination thereof.

[0041] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first reference signal may be transmitted during the first measurement period according to a first periodicity, and the second reference signal may be transmitted during the second measurement period according to a second periodicity greater than the first periodicity based on the first signal characteristic failing to exceed the threshold value.

[0042] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first reference signal may be transmitted during the

first measurement period according to a first periodicity, and the second reference signal may be transmitted during the second measurement period according to a second periodicity less than the first periodicity based on the first signal characteristic exceeding the threshold value.

[0043] Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for receiving, on the first serving cell, a CLI measurement configuration indicating resources for the second wireless device to use to transmit the first reference signal during the first measurement period and the second reference signal during the second measurement period.

[0044] Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for transmitting, to the first wireless device, the second reference signal based on an event trigger.

[0045] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the event trigger may include an identification of a handover procedure, a signal quality for a wireless connection between the first wireless device and the first serving cell falling below a signal quality threshold, or a combination thereof.

[0046] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the second wireless device may be associated with the first serving cell.

[0047] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the second wireless device may be associated with a second serving cell different from the first serving cell.

[0048] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first serving cell may be served by a base station, and the second serving cell may be served by the base station.

[0049] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first serving cell may be served by a first base station, and the second serving cell may be served by a second base station.

[0050] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first signal characteristic may include an RSSI or an SINR, and the second signal characteristic may include an RSRP.

[0051] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first signal characteristic may include an RSRP, and the second signal characteristic may include an RSSI or an SINR.

[0052] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the comparison of the first signal characteristic to the threshold value may include an RSSI being at or above the threshold value, where the first signal characteristic includes the RSSI; an SINR being at or below the threshold value, where the first signal characteristic includes the SINR; or a combination thereof.

[0053] A method of wireless communications at a base station is described. The method may include transmitting, to a first wireless device (e.g., a victim wireless device) in a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure; receiving, from the first wireless device, a first signal characteristic of a first reference signal measured by the first wireless device during a first measurement period of the CLI measurement procedure, the first reference signal received from a second wireless device (e.g., an aggressor wireless device); comparing the first signal characteristic to a threshold value; transmitting, to the first wireless device based on the comparing, an indication that the first wireless device is to measure a second signal characteristic of a second reference signal during a second measurement period of the CLI measurement procedure; and receiving, from the first wireless device, the second signal characteristic of the second reference signal measured by the first wireless device during the second measurement period of the CLI measurement procedure.

[0054] An apparatus for wireless communications at a base station is described. The apparatus may include a processor, memory in communication with the processor, and instructions stored in the memory. The instructions may be executable by the processor to cause the apparatus to transmit, to a first wireless device (e.g., a victim wireless device) in a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure; to receive, from the first wireless device, a first signal characteristic of a first reference signal measured by the first wireless device during a first measurement

period of a CLI measurement procedure, the first reference signal received from a second wireless device (e.g., an aggressor wireless device); to compare the first signal characteristic to a threshold value; to transmit, to the first wireless device based on the comparing, an indication that the first wireless device is to measure a second signal characteristic of a second reference signal during a second measurement period of the CLI measurement procedure; and to receive, from the first wireless device, the second signal characteristic of the second reference signal measured by the first wireless device during the second measurement period of the CLI measurement procedure.

[0055] Another apparatus for wireless communications at a base station is described. The apparatus may include means for transmitting, to a first wireless device (e.g., a victim wireless device) in a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure; means for receiving, from the first wireless device, a first signal characteristic of a first reference signal measured by the first wireless device during a first measurement period of the CLI measurement procedure, the first reference signal received from a second wireless device (e.g., an aggressor wireless device); means for comparing the first signal characteristic to a threshold value; means for transmitting, to the first wireless device based on the comparing, an indication that the first wireless device is to measure a second signal characteristic of a second reference signal during a second measurement period of the CLI measurement procedure; and means for receiving, from the first wireless device, the second signal characteristic of the second reference signal measured by the first wireless device during the second measurement period of the CLI measurement procedure.

[0056] A non-transitory computer-readable medium storing code for wireless communications at a base station is described. The code may include instructions executable by a processor to transmit, to a first wireless device (e.g., a victim wireless device) in a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure; to receive, from the first wireless device, a first signal characteristic of a first reference signal measured by the first wireless device during a first measurement period of the CLI measurement procedure, the first reference signal received from a second wireless device (e.g., an aggressor wireless device); to compare the first signal characteristic to a threshold value; to transmit, to the first wireless device based on the comparing, an indication that the first wireless device is to measure a second signal characteristic of a second reference

signal during a second measurement period of the CLI measurement procedure; and to receive, from the first wireless device, the second signal characteristic of the second reference signal measured by the first wireless device during the second measurement period of the CLI measurement procedure.

- 5 **[0057]** Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for transmitting, to the second wireless device, a CLI transmission configuration indicating that the second wireless device is to continue to transmit the second reference signal regardless of whether the first signal characteristic exceeds the threshold value.
- 10 **[0058]** Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for transmitting, to the first wireless device, a CLI measurement configuration indicating that the second wireless device is to continue to transmit the second reference signal regardless of whether the first signal characteristic exceeds the threshold value.
- 15 **[0059]** Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for transmitting, to the second wireless device, a trigger for the second wireless device to transmit the first reference signal for measurement by the first wireless device during the first measurement period.
- 20 **[0060]** Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for transmitting, to the second wireless device based on the determining, a trigger for the second wireless device to transmit the second reference signal for measurement by the first wireless device during the second measurement period.
- 25 **[0061]** Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for transmitting, to the first wireless device, a trigger for the first wireless device to measure the first signal characteristic during the first measurement period.
- 30 **[0062]** Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for

transmitting, to the first wireless device, a trigger for the first wireless device to measure the second signal characteristic during the second measurement period.

[0063] Some examples of the method, apparatuses, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for transmitting, to the first wireless device, a CLI measurement configuration indicating resources for the first wireless device to use to receive the first reference signal during the first measurement period and the second reference signal during the second measurement period.

[0064] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the CLI measurement configuration may further indicate that the first reference signal is to be transmitted during the first measurement period according to a first periodicity and that the second reference signal is to be transmitted during the second measurement period according to a second periodicity greater than the first periodicity based on the first signal characteristic failing to exceed the threshold value.

[0065] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the CLI measurement configuration may further indicate that the first reference signal is to be transmitted during the first measurement period according to a first periodicity and that the second reference signal is to be transmitted during the second measurement period according to a second periodicity greater than the first periodicity based on the first signal characteristic exceeding the threshold value.

[0066] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the second wireless device may be associated with the first serving cell.

[0067] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the second wireless device may be associated with a second serving cell different from the first serving cell.

[0068] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first serving cell may be served by the base station, and the second serving cell may be served by the base station.

[0069] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first serving cell may be served by a first base station, and the second serving cell may be served by a second base station.

[0070] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first signal characteristic may include an RSSI or an SINR, and the second signal characteristic may include an RSRP.

[0071] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the first signal characteristic may include an RSRP, and the second signal characteristic may include an RSSI or an SINR.

[0072] In some examples of the method, apparatuses, and non-transitory computer-readable medium described herein, the comparison of the first signal characteristic to the threshold value may include an RSSI being at or above the threshold value, where the first signal characteristic includes the RSSI; an SINR being at or below the threshold value, where the first signal characteristic includes the SINR; or a combination thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0073] FIG. 1 illustrates an example of a system for wireless communications that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure.

[0074] FIG. 2 illustrates an example of a wireless communications system that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure.

[0075] FIGs. 3 through 9 illustrate examples of process flows that support two stage CLI transmission and measurement in accordance with aspects of the present disclosure.

[0076] FIGs. 10 and 11 show diagrams of devices that support two stage CLI transmission and measurement in accordance with aspects of the present disclosure.

[0077] FIG. 12 shows a diagram of a communications manager that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure.

[0078] FIG. 13 shows a diagram of a system including a UE that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure.

[0079] FIG. 14 shows a diagram of a system including a base station that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure.

5 [0080] FIGs. 15 and 16 show diagrams of devices that support two stage CLI transmission and measurement in accordance with aspects of the present disclosure.

[0081] FIG. 17 shows a diagram of a base station communications manager that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure.

10 [0082] FIG. 18 shows a diagram of a system including a device that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure.

[0083] FIGs. 19 through 21 show flowcharts illustrating methods that support two stage CLI transmission and measurement in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

15 [0084] A wireless communications system may employ TDD techniques for communications, where a wireless channel is used for both uplink transmissions and downlink transmissions. In a TDD system with macro cells which provide a wide coverage area, the macro cells may often use a same TDD uplink/downlink configuration. For example, multiple macro cells may use a same slot format which provides, on average, a largest
20 throughput for a large number of users (e.g., a majority of users) connected to the macro cells. For small cells (e.g., with a cell radius of a few hundred meters), TDD uplink/downlink configurations may dynamically change to follow a change of traffic. For example, if the traffic in a small cell shifts toward being more uplink-heavy (e.g., a higher amount of uplink traffic than downlink traffic), the TDD configuration of the small cell may change to using
25 slots which have more uplink symbol periods and corresponding fewer downlink symbol periods. The TDD configuration of the small cell may be dynamically indicated to UEs in the small cell by a slot format indicator (SFI) in downlink control information (DCI). Additionally, or alternatively, the TDD configuration of the small cell may be semi-statically configured (e.g., included in a radio resource control (RRC) configuration) by higher layer
30 signaling, such as RRC signaling, or through DCI.

[0085] In some cases, neighboring cells may use different TDD configurations, which can lead to conflicting symbol periods. For example, a symbol period of a first cell may be configured for downlink, where the same symbol period is configured for uplink in a second cell. If a first UE in a first cell is configured for an uplink transmission during a symbol period and a second UE in a second cell is configured to receive a downlink transmission during the same symbol period, where the first UE and the second UE are in close proximity, the uplink transmission of the first UE may cause interference to reception of the downlink transmission at the second UE. This type of interference may be referred to as CLI. Generally, differing TDD configurations may result in a UE-to-UE CLI, where an uplink symbol of one cell collides with a downlink symbol of a nearby cell. In some cases, CLI may occur near or between cell edge UEs of nearby cells.

[0086] To manage CLI in the wireless communications system, a victim wireless device (e.g., a UE or a cell that is affected by the CLI) may measure one or more metrics of the CLI to determine a strength of the CLI. For example, the one or more metrics may include an RSRP, an RSSI, an SINR, or similar power measurements in order to determine an amount of the CLI that is affecting the victim wireless device. However, each CLI measurement have different advantages and disadvantages such that choosing one of the measurements to perform over the other may lead to a less accurate measurement for the CLI, an inefficient use of resources for measuring the CLI, or a combination thereof.

[0087] As described herein, efficient techniques for a CLI measurement procedure that utilizes multiple metrics of the CLI (e.g., RSRP, RSSI, SINR, etc.) in two or more steps are described. For example, an aggressor wireless device (e.g., a UE, a base station, a cell, etc., that causes the CLI) may transmit a reference signal for an RSSI or RSRP measurement in a first step of the CLI measurement procedure. Subsequently, a victim wireless device (e.g., a UE or cell that is affected by the CLI) may measure the reference signal to determine an RSSI or RSRP for a strength of the CLI in the same first step of the CLI measurement procedure. A serving cell for the victim wireless device may then compare the RSSI or RSRP measurement against a threshold value, where the serving cell triggers a second step of the CLI measurement procedure based on the comparison of the RSSI or RSRP measurements with respect to the threshold value. Accordingly, in the second step of the CLI measurement procedure, the aggressor wireless device may transmit a second reference signal for either an RSSI or RSRP measurement (e.g., the second reference signal is transmitted based on the

comparison of the first measurement against the threshold value), and the victim wireless device may measure the second reference signal to determine an RSSI or RSRP for the strength of CLI. Additionally, the CLI measurement procedure may include an extensible periodicity for performing the reference signal transmission and the CLI measurements. In some cases, the serving cell may utilize an event trigger (e.g., a handover procedure, a signal quality falling below a threshold value, etc.) to determine when to initiate the CLI measurement procedure.

[0088] Aspects of the disclosure are initially described in the context of a wireless communications system. Additionally, aspects of the disclosure are illustrated by an additional wireless communications system and multiple process flow examples. Aspects of the disclosure are further illustrated by and described with reference to apparatus diagrams, system diagrams, and flowcharts that relate to two stage CLI transmission and measurement.

[0089] FIG. 1 illustrates an example of a wireless communications system 100 that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure. The wireless communications system 100 includes base stations 105, UEs 115, and a core network 130. In some examples, the wireless communications system 100 may be an LTE network, an LTE-A network, an LTE-A Pro network, or an NR network. In some cases, wireless communications system 100 may support enhanced broadband communications, ultra-reliable (e.g., mission critical) communications, low latency communications, or communications with low-cost and low-complexity devices.

[0090] Base stations 105 may wirelessly communicate with UEs 115 via one or more base station antennas. Base stations 105 described herein may include or may be referred to by those skilled in the art as a base transceiver station, a radio base station, an access point, a radio transceiver, a NodeB, an eNodeB (eNB), a next-generation NodeB or giga-NodeB (either of which may be referred to as a gNB), a Home NodeB, a Home eNodeB, or some other suitable terminology. Wireless communications system 100 may include base stations 105 of different types (e.g., macro or small cell base stations). The UEs 115 described herein may be able to communicate with various types of base stations 105 and network equipment including macro eNBs, small cell eNBs, gNBs, relay base stations, and the like.

[0091] Each base station 105 may be associated with a particular geographic coverage area 110 in which communications with various UEs 115 is supported. Each base station 105

may provide communication coverage for a respective geographic coverage area 110 via communication links 125, and communication links 125 between a base station 105 and a UE 115 may utilize one or more carriers. Communication links 125 shown in wireless communications system 100 may include uplink transmissions from a UE 115 to a base station 105, or downlink transmissions from a base station 105 to a UE 115. Downlink transmissions may also be called forward link transmissions while uplink transmissions may also be called reverse link transmissions.

[0092] The geographic coverage area 110 for a base station 105 may be divided into sectors making up a portion of the geographic coverage area 110, and each sector may be associated with a cell. For example, each base station 105 may provide communication coverage for a macro cell, a small cell, a hot spot, or other types of cells, or various combinations thereof. In some examples, a base station 105 may be movable and therefore provide communication coverage for a moving geographic coverage area 110. In some examples, different geographic coverage areas 110 associated with different technologies may overlap, and overlapping geographic coverage areas 110 associated with different technologies may be supported by the same base station 105 or by different base stations 105. The wireless communications system 100 may include, for example, a heterogeneous LTE/LTE-A/LTE-A Pro or NR network in which different types of base stations 105 provide coverage for various geographic coverage areas 110.

[0093] The term “cell” refers to a logical communication entity used for communication with a base station 105 (e.g., over a carrier), and may be associated with an identifier for distinguishing neighboring cells (e.g., a physical cell identifier (PCID), a virtual cell identifier (VCID)) operating via the same or a different carrier. In some examples, a carrier may support multiple cells, and different cells may be configured according to different protocol types (e.g., machine-type communication (MTC), narrowband Internet-of-Things (NB-IoT), enhanced mobile broadband (eMBB), or others) that may provide access for different types of devices. In some cases, the term “cell” may refer to a portion of a geographic coverage area 110 (e.g., a sector) over which the logical entity operates.

[0094] UEs 115 may be dispersed throughout the wireless communications system 100, and each UE 115 may be stationary or mobile. A UE 115 may also be referred to as a mobile device, a wireless device, a remote device, a handheld device, or a subscriber device, or some

other suitable terminology, where the “device” may also be referred to as a unit, a station, a terminal, or a client. A UE 115 may also be a personal electronic device such as a cellular phone, a personal digital assistant (PDA), a tablet computer, a laptop computer, or a personal computer. In some examples, a UE 115 may also refer to a wireless local loop (WLL) station, an Internet of Things (IoT) device, an Internet of Everything (IoE) device, or an MTC device, or the like, which may be implemented in various articles such as appliances, vehicles, meters, or the like.

[0095] Some UEs 115, such as MTC or IoT devices, may be low cost or low complexity devices, and may provide for automated communication between machines (e.g., via Machine-to-Machine (M2M) communication). M2M communication or MTC may refer to data communication technologies that allow devices to communicate with one another or a base station 105 without human intervention. In some examples, M2M communication or MTC may include communications from devices that integrate sensors or meters to measure or capture information and relay that information to a central server or application program that can make use of the information or present the information to humans interacting with the program or application. Some UEs 115 may be designed to collect information or enable automated behavior of machines. Examples of applications for MTC devices include smart metering, inventory monitoring, water level monitoring, equipment monitoring, healthcare monitoring, wildlife monitoring, weather and geological event monitoring, fleet management and tracking, remote security sensing, physical access control, and transaction-based business charging.

[0096] Some UEs 115 may be configured to employ operating modes that reduce power consumption, such as half-duplex communications (e.g., a mode that supports one-way communication via transmission or reception, but not transmission and reception simultaneously). In some examples half-duplex communications may be performed at a reduced peak rate. Other power conservation techniques for UEs 115 include entering a power saving “deep sleep” mode when not engaging in active communications, or operating over a limited bandwidth (e.g., according to narrowband communications). In some cases, UEs 115 may be designed to support critical functions (e.g., mission critical functions), and a wireless communications system 100 may be configured to provide ultra-reliable communications for these functions.

[0097] In some cases, a UE 115 may also be able to communicate directly with other UEs 115 (e.g., using a peer-to-peer (P2P) or device-to-device (D2D) protocol). One or more of a group of UEs 115 utilizing D2D communications may be within the geographic coverage area 110 of a base station 105. Other UEs 115 in such a group may be outside the geographic coverage area 110 of a base station 105, or be otherwise unable to receive transmissions from a base station 105. In some cases, groups of UEs 115 communicating via D2D communications may utilize a one-to-many (1:M) system in which each UE 115 transmits to every other UE 115 in the group. In some cases, a base station 105 facilitates the scheduling of resources for D2D communications. In other cases, D2D communications are carried out between UEs 115 without the involvement of a base station 105.

[0098] Base stations 105 may communicate with the core network 130 and with one another. For example, base stations 105 may interface with the core network 130 through backhaul links 132 (e.g., via an S1, N2, N3, or other interface). Base stations 105 may communicate with one another over backhaul links 134 (e.g., via an X2, Xn, or other interface) either directly (e.g., directly between base stations 105) or indirectly (e.g., via core network 130).

[0099] The core network 130 may provide user authentication, access authorization, tracking, Internet Protocol (IP) connectivity, and other access, routing, or mobility functions. The core network 130 may be an evolved packet core (EPC), which may include at least one mobility management entity (MME), at least one serving gateway (S-GW), and at least one Packet Data Network (PDN) gateway (P-GW). The MME may manage non-access stratum (e.g., control plane) functions such as mobility, authentication, and bearer management for UEs 115 served by base stations 105 associated with the EPC. User IP packets may be transferred through the S-GW, which itself may be connected to the P-GW. The P-GW may provide IP address allocation as well as other functions. The P-GW may be connected to the network operators IP services. The operators IP services may include access to the Internet, Intranet(s), an IP Multimedia Subsystem (IMS), or a Packet-Switched (PS) Streaming Service.

[0100] At least some of the network devices, such as a base station 105, may include subcomponents such as an access network entity, which may be an example of an access node controller (ANC). Each access network entity may communicate with UEs 115 through a number of other access network transmission entities, which may be referred to as a radio

head, a smart radio head, or a transmission/reception point (TRP). In some configurations, various functions of each access network entity or base station 105 may be distributed across various network devices (e.g., radio heads and access network controllers) or consolidated into a single network device (e.g., a base station 105).

- 5 **[0101]** Wireless communications system 100 may operate using one or more frequency bands, typically in the range of 300 megahertz (MHz) to 300 gigahertz (GHz). Generally, the region from 300 MHz to 3 GHz is known as the ultra-high frequency (UHF) region or decimeter band, since the wavelengths range from approximately one decimeter to one meter in length. UHF waves may be blocked or redirected by buildings and environmental features.
- 10 However, the waves may penetrate structures sufficiently for a macro cell to provide service to UEs 115 located indoors. Transmission of UHF waves may be associated with smaller antennas and shorter range (e.g., less than 100 km) compared to transmission using the smaller frequencies and longer waves of the high frequency (HF) or very high frequency (VHF) portion of the spectrum below 300 MHz.
- 15 **[0102]** Wireless communications system 100 may also operate in a super high frequency (SHF) region using frequency bands from 3 GHz to 30 GHz, also known as the centimeter band. The SHF region includes bands such as the 5 GHz industrial, scientific, and medical (ISM) bands, which may be used opportunistically by devices that may be capable of tolerating interference from other users.
- 20 **[0103]** Wireless communications system 100 may also operate in an extremely high frequency (EHF) region of the spectrum (e.g., from 30 GHz to 300 GHz), also known as the millimeter band. In some examples, wireless communications system 100 may support millimeter wave (mmW) communications between UEs 115 and base stations 105, and EHF antennas of the respective devices may be even smaller and more closely spaced than UHF
- 25 antennas. In some cases, this may facilitate use of antenna arrays within a UE 115. However, the propagation of EHF transmissions may be subject to even greater atmospheric attenuation and shorter range than SHF or UHF transmissions. Techniques disclosed herein may be employed across transmissions that use one or more different frequency regions, and designated use of bands across these frequency regions may differ by country or regulating
- 30 body.

[0104] In some cases, wireless communications system 100 may utilize both licensed and unlicensed radio frequency spectrum bands. For example, wireless communications system 100 may employ License Assisted Access (LAA), LTE-Unlicensed (LTE-U) radio access technology, or NR technology in an unlicensed band such as the 5 GHz ISM band. When
5 operating in unlicensed radio frequency spectrum bands, wireless devices such as base stations 105 and UEs 115 may employ listen-before-talk (LBT) procedures to ensure a frequency channel is clear before transmitting data. In some cases, operations in unlicensed bands may be based on a carrier aggregation configuration in conjunction with component carriers operating in a licensed band (e.g., LAA). Operations in unlicensed spectrum may
10 include downlink transmissions, uplink transmissions, peer-to-peer transmissions, or a combination of these. Duplexing in unlicensed spectrum may be based on frequency division duplexing (FDD), TDD, or a combination of both.

[0105] In some examples, base station 105 or UE 115 may be equipped with multiple antennas, which may be used to employ techniques such as transmit diversity, receive
15 diversity, multiple-input multiple-output (MIMO) communications, or beamforming. For example, wireless communications system 100 may use a transmission scheme between a transmitting device (e.g., a base station 105) and a receiving device (e.g., a UE 115), where the transmitting device is equipped with multiple antennas and the receiving device is equipped with one or more antennas. MIMO communications may employ multipath signal
20 propagation to increase the spectral efficiency by transmitting or receiving multiple signals via different spatial layers, which may be referred to as spatial multiplexing. The multiple signals may, for example, be transmitted by the transmitting device via different antennas or different combinations of antennas. Likewise, the multiple signals may be received by the receiving device via different antennas or different combinations of antennas. Each of the
25 multiple signals may be referred to as a separate spatial stream, and may carry bits associated with the same data stream (e.g., the same codeword) or different data streams. Different spatial layers may be associated with different antenna ports used for channel measurement and reporting. MIMO techniques include single-user MIMO (SU-MIMO) where multiple spatial layers are transmitted to the same receiving device, and multiple-user MIMO (MU-
30 MIMO) where multiple spatial layers are transmitted to multiple devices.

[0106] Beamforming, which may also be referred to as spatial filtering, directional transmission, or directional reception, is a signal processing technique that may be used at a

transmitting device or a receiving device (e.g., a base station 105 or a UE 115) to shape or steer an antenna beam (e.g., a transmit beam or receive beam) along a spatial path between the transmitting device and the receiving device. Beamforming may be achieved by combining the signals communicated via antenna elements of an antenna array such that signals propagating at particular orientations with respect to an antenna array experience constructive interference while others experience destructive interference. The adjustment of signals communicated via the antenna elements may include a transmitting device or a receiving device applying certain amplitude and phase offsets to signals carried via each of the antenna elements associated with the device. The adjustments associated with each of the antenna elements may be defined by a beamforming weight set associated with a particular orientation (e.g., with respect to the antenna array of the transmitting device or receiving device, or with respect to some other orientation).

[0107] In one example, a base station 105 may use multiple antennas or antenna arrays to conduct beamforming operations for directional communications with a UE 115. For instance, some signals (e.g. synchronization signals, reference signals, beam selection signals, or other control signals) may be transmitted by a base station 105 multiple times in different directions, which may include a signal being transmitted according to different beamforming weight sets associated with different directions of transmission. Transmissions in different beam directions may be used to identify (e.g., by the base station 105 or a receiving device, such as a UE 115) a beam direction for subsequent transmission and/or reception by the base station 105.

[0108] Some signals, such as data signals associated with a particular receiving device, may be transmitted by a base station 105 in a single beam direction (e.g., a direction associated with the receiving device, such as a UE 115). In some examples, the beam direction associated with transmissions along a single beam direction may be determined based at least in part on a signal that was transmitted in different beam directions. For example, a UE 115 may receive one or more of the signals transmitted by the base station 105 in different directions, and the UE 115 may report to the base station 105 an indication of the signal it received with a highest signal quality, or an otherwise acceptable signal quality. Although these techniques are described with reference to signals transmitted in one or more directions by a base station 105, a UE 115 may employ similar techniques for transmitting signals multiple times in different directions (e.g., for identifying a beam direction for

subsequent transmission or reception by the UE 115), or transmitting a signal in a single direction (e.g., for transmitting data to a receiving device).

[0109] A receiving device (e.g., a UE 115, which may be an example of a mmW receiving device) may try multiple receive beams when receiving various signals from the base station 105, such as synchronization signals, reference signals, beam selection signals, or other control signals. For example, a receiving device may try multiple receive directions by receiving via different antenna subarrays, by processing received signals according to different antenna subarrays, by receiving according to different receive beamforming weight sets applied to signals received at a plurality of antenna elements of an antenna array, or by processing received signals according to different receive beamforming weight sets applied to signals received at a plurality of antenna elements of an antenna array, any of which may be referred to as “listening” according to different receive beams or receive directions. In some examples a receiving device may use a single receive beam to receive along a single beam direction (e.g., when receiving a data signal). The single receive beam may be aligned in a beam direction determined based at least in part on listening according to different receive beam directions (e.g., a beam direction determined to have a highest signal strength, highest signal-to-noise ratio, or otherwise acceptable signal quality based at least in part on listening according to multiple beam directions).

[0110] In some cases, the antennas of a base station 105 or UE 115 may be located within one or more antenna arrays, which may support MIMO operations, or transmit or receive beamforming. For example, one or more base station antennas or antenna arrays may be co-located at an antenna assembly, such as an antenna tower. In some cases, antennas or antenna arrays associated with a base station 105 may be located in diverse geographic locations. A base station 105 may have an antenna array with a number of rows and columns of antenna ports that the base station 105 may use to support beamforming of communications with a UE 115. Likewise, a UE 115 may have one or more antenna arrays that may support various MIMO or beamforming operations.

[0111] In some cases, wireless communications system 100 may be a packet-based network that operate according to a layered protocol stack. In the user plane, communications at the bearer or Packet Data Convergence Protocol (PDCP) layer may be IP-based. A Radio Link Control (RLC) layer may perform packet segmentation and reassembly to communicate

over logical channels. A Medium Access Control (MAC) layer may perform priority handling and multiplexing of logical channels into transport channels. The MAC layer may also use hybrid automatic repeat request (HARQ) to provide retransmission at the MAC layer to improve link efficiency. In the control plane, the RRC protocol layer may provide establishment, configuration, and maintenance of an RRC connection between a UE 115 and a base station 105 or core network 130 supporting radio bearers for user plane data. At the Physical layer, transport channels may be mapped to physical channels.

[0112] In some cases, UEs 115 and base stations 105 may support retransmissions of data to increase the likelihood that data is received successfully. HARQ feedback is one technique of increasing the likelihood that data is received correctly over a communication link 125. HARQ may include a combination of error detection (e.g., using a cyclic redundancy check (CRC)), forward error correction (FEC), and retransmission (e.g., automatic repeat request (ARQ)). HARQ may improve throughput at the MAC layer in poor radio conditions (e.g., signal-to-noise conditions). In some cases, a wireless device may support same-slot HARQ feedback, where the device may provide HARQ feedback in a specific slot for data received in a previous symbol in the slot. In other cases, the device may provide HARQ feedback in a subsequent slot, or according to some other time interval.

[0113] Time intervals in LTE or NR may be expressed in multiples of a basic time unit, which may, for example, refer to a sampling period of $T_s = 1/30,720,000$ seconds. Time intervals of a communications resource may be organized according to radio frames each having a duration of 10 milliseconds (ms), where the frame period may be expressed as $T_f = 307,200 T_s$. The radio frames may be identified by a system frame number (SFN) ranging from 0 to 1023. Each frame may include 10 subframes numbered from 0 to 9, and each subframe may have a duration of 1 ms. A subframe may be further divided into 2 slots each having a duration of 0.5 ms, and each slot may contain 6 or 7 modulation symbol periods (e.g., depending on the length of the cyclic prefix prepended to each symbol period). Excluding the cyclic prefix, each symbol period may contain 2048 sampling periods. In some cases, a subframe may be the smallest scheduling unit of the wireless communications system 100, and may be referred to as a transmission time interval (TTI). In other cases, a smallest scheduling unit of the wireless communications system 100 may be shorter than a subframe or may be dynamically selected (e.g., in bursts of shortened TTIs (sTTIs) or in selected component carriers using sTTIs).

[0114] In some wireless communications systems, a slot may further be divided into multiple mini-slots containing one or more symbols. In some instances, a symbol of a mini-slot or a mini-slot may be the smallest unit of scheduling. Each symbol may vary in duration depending on the subcarrier spacing or frequency band of operation, for example. Further, some wireless communications systems may implement slot aggregation in which multiple slots or mini-slots are aggregated together and used for communication between a UE 115 and a base station 105.

[0115] The term “carrier” refers to a set of radio frequency spectrum resources having a defined physical layer structure for supporting communications over a communication link 125. For example, a carrier of a communication link 125 may include a portion of a radio frequency spectrum band that is operated according to physical layer channels for a given radio access technology. Each physical layer channel may carry user data, control information, or other signaling. A carrier may be associated with a pre-defined frequency channel (e.g., an evolved universal mobile telecommunication system terrestrial radio access (E-UTRA) absolute radio frequency channel number (EARFCN)), and may be positioned according to a channel raster for discovery by UEs 115. Carriers may be downlink or uplink (e.g., in an FDD mode), or be configured to carry downlink and uplink communications (e.g., in a TDD mode). In some examples, signal waveforms transmitted over a carrier may be made up of multiple sub-carriers (e.g., using multi-carrier modulation (MCM) techniques such as orthogonal frequency division multiplexing (OFDM) or DFT-S-OFDM).

[0116] The organizational structure of the carriers may be different for different radio access technologies (e.g., LTE, LTE-A, LTE-A Pro, NR). For example, communications over a carrier may be organized according to TTIs or slots, each of which may include user data as well as control information or signaling to support decoding the user data. A carrier may also include dedicated acquisition signaling (e.g., synchronization signals or system information, etc.) and control signaling that coordinates operation for the carrier. In some examples (e.g., in a carrier aggregation configuration), a carrier may also have acquisition signaling or control signaling that coordinates operations for other carriers.

[0117] Physical channels may be multiplexed on a carrier according to various techniques. A physical control channel and a physical data channel may be multiplexed on a downlink carrier, for example, using time division multiplexing (TDM) techniques, frequency division

multiplexing (FDM) techniques, or hybrid TDM-FDM techniques. In some examples, control information transmitted in a physical control channel may be distributed between different control regions in a cascaded manner (e.g., between a common control region or common search space and one or more UE-specific control regions or UE-specific search spaces).

- 5 **[0118]** A carrier may be associated with a particular bandwidth of the radio frequency spectrum, and in some examples the carrier bandwidth may be referred to as a “system bandwidth” of the carrier or the wireless communications system 100. For example, the carrier bandwidth may be one of a number of predetermined bandwidths for carriers of a particular radio access technology (e.g., 1.4, 3, 5, 10, 15, 20, 40, or 80 MHz). In some
- 10 examples, each served UE 115 may be configured for operating over portions or all of the carrier bandwidth. In other examples, some UEs 115 may be configured for operation using a narrowband protocol type that is associated with a predefined portion or range (e.g., set of subcarriers or RBs) within a carrier (e.g., “in-band” deployment of a narrowband protocol type).
- 15 **[0119]** In a system employing MCM techniques, a resource element may consist of one symbol period (e.g., a duration of one modulation symbol) and one subcarrier, where the symbol period and subcarrier spacing are inversely related. The number of bits carried by each resource element may depend on the modulation scheme (e.g., the order of the modulation scheme). Thus, the more resource elements that a UE 115 receives and the higher
- 20 the order of the modulation scheme, the higher the data rate may be for the UE 115. In MIMO systems, a wireless communications resource may refer to a combination of a radio frequency spectrum resource, a time resource, and a spatial resource (e.g., spatial layers), and the use of multiple spatial layers may further increase the data rate for communications with a UE 115.
- 25 **[0120]** Devices of the wireless communications system 100 (e.g., base stations 105 or UEs 115) may have a hardware configuration that supports communications over a particular carrier bandwidth, or may be configurable to support communications over one of a set of carrier bandwidths. In some examples, the wireless communications system 100 may include base stations 105 and/or UEs 115 that support simultaneous communications via carriers
- 30 associated with more than one different carrier bandwidth.

[0121] Wireless communications system 100 may support communication with a UE 115 on multiple cells or carriers, a feature which may be referred to as carrier aggregation or multi-carrier operation. A UE 115 may be configured with multiple downlink component carriers and one or more uplink component carriers according to a carrier aggregation configuration. Carrier aggregation may be used with both FDD and TDD component carriers.

[0122] In some cases, wireless communications system 100 may utilize enhanced component carriers (eCCs). An eCC may be characterized by one or more features including wider carrier or frequency channel bandwidth, shorter symbol duration, shorter TTI duration, or modified control channel configuration. In some cases, an eCC may be associated with a carrier aggregation configuration or a dual connectivity configuration (e.g., when multiple serving cells have a suboptimal or non-ideal backhaul link). An eCC may also be configured for use in unlicensed spectrum or shared spectrum (e.g., where more than one operator is allowed to use the spectrum). An eCC characterized by wide carrier bandwidth may include one or more segments that may be utilized by UEs 115 that are not capable of monitoring the whole carrier bandwidth or are otherwise configured to use a limited carrier bandwidth (e.g., to conserve power).

[0123] In some cases, an eCC may utilize a different symbol duration than other component carriers, which may include use of a reduced symbol duration as compared with symbol durations of the other component carriers. A shorter symbol duration may be associated with increased spacing between adjacent subcarriers. A device, such as a UE 115 or base station 105, utilizing eCCs may transmit wideband signals (e.g., according to frequency channel or carrier bandwidths of 20, 40, 60, 80 MHz, etc.) at reduced symbol durations (e.g., 16.67 microseconds). A TTI in eCC may consist of one or multiple symbol periods. In some cases, the TTI duration (that is, the number of symbol periods in a TTI) may be variable.

[0124] Wireless communications system 100 may be an NR system that may utilize any combination of licensed, shared, and unlicensed spectrum bands, among others. The flexibility of eCC symbol duration and subcarrier spacing may allow for the use of eCC across multiple spectrums. In some examples, NR shared spectrum may increase spectrum utilization and spectral efficiency, specifically through dynamic vertical (e.g., across the frequency domain) and horizontal (e.g., across the time domain) sharing of resources.

[0125] In the context of CLI, measurement metrics may include an RSRP, an RSSI, an SINR, or similar power measurements in order to determine an amount of the CLI. RSRP may indicate a received reference signal power of a configured reference signal resource (e.g., a power measured on a reference signal on a configured reference signal resource). In some cases, the configured reference signal may include specific time and frequency resources (e.g., a sequence) in order to separate the reference signal in the reception to measure the CLI alone. The RSRP measurement may be a more accurate (e.g., correct) measurement of the CLI relative to an RSSI measurement. However, the RSRP measurement may lead to a higher resource cost (e.g., more resource cost) relative to other CLI measurements (e.g., RSSI measurements), and, as such, frequent RSRP measurements may lead to a significant cost in resources for a UE. Additionally or alternatively, an RSSI measurement may indicate a total received power measured in certain OFDM symbols (e.g., all signals, messages, etc., received and measured within a given timespan). Accordingly, the RSSI may not require specific time and frequency resources (e.g., a sequence indicated for the RSSI measurement), as this total power estimation may be enough to indicate a relative strength of the CLI. In some cases, the use of an RSSI measurement may save resources (e.g., compared to an RSRP measurement), but the RSSI measurement may be less accurate than other CLI measurements (e.g., an RSRP measurement).

[0126] In some cases, by using different TDD configurations, neighboring cells may have conflicting symbol periods. For example, a symbol period of a first cell may be configured for downlink, where the same symbol period is configured for uplink in a second cell. If a first UE in a first cell is configured for an uplink transmission during a symbol period and a second UE in a second cell is configured to receive a downlink transmission during the same symbol period, where the first UE and the second UE are in close proximity, the uplink transmission of the first UE may cause interference to reception of the downlink transmission at the second UE. This type of interference may be referred to as CLI. Generally, differing TDD configurations may result in a UE-to-UE CLI when an uplink symbol of one cell collides with a downlink symbol of a nearby cell. In some cases, CLI may occur near or between cell edge UEs of nearby cells. As discussed above, the second UE (e.g., a victim UE) may be configured to measure a CLI via an RSSI or RSRP measurement. However, each CLI measurement may have different advantages and disadvantages as noted above such that choosing one of the measurements to perform over the other may lead to a less accurate

measurement for the CLI (e.g., when measuring RSSI over RSRP), an inefficient use of resources for measuring the CLI (e.g., when measuring RSRP over RSSI), or a combination thereof.

[0127] Wireless communications system 100 may support efficient techniques for a CLI measurement procedure that utilizes both metrics of the RSRP and RSSI measurements in two or more steps. For example, an aggressor wireless device (e.g., a UE 115 that causes the CLI) may transmit a reference signal for an RSSI or RSRP measurement in a first step of the CLI measurement procedure. Subsequently, a victim wireless device (e.g., a UE 115 that is affected by the CLI) may measure the reference signal to determine an RSSI or RSRP for the strength of the CLI in the same first step of the CLI measurement procedure. A serving cell for the victim wireless device may then compare the RSSI or RSRP measurement against a threshold value, where the serving cell triggers a second step of the CLI measurement procedure based on the comparison of the strength measurements with respect to the threshold value. Accordingly, in the second step of the CLI measurement procedure, the aggressor wireless device may transmit a second reference signal for either an RSSI or RSRP measurement (e.g., the second reference signal is transmitted based on the comparison of the first measurement against the threshold value), and the victim wireless device may measure the second reference signal to determine an RSSI or RSRP for the strength of CLI. Additionally, the CLI measurement procedure may include an extensible periodicity for performing the reference signal transmission and the CLI measurements. In some cases, the serving cell may use one or more event triggers to trigger and perform the CLI measurement procedure.

[0128] FIG. 2 illustrates an example of a wireless communications system 200 that supports two-stage CLI transmission and measurement in accordance with aspects of the present disclosure. In some examples, wireless communications system 200 may implement aspects of wireless communications system 100. The wireless communications system 200 may include a UE 115-a and a UE 115-b, which may be examples of a UE 115 as described herein. The wireless communications system 200 may also include a base station 105-a and a base station 105-b, which may be examples of a base station 105 as described herein. Base station 105-a and base station 105-b may each be an example of a small cell (e.g., have a cell radius of a few hundred meters). The base stations 105 may each be associated with a cell

which provides wireless communications with the base station 105 within a respective coverage area 110.

[0129] The wireless communications system 200 may employ TDD communications, where a wireless communications channel is used for both uplink transmissions and downlink transmissions. Each cell may configure a TDD configuration 205 for the cell. For example, the first cell of base station 105-a may use a first TDD configuration 205-a, and the second cell of base station 105-b may use a second TDD configuration 205-b. UEs 115 in these cells may communicate with the base station 105 providing the cell based on the corresponding TDD configuration 205. For example, a slot of a TDD configuration 205 may include symbol periods for downlink symbols 210, flexible symbols 215, uplink symbols 220, sounding reference signal (SRS) symbols 225, or any combination thereof. The base station 105 may transmit downlink information and/or messages (e.g., downlink transmissions) in a downlink symbol 210, and the UE 115 may transmit uplink information and/or messages (e.g., uplink transmissions) in an uplink symbol 220. Additionally, for SRS transmissions and measurements, the UE 115 may transmit an SRS in an uplink transmission on an SRS symbol 225, and another UE 115 or a base station 105 may estimate the SRS with a corresponding configured resource in the downlink reception of a respective TDD configuration 205. Flexible symbols 215 may, in some cases, be used as guard periods between the uplink transmissions and downlink transmissions. A guard period may prevent inter-symbol interference or may provide time for a UE 115 to adjust radio frequency hardware for a subsequent transmission direction (e.g., from uplink to downlink or from downlink to uplink). In some cases, a flexible symbol 215 may be dynamically reconfigured to either a downlink symbol 210 or an uplink symbol 220.

[0130] The base stations 105 may dynamically change the TDD configurations 205. In an example, the traffic in the first cell may shift toward being more uplink-heavy, so the first TDD configuration 205-a of the first cell may change to using a slot configuration which has more uplink symbol periods. In some cases, a TDD configuration 205 may be dynamically indicated to UEs in the cell by an SFI in DCI. The DCI conveying the SFI may be transmitted in one of the first few downlink symbols 210 of the slot. Additionally or alternatively, the TDD configuration 205 may be semi-statically configured (e.g., included in an RRC configuration) by higher layer signaling, such as RRC signaling.

[0131] In some cases, different TDD configurations 205 used by neighboring cells may lead to conflicting transmission directions for some symbol periods of a slot. For example, the 9th and 10th symbol periods of the slot shown with respect to FIG. 2 may have conflicting directions for the first TDD configuration 205-a and the second TDD

5 configuration 205-b. The first TDD configuration 205-a may have uplink symbols 220 configured when the second TDD configuration 205-b has downlink symbols 210 configured. Therefore, UE 115-a in the first cell may be configured to transmit an uplink transmission while UE 115-b in the second cell is configured to receive a downlink transmission in that time duration (e.g., the 9th and 10th symbol periods of the slot). The first cell and the second
10 cell may be neighboring cells, and UE 115-b and UE 115-a may be near each other at the edge of their respective cells. In some cases, the uplink transmission of UE 115-a may cause interference to reception of the downlink transmission at UE 115-b. This type of interference may be referred to as UE-to-UE CLI, shown by a CLI 230 at the conflicting symbol periods. Generally, differing TDD configurations 205 may result in UE-to-UE CLI 230 when an
15 uplink symbol of one cell collides with a downlink symbol of another nearby cell.

Additionally, CLI 230 may occur near or between cell edge UEs 115 of nearby cells. The UE 115 transmitting the interfering uplink signal (e.g., UE 115-a as shown with respect to FIG. 2) may be referred to as the aggressor UE 115, and the UE 115 which is receiving the affected (e.g., interfered) downlink transmission (e.g., UE 115-b as shown with respect to FIG. 2) may
20 be referred to as the victim UE 115.

[0132] For interference management (e.g., whether more or less interference is allowed), a strength of CLI 230 may be measured by the UEs 115 involved in CLI 230 (e.g., UE 115-a and UE 115-b). The UEs 115 may use the interference management to determine whether a victim UE can tolerate more interference. In some cases, RSRP and RSSI may be identified
25 as the measurement metrics for CLI 230. RSRP may indicate the received reference signal power of a configured reference signal resource for measuring CLI 230. For example, one of the UEs 115 may demodulate a reference signal, perform a channel estimation on the demodulated signal, and measure the RSRP based on the channel estimation. RSSI may indicate a total received power from all signals that a UE 115 receives (e.g., from adjacent
30 channels, other cells, its own cell, etc.) and may be measured in certain OFDM symbols (e.g., the symbols where the CLI is present). In some cases, the RSRP and RSSI measurements may be performed on respective reference signals transmitted by the aggressor UE 115 (e.g.,

UE 115-a) for measuring CLI 230. For example, the aggressor UE 115 may transmit a first set of CLI reference signals (CLI-RSs) to enable a victim UE 115 (e.g., UE 115-b) to measure an RSRP on the CLI-RSs (e.g., CLI-RSs for RSRP) for determining a strength of CLI 230, a second set of CLI-RSs to enable the victim UE 115 to measure an RSSI on the CLI-RSs (e.g., CLI-RSs for RSSI) for determining the strength of CLI 230, or a combination thereof.

[0133] In some cases, the CLI-RSs may be existing reference signals that a victim UE 115 measures to determine different metrics about the CLI. For example, the CLI-RSs may include SRSs, channel state information reference signals (CSI-RSs), or similar uplink signals that an aggressor wireless device transmits during one or more corresponding downlink symbols at the victim UE 115. Accordingly, the victim UE 115 may measure a strength of the CLI based on one or more CLI-RSs received from the aggressor wireless device. Additionally or alternatively, the CLI-RSs may include dedicated reference signaling for measuring a strength of the CLI. For example, the aggressor wireless device may transmit one or more specific CLI-RSs to enable a corresponding strength measurement of the CLI at the victim UE 115. In some cases, the specific CLI-RSs may include reference signals to enable an RSSI measurement at the victim UE 115, an RSRP measurement at the victim UE 115, an SINR measurement at the victim UE 115, or a combination thereof.

[0134] The strength of CLI 230 may be measured in one or more ways. Victim UEs 115 (e.g., UE 115-b) may measure signals (e.g., CLI-RSs for RSRP or RSSI measurements) transmitted from the aggressor UEs 115 (e.g., UE 115-a). Additionally or alternatively, aggressor UEs 115 may measure signals transmitted from victim UEs 115. Due to a channel reciprocity of the TDD configurations and channel, the measurement made by the aggressor UEs 115 may reflect the aggressor-to-victim interference strength (e.g., the interference at the victim UEs 115 may be reciprocally determined from the measurement at the aggressor UE 115). Additionally, in some cases, these measurements for the strength of CLI 230 may be performed at different levels. For example, the strength measurement of CLI 230 may be cell-specific (e.g., all UEs 115 in a cell transmit the signals for the measurement), group-specific (e.g., a subset of UEs 115 in a cell transmit the signals for the measurement), or UE-specific (e.g., one UE 115 in the cell transmits the signals for the measurement). These different levels of measurements for CLI 230 may provide different levels of granularity for determining CLI strength, tolerance, and impact.

[0135] Additionally, the strength measurements may be performed periodically (e.g., periodic actions) or aperiodically (e.g., based on a series of aperiodic actions). For example, the aggressor UEs 115 may transmit one or more CLI-RSs periodically (e.g., based on a higher-layer configuration from a serving cell, from a base station 105, etc.), and the victim UEs 115 may accordingly perform the measurements on the CLI-RSs (e.g., RSRP, RSSI, etc.) according to the periodic transmissions. Additionally or alternatively, the aggressor UEs 115 may transmit one or more CLI-RSs aperiodically (e.g., based on an indication from the victim UE 115 when a strong interference is detected), and the victim UEs 115 may accordingly perform the measurements on the CLI-RSs according to the aperiodic transmissions. In some cases, a serving cell may configure both the aggressor UEs 115 and the victim UEs 115 to transmit and measure the CLI-RSs, respectively, according to the periodicity or based on the aperiodic interference detections.

[0136] To enable a signal strength measurement (e.g., a measurement of RSSI or RSRP) of CLI 230 (e.g., a CLI measurement configuration 235) in the wireless communications system 200 between two UEs 115 (e.g., UE 115-a and UE 115-b), one UE 115 may transmit an uplink signal in an uplink symbol 220, where this symbol corresponds to a downlink symbol 210 at another UE 115. For example, as shown in a CLI measurement configuration 235-a, UE 115-a may transmit an uplink signal in the 9th and 10th symbol periods of the slot, while UE 115-b is configured to receive downlink signals in the same of 9th and 10th symbol periods of the slot. In some cases, a symbol may be configured as a flexible symbol 215 but converted to an uplink symbol 220 or a downlink symbol 210 if transmission or reception, respectively, of a channel or signals is configured to a UE 115 in the flexible symbol 215.

[0137] Additionally or alternatively, UE 115-a may transmit specific uplink signals for UE 115-b to measure a strength of CLI 230. For example, a CLI measurement configuration 235-b may include an SRS transmission and measurement on one or more SRS symbols 225, where UE 115-a (e.g., an aggressor UE 115) may transmit an SRS in an uplink transmission and UE 115-b (e.g., a victim UE 115) may estimate the SRS with a configured resource in a downlink reception. Initially, UE 115-b (e.g., or any victim UE 115 in the victim or second cell of base station 105-b) may observe a strong interference (e.g., CLI 230) and report the observed strong interference to base station 105-b. The system (e.g., base station 105-a, base station 105-b, a serving cell, etc.) may then trigger a CLI measurement procedure (e.g., via a CLI measurement configuration 235) among the victim and aggressor cells (e.g., and

corresponding UEs 115). Accordingly, a potential aggressor cell (e.g., base station 105-a, UE 115-a, etc.) may transmit an SRS in two SRS symbols 225 of a slot configuration (e.g., the last two symbols of a TDD configuration 205-c for the first cell of base station 105-a as part of CLI measurement configuration 235-b). Subsequently, a victim cell UE 115 (e.g., UE 115-b, additional UEs 115 in the second cell of base station 105-b) may measure the SRS in the configured resource in the downlink reception (e.g., in the last two downlink symbols 210 of a TDD configuration 205-d for the second cell of base station 105-b). In some cases, the victim cell UE 115 may then report the information for the SRS measurement (e.g., an RSRP, RSSI, or others) to its serving base station 105 (e.g., base station 105-b, serving cell, etc.)

[0138] To ensure that the proper symbol types are present to enable the strength measurement of CLI 230 between the two UEs 115, a slot format for one or both UEs 115 may be explicitly configured to include the proper symbol types or uplink signaling may be configured to be transmitted in the appropriate symbols. For example, UE 115-a, UE 115-b, or both may receive additional TDD configurations different than the TDD configurations 205 shown in wireless communications system 200 (e.g., dynamic TDD configurations for data traffic) that change downlink symbols 210 to uplink symbols 220 or uplink symbols 220 to downlink symbols 210. Accordingly, UE 115-b may then measure the strength of CLI 230 on the changed symbols. Additionally or alternatively, the strength measurement of CLI 230 may rely on the TDD configurations 205 for each cell (e.g., TDD uplink-downlink configurations) for data traffic. For example, UE 115-a may transmit uplink signaling in the interfering symbols (e.g., uplink symbols 220 in the 9th and 10th symbol periods or SRS symbols 225 in the 13th and 14th symbol periods) of an uplink-downlink configuration for dynamic TDD traffic (e.g., TDD configuration 205-a or TDD configuration 205-c). UE 115-b (e.g., or additional other UEs 115 in other cells) may perform measurement of CLI 230 in the corresponding interfered symbols (e.g., downlink symbols 210 in the 9th and 10th symbol periods or downlink symbols 210 in the 13th and 14th symbol periods) of the uplink-downlink configuration for dynamic TDD traffic (e.g., TDD configuration 205-b or TDD configuration 205-d).

[0139] While it is shown in FIG. 2 that each UE 115-a and UE 115-b are connected to a first and second cell with corresponding base stations 105-a and 105-b, respectively, different scenarios may exist where uplink transmissions from UE 115-a may cause CLI on downlink transmissions received by UE 115-b. The various techniques described herein may also be

applied for other UE 115 to base station 105 connection scenarios. For example, UE 115-a and UE 115-b may be connected to a first cell and a second cell, respectively, but both cells may be associated with (e.g., served by) a same base station 105. Additionally or alternatively, UE 115-a and UE 115-b may be connected to the same cell served by the same base station 105, but UE 115-a and UE 115-b may have different configurations (e.g., UE-specific TDD configurations 205) that result in the CLI among each other while being connected to the same cell.

[0140] As described herein, the network (e.g., base stations 105-a and 105-b, serving cells, etc.) may utilize a combination of RSSI and RSRP metrics for CLI detection and management in multiple steps (e.g., two or more steps). In some cases, transmission and measurement of CLI-RSs for a CLI measurement procedure may be split into more than one step such that transmitting a CLI-RS for measuring an RSSI or RSRP may occur in more than one step and the measurement of the RSSI or RSRP on the CLI-RSs may occur in more than one step as well. For example, an aggressor wireless device (e.g., aggressor UE 115-a, an aggressor cell, a group of aggressor UEs 115, aggressor base station 105-a, etc.) may transmit a CLI-RS for an RSSI or RSRP in a first step of the CLI measurement procedure. Subsequently, a victim wireless device (e.g., victim UE 115-b, a victim cell, a victim base station 105-b, etc.) may measure the CLI-RS to determine an RSSI or RSRP for the strength of CLI 230 in the same first step of the CLI measurement procedure. A serving cell for the victim wireless device may then compare the RSSI or RSRP measurement against a threshold value, where the comparison may trigger a second step of the CLI measurement procedure. Accordingly, in the second step of the CLI measurement procedure, the aggressor wireless device may transmit a second CLI-RS for either an RSSI or RSRP measurement (e.g., the second CLI-RS is transmitted based on the comparison of the first measurement against the threshold value), and the victim wireless device may measure the second CLI-RS to determine an RSSI or RSRP for the strength of CLI 230. In some cases, the steps of the CLI measurement procedure (e.g., the CLI-RS transmissions and measurements) may occur periodically or via a series of aperiodic steps. Different examples of CLI measurement procedures may be further described below with reference to FIGs. 3-9.

[0141] In some cases, rather than comparing the different RSSI and RSRP measurements against the threshold value to trigger the different steps of the CLI measurement procedure, a serving cell (e.g., base station 105) may use an event trigger to trigger one or more actions of

the CLI measurement procedure. For example, events may be defined that trigger a corresponding action of the CLI measurement procedure, current events may trigger different actions, or a combination thereof. Accordingly, if a matching event is identified by the serving cell, the corresponding actions may be triggered by the serving cell. For example, a handover procedure (e.g., L3 event) may trigger the CLI measurement procedure or an action for the CLI measurement procedure. Additionally or alternatively, an event that indicates the serving cell has become worse than a threshold value (e.g., an A2 event), one or more actions may be triggered. For example, if the serving cell meets this event, a CLI transmission and measurement may be triggered, an RSSI measurement of the CLI may be transferred to an RSRP transmission and measurement, a CLI management is performed more frequently, or a combination thereof. Additionally or alternatively, a different event may be defined for when an interference measurement (e.g., RSSI, RSRP, SINR, etc.) exceeds the threshold.

[0142] FIG. 3 illustrates an example of a process flow 300 that supports two-stage CLI transmission and measurement in accordance with aspects of the present disclosure. In some examples, process flow 300 may implement aspects of wireless communications systems 100 and/or 200. Process flow 300 may include a UE 115-c, which may be an example of a UE 115 as described herein. Process flow 300 may also include a base station 105-c and a base station 105-d, which may be examples of a base station 105 as described herein. Additionally, process flow 300 may illustrate a scenario where UE 115-c (e.g., a victim wireless device) experiences a CLI based on one or more signals to or from base station 105-d (e.g., an aggressor wireless device). In some cases, base station 105-c may be a serving cell for UE 115-c and configure a CLI measurement procedure for UE 115-c. Although, process flow 300 shows base station 105-d as the aggressor wireless device, it is to be understood that any wireless device may cause the CLI. For example, a UE 115, an interfering cell, or any wireless device connected to the interfering cell may cause the CLI at UE 115-c. As shown, the CLI measurement procedure (e.g., a CLI management procedure) may occur in three phases, a detect and trigger CLI management 355, a CLI-RS transmission and measurement 360, and a CLI elimination 365.

[0143] At 305, as part of the detect and trigger CLI management 355, UE 115-c may detect a strong interference (e.g., CLI). Subsequently at 310, UE 115-a may report the interference to base station 105-c (e.g., the serving cell for UE 115-c). Accordingly, based on the reported interference, base station 105-c may trigger a CLI management procedure (e.g.,

the CLI measurement procedure, the CLI-RS transmission and measurement 360, etc.). At 320, base station 105-c may transmit a notification to potential aggressors for performing the CLI management procedure. In some cases, the potential aggressors may include interfering cells, UEs 115, base stations 105 (e.g., base station 105-d), or a combination thereof that are causing the CLI (e.g., strong interference) on downlink resources of UE 115-c.

[0144] After triggering the CLI management procedure and notifying the potential aggressors, the system may enter the CLI-RS transmission and measurement 360 that may include four or more messages exchanged between the different wireless devices. At 325, base station 105-d (e.g., or other potential aggressors) may feedback a configuration to base station 105-c. In some cases, the configuration that base station 105-d feedbacks or transmits to base station 105-c may include a current TDD configuration base station 105-d is using for communications with its own serving cell or a corresponding aggressor UE 115. At 330, base station 105-c may then transmit a message to UE 115-c to indicate a configuration for UE 115-c to perform a CLI measurement. In some cases, the configuration for the CLI measurement may be based on the current TDD configuration that base station 105-d transmitted to base station 105-c. For example, base station 105-c may indicate for UE 115-c to perform the CLI measurement on one or more downlink subframes that correspond to and occur at the same time as one or more uplink subframes of the TDD configuration transmitted by base station 105-d.

[0145] At 335, after configuring UE 115-c to perform the CLI measurement, base station 105-c may trigger UE 115-c to perform the CLI measurement. At 340, base station 105-d (e.g., the interfering cell, the aggressor cell, etc.) may then transmit one or more CLI-RSs to enable UE 115-c to measure a strength of the CLI (e.g., via an RSRP or RSSI measurement). In some cases, the resources used to transmit the CLI-RS may include time-domain resources, frequency-domain resources, a sequence for the CLI-RS (e.g., a non-zero power (NZP) sequence), or a combination thereof. Additionally, the CLI-RSs transmitted by base station 105-d may be intended specifically for an RSRP or RSSI measurement. In some cases, alternatively, base station 105-d may transmit an uplink SRS transmission for UE 115-c to measure the strength of the CLI, where base station 105-d is confirmed to be an interfering cell (e.g., or aggressor base station 105) based on uplink SRS transmissions. Subsequently, at 345, UE 115-c may measure the one or more CLI-RSs to determine the strength of the CLI. In some cases, UE 115-c may base its measurement of the one or more CLI-RSs on a CSI-RS

mechanism. At 345, UE 115-c may then measure the one or more CLI-RSs to determine the strength of the CLI (e.g., RSRP or RSSI measurement). Accordingly, at 350, UE 115-c may report the measurement to base station 105-c to then enable CLI elimination 365.

[0146] During CLI elimination 365, the network (e.g., base station 105-c, serving cell, etc.) may use the strength measurement reported at 350 to determine whether the CLI (e.g., UE-to-UE CLI) is causing too much performance degradation at UE 115-c or whether UE 115-c can handle more interference. In some cases, the network may determine that UE 115-c can handle more interference from the CLI and implement more aggressive TDD configurations for one or more of its cells. The more aggressive TDD configurations may introduce more overlapping symbols and more CLI, but possibly higher throughput may be achieved. In some cases, the network may determine that the interference from the CLI affects the downlink reception at UE 115-c too much, and the network may implement less aggressive TDD configurations for one or both of the cells. The less aggressive TDD configurations may reduce the number of overlapping symbols and reduce the CLI, which may improve channel conditions for the victim UE 115. In some examples, the determinations may be based on a threshold or a tolerance. For example, if the channel quality, RSRP, RSSI, or another measurement metric, at the victim UE 115 is below a threshold, the serving cell of the victim UE 115 may implement a less aggressive TDD configuration. In some cases, one or more of the base stations 105 may make the determination of whether to use a more aggressive or less aggressive TDD configuration. Additionally, or alternatively, a control unit (CU), a gNB, or some other entity may make the determination for the one or more TDD configurations based on the measurements.

[0147] However, as described above, UE 115-c may report one measurement as part of the CLI management procedure during the CLI-RS transmission and measurement 360 phase. For example, UE 115-c may report an RSSI measurement or an RSRP measurement of corresponding CLI-RSs for either measurement to indicate the strength of the detected CLI (e.g., CLI strength, strength measurement, etc.). Accordingly, this CLI management procedure that includes reporting one signal strength measurement for the CLI may lead to an inefficient use of resources to detect the CLI-RSs and measure the corresponding RSRP value for the CLI strength or may lead to a less accurate measurement of the CLI-RSs to measure a corresponding RSSI value for the CLI strength. In some cases, UE 115-c may measure an RSRP on corresponding CLI-RSs (e.g., reference signals configured for an RSRP

measurement), but base station 105-c may determine that the CLI strength is below a threshold value during the CLI elimination 365 phase, indicating that the CLI may not be strong enough to significantly affect downlink reception at UE 115-c. However, since UE 115-c had to identify a location of the corresponding CSI-RSs in order to measure the RSRP value to determine the CLI strength, a greater number of resources may have been used at UE 115-c for this CLI management procedure unnecessarily since the CLI strength resulted in being of a lower impact at UE 115-c.

[0148] Additionally or alternatively, UE 115-c may measure an RSSI on corresponding CLI-RSs (e.g., reference signals configured for an RSSI measurement), where base station 105-c may determine that the CLI strength is above or below the threshold value during the CLI elimination 365 phase based on the RSSI measurement. However, due to the less accurate nature of the RSSI measurement (e.g., the RSSI measurement includes a power estimation for all signals received in one or more OFDM symbols), UE 115-c may inaccurately report the CLI strength, leading base station 105-c to perform a counter-productive mitigation action during CLI elimination 365. For example, the RSSI measurement may indicate the CLI strength affects downlink reception at UE 115-c when, in actuality, the CLI strength is of less consequence. Accordingly, base station 105-c may schedule a less aggressive TDD configuration for UE 115-c unnecessarily to mitigate the CLI based on this RSSI measurement when UE 115-c may actually be able to handle more interference. Alternatively, the RSSI measurement may indicate the CLI strength does not affect downlink reception at UE 115-c when, in actuality, the CLI strength is of greater consequence to UE 115-c. Accordingly, base station 105-c may schedule a more aggressive TDD configuration for UE 115-c to take advantage of the more interference UE 115-c can handle based on the reported RSSI measurement, when the more aggressive TDD configuration may actually further the issues caused by the CLI.

[0149] Therefore, using one CLI measurement value over other available CLI measurement values may lead to an incorrect mitigation procedure employed by base station 105-c (e.g., or other serving cells) for UE 115-c (e.g., or other victim UEs 115). As described herein, techniques are described where UE 115-c, base station 105-c, and base station 105-d may utilize a CLI measurement procedure that combines two or more signal characteristics (e.g., RSRP measurements, RSSI measurements, SINR measurements, etc.) in two or more steps to transmit reference signals (e.g., CLI-RSs), measures the signal characteristics on the

transmitted reference signals, and determines a CLI strength (e.g., CLI value) based on the measured signal characteristics in each step of the CLI measurement procedure. Base station 105-c may then perform a subsequent mitigation procedure after determining the CLI strength through the two or more steps. In some cases, the two or more steps may include an extensible periodicity for transmitting the reference signals and measuring the signal characteristics.

[0150] FIG. 4 illustrates an example of a process flow 400 that supports two-stage CLI transmission and measurement in accordance with aspects of the present disclosure. In some examples, process flow 400 may implement aspects of wireless communications systems 100 and/or 200. Process flow 400 may include a UE 115-d, which may be an example of a UE 115 as described herein. Process flow 400 may also include a base station 105-e and a base station 105-f, which may be examples of a base station 105 as described herein. Additionally, process flow 400 may illustrate a scenario where UE 115-d (e.g., a victim wireless device) experiences a CLI based on one or more signals to or from base station 105-f (e.g., an aggressor wireless device). In some cases, base station 105-e may be a serving cell (e.g., or victim cell) for UE 115-d and configure a CLI measurement procedure for UE 115-d. Although, process flow 400 shows base station 105-f as the aggressor wireless device, it is to be understood that any wireless device may cause the CLI. For example, a UE 115, an interfering cell, or any wireless device connected to the interfering cell may cause the CLI at UE 115-d. As described herein, process flow 400 may utilize a CLI measurement procedure, where CLI-RS transmissions and measurements are divided into two stages 405 (e.g., steps). Accordingly, actions performed by both aggressor wireless devices (e.g., base station 105-f, aggressor UEs 115 connected to base station 105-f, etc.) and victim wireless devices (e.g., UE 115-d, base station 105-e, etc.) may be divided into the two stages 405, a first stage 405-a and a second stage 405-b.

[0151] As shown, process flow 400 may include a CLI transmission and measurement 360-a phase of the CLI measurement procedure (e.g., CLI management procedure) as described above with reference to the CLI transmission and measurement 360 in FIG. 3. Additionally, CLI transmission and measurement 360-a may be performed in conjunction with a detect and trigger CLI management 355 and CLI elimination 365 as described above with reference to FIG. 3.

[0152] At 410, base station 105-e may transmit a trigger to UE 115-d for configuring UE 115-d to perform a CLI measurement. In some cases, this trigger may correspond to the first stage 405-a of the CLI measurement procedure. Additionally, the first stage 405-a may include a first CLI-RS transmission and measurement opportunity, where any potential
5 aggressor cell and UE 115 may transmit a CLI-RS for an RSSI measurement. Accordingly, at 415, as part of the first stage 405-a and within the first CLI-RS transmission and measurement opportunity, base station 105-f may transmit one or more CLI-RSs configured for an RSSI measurement (e.g., a first reference signal). Subsequently, at 420 and still during the first stage 405-a, UE 115-d may perform a measurement of the transmitted CLI-RS to
10 determine a value for one or more RSSIs 402 (e.g., a first signal quality characteristic, an SINR value, etc.) of the CLI. For example, a CLI-RS transmission and measurement for an RSSI 402-a may occur in the first stage 405-a, where base station 105-f transmits a corresponding CLI-RS and UE 115-d measures an RSSI value for the CLI-RS to determine a strength of the CLI. Additionally or alternatively, additional CLI transmissions and
15 measurements for an RSSI 402-b and an RSSI 402-c may occur in the first stage 405-a, where additional aggressor wireless devices (e.g., or base station 105-f) may transmit additional CLI-RSs for UE 115-d to measure a corresponding RSSI value on the additional CSI-RSs.

[0153] At 425, UE 115-d may then report the measurement(s) of the RSSI value(s) to
20 base station 105-e. Accordingly, base station 105-e (e.g., the serving cell) may set a threshold value (e.g., or a condition) for determining if each RSSI value measurement warrants the second stage 405-b for a CLI-RS transmission and measurement opportunity to determine a respective CLI strengths associated with each RSSI value. In some cases, base station 105-e (e.g., or the network) may determine the threshold value based on a value distribution (e.g., a
25 set of RSSI values, where the threshold value separates higher RSSI values that warrant a closer examination over lower RSSI values). For example, base station 105-e may select RSSI values that exceed the threshold value for the second stage 405-b (e.g., or SINR values of the CLI-RSs that are lower than a corresponding threshold on interfered symbols).

[0154] At the end of the first stage 405-a, base station 105-c may then extract which
30 aggressor cells and UEs exceed the threshold value (e.g., or meet the condition). For example, as shown, base station 105-c may determine that the RSSI value reported for CLI-RS transmission and measurement for RSSI 402-a exceeds the threshold value and extract the

corresponding aggressor wireless device (e.g., base station 105-f) for the second stage 405-b. Additionally, base station 105-e may determine that the RSSI value reported for CLI-RS transmission and measurement for RSSI 402-b may also exceed the threshold value and extract the corresponding aggressor wireless device (e.g., an additional base station 105, an aggressor UE 115, etc.) for the second stage 405-b. However, for CLI-RS transmission and measurement for RSSI 402-c, base station 105-e may determine that the corresponding RSSI value does not exceed (e.g., is less than) the threshold value, and base station 105-e may not select the corresponding aggressor wireless device for the second stage 405-b.

[0155] At 430 and 435, base station 105-e (e.g., serving cell, victim cell, etc.) may initiate the second stage 405-b by triggering the extracted aggressor cells and UEs 115 to transmit a CLI-RS for an RSRP measurement at UE 115-d. For example, the CLI-RS transmission and measurement opportunity within the second stage 405-b may include CLI-RS transmissions and measurements for one or more RSRPs 403. In some cases, at 430 and 435, base station 105-e may indicate which time resources, frequency resources, sequence, or a combination thereof to use for transmitting the CLI-RSs for the RSRP measurement. Accordingly, base station 105-e may transmit this indication to both base station 105-f (e.g., and any additional aggressor wireless devices extracted based on the first RSSI measurements) and UE 115-d (e.g., or any additional victim wireless devices) to enable both the CLI-RS transmission and measurement for the RSRP. Additionally, the triggers for the RSRP measurement may include an indication for the CLI-RS transmission and corresponding RSRP measurement to occur in a next measurement period (e.g., second stage 405-b).

[0156] Accordingly, based on the transmitted trigger at 430, at 440, the extracted aggressor cells may transmit CLI-RSs (e.g., second reference signal(s)) configured for the RSRP measurement at UE 115-d. For example, base station 105-f may transmit a CLI-RS for the RSRP measurement in a CLI-RS transmission and measurement for an RSRP 403-a. Additionally, an additional aggressor wireless device (e.g., a UE 115, aggressor cell, interfering cell, base station 105-f, etc.) may also transmit a CLI-RS for the RSRP measurement in a CLI-RS transmission and measurement for RSRP 403-b. In some cases, CLI-RS transmission and measurement for RSRP 403-a and 403-b in the second stage 405-b may correspond to the CLI-RS transmission and measurement for RSSI 402-a and 402-b. For example, base station 105-f and the additional aggressor wireless device may transmit the

respective CLI-RSs in each stage 405 on a same set of frequency resources, using a same sequence, or a combination thereof.

[0157] At 445, UE 115-d may measure the transmitted CLI-RSs to determine an RSRP value (e.g., a second signal characteristic) for the CLIs from each aggressor wireless device in the corresponding CLI-RS transmissions and measurements for RSRPs 403. In some cases, UE 115-d may use the indicated resources and sequences transmitted with the trigger for the RSRP measurements at 435 in order to detect and measure the CLI-RSs for the RSRP measurement. Subsequently, at 450, UE 115-d may report the RSRP measurements to base station 105-e. Base station 105-e may then perform a CLI elimination 365 as described above with reference to FIG. 3 based on the RSRP measurements, RSSI measurements, or a combination thereof.

[0158] As shown in process flow 400, an initial CLI-RS transmission and measurement stage may be performed for determining an RSSI value that utilizes fewer resources than for determining an RSRP value. Based off the threshold value, base station 105-e may determine which potential aggressor wireless devices may need to be further analyzed via an RSRP measurement. The RSRP measurement may provide a more accurate measurement (e.g., in comparison to the RSSI value) of whether each potential aggressor wireless device is an actual aggressor wireless device that negatively affects downlink reception at UE 115-d greater than an interference level that UE 115-d is capable of handling. Therefore, the potential aggressor wireless device(s) may transmit one or more CLI-RSs for an RSRP measurement, and UE 115-d may measure an RSRP value for the corresponding CLI-RSs. By performing a two-stage process in both CLI-RS transmissions and measurements that utilizes both RSSI measurements and RSRP measurements (e.g., a partial base station 105/UE 115 and resource utilization for an RSRP transmission and measurement) as shown in process flow 400, both a victim side (e.g., UE 115-d, additional victim wireless devices, etc.) and an aggressor side (e.g., base station 105-f, additional aggressor wireless devices, etc.) may save resources for a CLI measurement or management procedure, while still providing an accurate indication of which wireless devices are aggressors to the victim wireless device. However, process flow 400 may include additional steps and actions for both the victim and aggressor sides of the CLI measurement procedure, which may result in a higher number of messages and configurations transmitted between the different wireless devices.

[0159] FIG. 5 illustrates an example of a process flow 500 that supports two-stage CLI transmission and measurement in accordance with aspects of the present disclosure. In some examples, process flow 500 may implement aspects of wireless communications systems 100 and/or 200. Process flow 500 may include a UE 115-e, which may be an example of a UE 115 as described herein. Process flow 500 may also include a base station 105-g and a base station 105-h, which may be examples of a base station 105 as described herein. Additionally, process flow 500 may illustrate a scenario where UE 115-e (e.g., a victim wireless device) experiences a CLI based on one or more signals to or from base station 105-h (e.g., an aggressor wireless device). In some cases, base station 105-g may be a serving cell (e.g., or victim cell) for UE 115-e and configure a CLI measurement procedure for UE 115-e. Although process flow 500 shows base station 105-h as the aggressor wireless device, it is to be understood that any wireless device may cause the CLI. For example, a UE 115, an interfering cell, or any wireless device connected to the interfering cell may cause the CLI at UE 115-e. As described herein, process flow 500 may utilize a CLI measurement procedure, where CLI-RS measurements are divided into two stages 505 (e.g., steps). Accordingly, actions performed by victim wireless devices (e.g., UE 115-d, base station 105-e, etc.) may be divided into the two stages 505, a first stage 505-a and a second stage 505-b.

[0160] As shown, process flow 500 may include a CLI transmission and measurement 360-b phase of the CLI measurement procedure (e.g., CLI management procedure) as described above with reference to the CLI transmission and measurement 360 as described above with reference to FIG. 3. Additionally, CLI transmission and measurement 360-b may be performed in conjunction with a detect and trigger CLI management 355 and CLI elimination 365 as described above with reference to FIG. 3.

[0161] As described herein, process flow 500 may include a number of the same operations as process flow 400 as described above with reference to FIG. 4. For example, at 510 base station 105-g may transmit a trigger to UE 115-e for configuring UE 115-e to perform a CLI measurement, and this trigger may correspond to the first stage 505-a of the CLI measurement procedure. However, alternative to the steps discussed with reference to FIG. 4, the first stage 505-a may include a first CLI-RS transmission and measurement opportunity, where any potential aggressor cells and UEs 115 (e.g., aggressor wireless devices) may transmit a CLI-RS for an RSRP measurement. Accordingly, at 515, as part of the first stage 505-a and within the first CLI-RS transmission and measurement opportunity,

base station 105-h may transmit one or more CLI-RSs configured for an RSRP measurement (e.g., a first reference signal). In some cases, the resources (e.g., time and/or frequency resources) and sequence to be used for the CLI-RS transmissions for the RSRP measurement may be indicated to base station 105-h by base station 105-g (e.g., the network, serving cell, etc.).

[0162] At 520 and still during the first stage 505-a, UE 115-e may then perform a measurement of the transmitted CLI-RS to determine a value for one or more RSSIs 502 (e.g., a first signal quality characteristic, an SINR value, etc.) of the CLI even though the aggressor wireless devices transmitted a CLI-RS for an RSRP measurement. For example, a CLI-RS measurement for an RSSI 502-a may occur in the first stage 505-a, where base station 105-h transmits a CLI-RS for an RSRP measurement, but UE 115-e measures an RSSI value for the CLI-RS to determine a less accurate strength of the CLI. Additionally or alternatively, additional CLI-RS measurements for an RSSI 502-b and for an RSSI 502-c may occur in the first stage 505-a, where additional aggressor wireless devices (e.g., or base station 105-h) may transmit additional CLI-RSs for an RSRP measurement and UE 115-e measures an RSSI value on the additional CLI-RSs.

[0163] At 525, UE 115-e may then report the measurement(s) of the RSSI value(s) to base station 105-g. Accordingly, base station 105-g (e.g., the serving cell) may set a threshold value (e.g., or a condition) for determining if each RSSI value measurement warrants a second stage 505-b for a CLI-RS transmission and measurement opportunity to determine a respective CLI strengths associated with each RSSI value. In some cases, base station 105-g (e.g., or the network) may determine the threshold value based on a value distribution (e.g., a set of RSSI values, where the threshold separates higher RSSI values that warrant a closer examination over lower RSSI values). For example, base station 105-g may select RSSI values that exceed the threshold value for the second stage 505-b (e.g., or SINR values of the CLI-RSs that are lower than a corresponding threshold on interfered symbols).

[0164] At the end of the first stage 505-a, base station 105-c may then extract which aggressor cells and UEs exceed the threshold value (e.g., or meet the condition). For example, as shown, base station 105-c may determine that the RSSI value reported for CLI-RS measurement for RSSI 502-a exceeds the threshold value and extract the corresponding aggressor wireless device (e.g., base station 105-h) for the second stage 505-b. Additionally,

base station 105-g may determine that the RSSI value reported for CLI-RS measurement for RSSI 502-b may also exceed the threshold value and extract the corresponding aggressor wireless device (e.g., an additional base station 105, an aggressor UE 115, etc.) for the second stage 505-b. However, for CLI-RS measurement for RSSI 502-c, base station 105-g may
5 determine that the corresponding RSSI value does not exceed (e.g., is less than) the threshold value, and base station 105-g may not select the corresponding aggressor wireless device for the second stage 505-b.

[0165] At 535, base station 105-g (e.g., serving cell, victim cell, etc.) may initiate the second stage 505-b by triggering UE 115-e to receive a CLI-RS for an RSRP measurement
10 from the extracted aggressor wireless devices. For example, the CLI-RS transmission and measurement opportunity within the second stage 505-b may include CLI-RS measurements for one or more RSRPs 503. In some cases, at 530, base station 105-g may indicate which time resources, frequency resources, sequence, or a combination thereof that the CLI-RSs for the RSRP measurement are to be received on. Accordingly, base station 105-g may transmit
15 this indication to UE 115-e (e.g., or any additional victim wireless devices) to enable the CLI-RS measurement for the RSRP. Additionally, the trigger for the RSRP measurement may include an indication for the CLI-RS RSRP measurement to occur in a next measurement period (e.g., second stage 505-b).

[0166] Accordingly, based on the transmitted trigger at 535, at 540, UE 115-e may detect
20 and measure transmitted CLI-RSs from the extracted aggressor cells (e.g., second reference signal(s)) to determine an RSRP measurement. For example, base station 105-h may transmit a CLI-RS for the RSRP measurement in a CLI-RS measurement for an RSRP 503-a based on an initial configuration used in the first stage 505-a. Additionally, an additional aggressor wireless device (e.g., a UE 115, aggressor cell, interfering cell, base station 105-h, etc.) may
25 also transmit a CLI-RS for the RSRP measurement in a CLI-RS measurement for an RSRP 503-b based on an initial configuration used in the first stage 505-a. Accordingly, UE 115-e may use the indicated resources and sequences transmitted with the trigger for the RSRP measurements at 535 in order to detect and measure the CLI-RSs for the RSRP measurement.

[0167] In some cases, CLI-RS measurement for RSRP 503-a and 503-b in the second
30 stage 505-b may correspond to the CLI-RS measurement for RSSI 502-a and 502-b. For example, base station 105-h and the additional aggressor wireless device may transmit the

respective CLI-RSs in each stage 505 on a same set of frequency resources, using a same sequence, or a combination thereof. Additionally, even though UE 115-c is not monitoring resources of a CLI-RS measurement for RSRP 503-c that corresponds to the CLI-RS measurement for RSSI 502-c, the corresponding aggressor wireless device may still transmit the CLI-RSs for an RSRP measurement. However, since the aggressor wireless device was not extracted based on the RSSI measurement not exceeding the threshold, UE 115-e may refrain from detecting the corresponding CSI-RSs and measuring an RSRP for the CSI-RSs. Subsequently, at 550, UE 115-e may report the RSRP measurements to base station 105-g. Base station 105-g may then perform a CLI elimination 365 as described above with reference to FIG. 3 based on the RSRP measurements, RSSI measurements, or a combination thereof.

[0168] As shown in process flow 500, aggressor wireless devices may be configured to transmit CLI-RSs for an RSRP measurement regardless of a measurement performed by any victim wireless device. However, an initial CLI-RS measurement stage may be performed for determining an RSSI value that utilizes fewer resources than for determining an RSRP value. Based off the threshold value, base station 105-g may determine which potential aggressor wireless devices may need to be further analyzed via an RSRP measurement. The RSRP measurement may provide a more accurate measurement (e.g., in comparison to the RSSI value) of whether each potential aggressor wireless device is an actual aggressor wireless device that negatively affects downlink reception at UE 115-e greater than an interference level that UE 115-e is capable of handling. Therefore, UE 115-e may measure an RSRP value for CLI-RSs in a subsequent stage based on the CLI-RSs that the aggressor wireless devices are configured to transmit. By performing a two-stage process in the CLI-RS measurement process that utilizes both RSSI measurements and RSRP measurements (e.g., a partial base station 105/UE 115 and resource utilization for an RSRP measurement) as shown in process flow 500, a victim side (e.g., UE 115-e, additional victim wireless devices, etc.) may save resources for a CLI measurement or management procedure, while reducing the number of additional actions and configuration transmission at an aggressor side. However, process flow 500 may still include additional steps and actions for the victim side of the CLI measurement procedure while not saving resources on the aggressor side (e.g., transmit side).

[0169] FIG. 6 illustrates an example of a process flow 600 that supports two-stage CLI transmission and measurement in accordance with aspects of the present disclosure. In some

examples, process flow 600 may implement aspects of wireless communications systems 100 and/or 200. Process flow 600 may include a UE 115-f, which may be an example of a UE 115 as described herein. Process flow 600 may also include a base station 105-i and a base station 105-j, which may be examples of a base station 105 as described herein. Additionally, process flow 600 may illustrate a scenario where UE 115-f (e.g., a victim wireless device) experiences a CLI based on one or more signals to or from base station 105-j (e.g., an aggressor wireless device). In some cases, base station 105-i may be a serving cell (e.g., or victim cell) for UE 115-f and configure a CLI measurement procedure for UE 115-f. Although, process flow 600 shows base station 105-j as the aggressor wireless device, it is to be understood that any wireless device may cause the CLI. For example, a UE 115, an interfering cell, or any wireless device connected to the interfering cell may cause the CLI at UE 115-f. As described herein, process flow 600 may utilize a periodic CLI measurement procedure, where CLI-RS transmissions and measurements are divided into two or more stages 605 (e.g., steps) in the time domain, such as a first stage 605-a, a second stage 605-b, a third stage 605-c, and a fourth stage 605-d.

[0170] As shown, process flow 600 may include a CLI transmission and measurement 360-c phase of the CLI measurement procedure (e.g., CLI management procedure) as described above with reference to the CLI transmission and measurement 360 as described above with reference to FIG. 3. Additionally, CLI transmission and measurement 360-c may be performed in conjunction with a detect and trigger CLI management 355 and CLI elimination 365 as described above with reference to FIG. 3.

[0171] As described herein, process flow 600 may include a number of the same operations as process flows 400 and 500 as described above with reference to FIGs. 4 and 5. For example, as part of the first stage 605-a of the CLI measurement procedure, at 610, base station 105-i may transmit a trigger to UE 115-f for configuring UE 115-f to perform a CLI measurement. Subsequently, at 615 and 620, base station 105-j may transmit a first CLI-RS (e.g., first reference signal), and UE 115-f may measure a first signal characteristic (e.g., RSRP, RSSI, SINR, etc.) of the first CLI-RS. At 625, UE 115-f may report the measured signal characteristics to base station 105-i, which may then extract any aggressor cells (e.g., aggressor wireless devices) whose first signal characteristic does not meet a condition (e.g., is above a threshold value, below a threshold value, etc.). Based on the extracted aggressor wireless devices, base station 105-i may initiate the second stage 605-b of the CLI

measurement procedure based on triggers sent at 630 and 635. During the second stage 605-b, potential aggressor wireless devices may transmit a second CLI-RS (e.g., second reference signal) at 640, and UE 115-f may measure a second signal characteristic of the second CLI-RS at 645. Subsequently, at 650, UE 115-f may report the second signal characteristic measurements to base station 105-i to enable a CLI elimination 365 as described above with reference to FIG. 3.

[0172] However, alternative to process flows 400 and 500, in the first stage 605-a of the CLI measurement procedure, base station 105-i (e.g., or the network, a separate serving cell, etc.) may configure a first set of the aggressor wireless devices (e.g., aggressor cells and UEs 115) to transmit a CLI-RS for an RSSI measurement and a second set of the aggressor wireless devices to transmit a CLI-RS for an RSRP measurement, both at 615. In some cases, base station 105-i may determine which CLI-RS for which measurement each aggressor wireless device transmits via a random selection, based on previous measurements. or some other selection process. Accordingly, at 620, UE 115-f (e.g., or other victim UEs 115) may measure a corresponding RSSI value (e.g., or SINR value) and/or RSRP value based on the configurations of the different aggressor wireless devices. For example, UE 115-f may measure an RSSI value for CLI-RSs transmitted for an RSSI measurement and an RSRP value for CLI-RSs transmitted for an RSRP measurement.

[0173] Accordingly, when extracting the aggressor cells, base station 105-i may set a single threshold (e.g., or a condition). In some cases, base station 105-i may base the single threshold value on a value (e.g., 10%) distribution of the reported RSSI values. Base station 105-i may then use this single threshold value to trigger the aggressor wireless devices and victim wireless devices to keep or change the respective CLI-RS transmissions and measurements for RSSI or CLI-RS transmissions and measurements for RSRP from the first stage 605-a to the second stage 605-b. For example, if an RSSI value in the first stage 605-a exceeds the threshold value, the corresponding aggressor wireless device may switch to transmitting a CLI-RS for an RSRP measurement in the second stage 605-b. Alternatively, if the RSSI value in the first stage 605-a does not exceed the threshold value, the corresponding aggressor wireless device may continue to transmit the CLI-RS for an RSSI measurement in the second stage 605-b. Similarly, if an RSRP value in the first stage 605-a is below the threshold value, the corresponding aggressor wireless device may switch to transmitting a CLI-RS for an RSSI measurement in the second stage 605-b, and if the RSRP value in the

first stage 605-a is above the threshold value, the corresponding aggressor wireless device may continue to transmit the CLI-RS for the RSRP measurement in the second stage 605-b.

[0174] Since the RSRP transmissions and measurements require a higher number of resources to accommodate, the aggressor wireless devices and victim wireless devices may save resources by switching to the CLI-RS transmission and measurement for an RSSI value. As such, if an RSRP value is below the threshold value, it may indicate to base station 105-i that the CLI caused by the corresponding aggressor wireless devices is no longer affecting downlink receptions at UE 115-f, and, as such, base station 105-i may trigger a switch to the CLI-RS transmission and measurement for an RSSI value for the aggressor wireless devices and victim wireless devices.

[0175] Additionally, the techniques described in process flow 600 may be extended to more than the first stage 605-a and the second stage 605-b. For example, as shown, a first CLI-RS transmission and measurement for an RSRP 602-a, a second CLI-RS transmission and measurement for an RSRP 602-b, and a first CLI-RS transmission and measurement for an RSSI 602-c in the first stage 605-a may become a first CLI-RS transmission and measurement for an RSSI 603-a, a first CLI-RS transmission and measurement for an RSRP 603-b, and a second CLI-RS transmission and measurement for an RSSI 603-c, respectively, in the second stage 605-b (e.g., the configuration for the second CLI-RS transmission and measurement for RSRP 602-b was kept, while the first CLI-RS transmission and measurement for RSRP 602-a and the first CLI-RS transmission and measurement for RSSI 602-c were changed). The process may then be extended to the third stage 605-c and the fourth stage 605-d, where CLI-RS transmissions and measurements for RSSIs and RSRPs 603 of the second stage 605-b may be kept or changed for CLI-RS transmissions and measurements for RSSIs and RSRPs 612 of the third stage 605-c, which may be then kept or changed based on corresponding signal characteristic measurements for CLI-RS transmissions and measurements for RSSIs and RSRPs 613 of the fourth stage 605-d.

[0176] Similar to the two stage CLI measurement procedures as described above with reference to FIGs. 4 and 5, each of the CLI-RS transmissions and measurements for RSSI or RSRP in each stage 605 may correspond to a respective CLI-RS transmissions and measurements for RSSI or RSRP in a subsequent stage 605. For example, CLI-RS transmissions and measurements for RSSI or RSRP 602-a in the first stage 605-a, 603-a in

the second stage 605-b, 612-a in the third stage 605-b, and 613-a in the fourth stage 605-d may each be located on a same set of frequency resources and/or according to a same sequence across the stages 605. Additionally, while four different stages 605 are shown with reference to process flow 600, it is to be understood that more or fewer stages 605 may occur for the CLI measurement procedure as described herein.

[0177] FIG. 7 illustrates an example of a process flow 700 that supports two-stage CLI transmission and measurement in accordance with aspects of the present disclosure. In some examples, process flow 700 may implement aspects of wireless communications systems 100 and/or 200. Process flow 700 may include a UE 115-g, which may be an example of a UE 115 as described herein. Process flow 700 may also include a base station 105-k and a base station 105-l, which may be examples of a base station 105 as described herein. Additionally, process flow 700 may illustrate a scenario where UE 115-g (e.g., a victim wireless device) experiences a CLI based on one or more signals to or from base station 105-l (e.g., an aggressor wireless device). In some cases, base station 105-k may be a serving cell (e.g., or victim cell) for UE 115-g and configure a CLI measurement procedure for UE 115-g. Although, process flow 700 shows base station 105-l as the aggressor wireless device, it is to be understood that any wireless device may cause the CLI. For example, a UE 115, an interfering cell, or any wireless device connected to the interfering cell may cause the CLI at UE 115-g. As described herein, process flow 700 may utilize a periodic CLI measurement procedure, where CLI-RS measurements are divided into two or more stages 705 (e.g., steps) in the time domain, such as a first stage 705-a, a second stage 705-b, a third stage 705-c, and a fourth stage 705-d.

[0178] As shown, process flow 700 may include a CLI transmission and measurement 360-d phase of the CLI measurement procedure (e.g., CLI management procedure) as described above with reference to the CLI transmission and measurement 360 as described above with reference to FIG. 3. Additionally, CLI transmission and measurement 360-d may be performed in conjunction with a detect and trigger CLI management 355 and CLI elimination 365 as described above with reference to FIG. 3.

[0179] As described herein, process flow 700 may include a number of the same operations as process flow 400, 500, and 600 as described above with reference to FIGs. 4, 5, and 6. For example, as part of the first stage 705-a of the CLI measurement procedure, at 710,

base station 105-k may transmit a trigger to UE 115-g for configuring UE 115-g to perform a CLI measurement. Subsequently, at 715 and 720, base station 105-l may transmit a first CLI-RS (e.g., first reference signal), and UE 115-g may measure a first signal characteristic (e.g., RSRP, RSSI, SINR, etc.) of the first CLI-RS. At 725, UE 115-f may report the measured
5 signal characteristics to base station 105-k, which may then extract any aggressor cells (e.g., aggressor wireless devices) whose first signal characteristic does not meet a condition (e.g., is above a threshold value, below a threshold value, etc.). Based on the extracted aggressor wireless devices, base station 105-k may initiate the second stage 705-b of the CLI measurement procedure based on a trigger sent at 735. During the second stage 705-b,
10 potential aggressor wireless devices may transmit a second CLI-RS (e.g., second reference signal), and UE 115-g may measure a second signal characteristic of the second CLI-RS at 740. Subsequently, at 745, UE 115-g may report the second signal characteristic measurements to base station 105-k to enable a CLI elimination 365 as described above with reference to FIG. 3.

15 **[0180]** However, alternative to process flow 600 and similar to process flow 500, in the first stage 705-a, any potential aggressor cells and aggressor UEs 115 (e.g., aggressor wireless devices) may be configured to transmit a CLI-RS for an RSRP measurement. Subsequently, at 710, when transmitting the CLI measurement trigger, base station 105-k may configure UE 115-g (e.g., and/or additional victim wireless devices) to measure for an
20 RSRP value from one set of potential aggressor wireless devices and to measure for an RSSI value from a second set of potential aggressor wireless devices. As such, the aggressor side of the CLI measurement procedure may transmit a same CLI-RS across each stage 705, but base station 105-k may indicate a specific measurement for UE 115-g to perform for each stage 705 based on a measurement from a preceding stage 705. For the first stage 705-a and the
25 initial measurement configurations, base station 105-k may determine which measurement UE 115-g performs via a random selection, based on previous measurements. or some other selection process.

[0181] Similar to process flow 600, the techniques described in process flow 700 may be extended to more than the first stage 705-a and the second stage 705-b (e.g., the third stage
30 705-c and the fourth stage 705-d may also be used), where the same frequency resources and/or sequence for the respective CLI-RS transmissions for RSRP may be utilized across the different stages 705. Additionally, while four different stages 705 are shown with reference to

process flow 700, it is to be understood that more or fewer stages 705 may occur for the CLI measurement procedure as described herein.

[0182] FIG. 8 illustrates an example of a process flow 800 that supports two-stage CLI transmission and measurement in accordance with aspects of the present disclosure. In some examples, process flow 800 may implement aspects of wireless communications systems 100 and/or 200. Process flow 800 may include a UE 115-h, which may be an example of a UE 115 as described herein. Process flow 800 may also include a base station 105-m and a base station 105-n, which may be examples of a base station 105 as described herein. Additionally, process flow 800 may illustrate a scenario where UE 115-h (e.g., a victim wireless device) experiences a CLI based on one or more signals to or from base station 105-n (e.g., an aggressor wireless device). In some cases, base station 105-m may be a serving cell (e.g., or victim cell) for UE 115-h and configure a CLI measurement procedure for UE 115-h. Although, process flow 800 shows base station 105-n as the aggressor wireless device, it is to be understood that any wireless device may cause the CLI. For example, a UE 115, an interfering cell, or any wireless device connected to the interfering cell may cause the CLI at UE 115-h. As described herein, process flow 800 may utilize a CLI measurement procedure, where CLI-RS measurements and transmissions are triggered based on a fixed periodicity and an extensible (e.g., exponential increment) periodicity and occur in two or more stages 805, such as a first stage 805-a, a second stage 805-b, a third stage 805-c, and a fourth stage 805-d.

[0183] As shown, process flow 800 may include a CLI transmission and measurement 360-e phase of the CLI measurement procedure (e.g., CLI management procedure) as described above with reference to the CLI transmission and measurement 360 as described above with reference to FIG. 3. Additionally, CLI transmission and measurement 360-e may be performed in conjunction with a detect and trigger CLI management 355 and CLI elimination 365 as described above with reference to FIG. 3.

[0184] As described herein, process flow 800 may include a number of the same operations as process flow 400, 500, 600, and 700 as described above with reference to FIGs. 4, 5, 6, and 7. For example, as part of the first stage 805-a of the CLI measurement procedure, at 810, base station 105-m may transmit a trigger to UE 115-h for configuring UE 115-h to perform a CLI measurement. Subsequently, at 815 and 820, base station 105-n may transmit a first CLI-RS (e.g., first reference signal), and UE 115-h may measure a first signal

characteristic (e.g., RSRP, RSSI, SINR, etc.) of the first CLI-RS. At 825, UE 115-f may report the measured signal characteristics to base station 105-m, which may then extract any aggressor cells (e.g., aggressor wireless devices) whose first signal characteristic does not meet a condition (e.g., is above a threshold value, below a threshold value, etc.). Based on the extracted aggressor wireless devices, base station 105-m may initiate the second stage 805-b of the CLI measurement procedure based on triggers sent at 830 and 835. During the second stage 805-b, potential aggressor wireless devices may transmit a second CLI-RS (e.g., second reference signal) at 840, and UE 115-h may measure a second signal characteristic of the second CLI-RS at 845. Subsequently, at 850, UE 115-h may report the second signal characteristic measurements to base station 105-m to enable a CLI elimination 365 as described above with reference to FIG. 3.

[0185] However, alternative to process flows 400, 500, 600, and 700, base station 105-m may trigger the CLI-RS measurements at UE 115-h and the CLI-RS transmissions at base station 105-n based on a fixed periodicity, an extensible periodicity, or a combination thereof.

The fixed periodicity may occur when the system (e.g., base station 105-m, the network, a separate serving cell, etc.) sets the CLI-RS measurement and transmission periodicity with a fixed value. The extensible periodicity may indicate that at the beginning of the CLI measurement procedure (e.g., when UE 115-h detects the CLI), the system triggers the CLI-RS with a short or normal cycle (e.g., e.g., a first time $(t_1) = T$). Subsequently, if the measurement of an RSSI value or an RSRP value is lower than a threshold value, the periodicity may be increased to a larger value (e.g., a second time $(t_2) = t_1^2$). Additionally or alternatively, if the measurement of RSSI or RSRP exceeds the threshold value, the periodicity may be reduced to the normal value T or to a smaller value (e.g., $t_2 = t_1^{-2}$).

Accordingly, if the value of the RSSI value or the RSRP value is determined to be below a threshold, the corresponding potential aggressor wireless device may be determined to not be an aggressor wireless device, indicating that a next CLI-RS transmission and measurement for an RSSI value or RSRP value can occur less frequently than if the potential aggressor wireless device were to be determined to be an actual aggressor wireless device and would entail more frequent CLI-RS measurements.

[0186] As shown, the first stage 805-a may include a first CLI-RS transmission and measurement opportunity that occurs at the first time (e.g., t_1 , T , etc.). Subsequently, the measured signal characteristic (e.g., RSSI or RSRP) of the CLI-RS transmitted in the first

CLI-RS transmission and measurement opportunity may fall below the threshold value, such that a second CLI-RS transmission and measurement opportunity in the second stage 805-b may occur at a second time based on a second periodicity (e.g., t_2 , t_1^2 , etc.). Similarly, the measured signal characteristic of the CLI-RS transmitted in the second CLI-RS transmission and measurement opportunity may still fall below the threshold value, and, as such, base station 105-m may determine for base station 105-n to transmit a subsequent CLI-RS during a third CLI-RS transmission and measurement opportunity in the third stage 805-c according to a third time based on a third periodicity greater than the second periodicity (e.g., t_3 , t_2^2 , t_1^4 , etc.). However, the measured signal characteristic of the CLI-RS transmitted in the third CLI-RS transmission and measurement opportunity may exceed the threshold value, and, as such, base station 105-m may revert to the initial periodicity (e.g., t_1 , T , etc.) for a fourth CLI-RS transmission and measurement opportunity in the fourth stage 805-d.

[0187] Each of the CLI-RS transmission and measurement opportunities as described in process flow 800 may include CLI-RSs for an RSRP measurement, CLI-RSs for an RSSI measurement, or a combination thereof as described above with reference to FIGs. 6 and 7. Additionally, while four different stages 805 are shown with reference to process flow 800, it is to be understood that more or fewer stages 805 may occur for the CLI measurement procedure as described herein.

[0188] FIG. 9 illustrates an example of a process flow 900 that supports two-stage CLI transmission and measurement in accordance with aspects of the present disclosure. In some examples, process flow 900 may implement aspects of wireless communications systems 100 and/or 200. Process flow 900 may include a UE 115-i, which may be an example of a UE 115 as described herein. Process flow 900 may also include a base station 105-o and a base station 105-p, which may be examples of a base station 105 as described herein. Additionally, process flow 900 may illustrate a scenario where UE 115-i (e.g., a victim wireless device) experiences a CLI based on one or more signals to or from base station 105-p (e.g., an aggressor wireless device). In some cases, base station 105-o may be a serving cell (e.g., or victim cell) for UE 115-i and configure a CLI measurement procedure for UE 115-i. Although, process flow 900 shows base station 105-p as the aggressor wireless device, it is to be understood that any wireless device may cause the CLI. For example, a UE 115, an interfering cell, or any wireless device connected to the interfering cell may cause the CLI at UE 115-i. As described herein, process flow 900 may utilize a CLI measurement procedure,

where CLI-RS measurements are triggered based on a fixed periodicity and an extensible (e.g., exponential increment) periodicity and occur in two or more stages 905, such as a first stage 905-a, a second stage 905-b, a third stage 905-c, and a fourth stage 905-d.

[0189] As shown, process flow 900 may include a CLI transmission and measurement 360-f phase of the CLI measurement procedure (e.g., CLI management procedure) as described above with reference to the CLI transmission and measurement 360 as described above with reference to FIG. 3. Additionally, CLI transmission and measurement 360-f may be performed in conjunction with a detect and trigger CLI management 355 and CLI elimination 365 as described above with reference to FIG. 3.

[0190] As described herein, process flow 900 may include a number of the same operations as process flow 400, 500, 600, 700, and 800 as described above with reference to FIGs. 4, 5, 6, 7 and 8. For example, as part of the first stage 905-a of the CLI measurement procedure, at 910, base station 105-o may transmit a trigger to UE 115-i for configuring UE 115-i to perform a CLI measurement. Subsequently, at 915 and 920, base station 105-p may transmit a first CLI-RS (e.g., first reference signal), and UE 115-i may measure a first signal characteristic (e.g., RSRP, RSSI, SINR, etc.) of the first CLI-RS. At 925, UE 115-i may report the measured signal characteristics to base station 105-o, which may then extract any aggressor cells (e.g., aggressor wireless devices) whose first signal characteristic does not meet a condition (e.g., is above a threshold value, below a threshold value, etc.). Based on the extracted aggressor wireless devices, base station 105-o may initiate the second stage 905-b of the CLI measurement procedure based on a trigger sent at 935. During the second stage 905-b, potential aggressor wireless devices may transmit a second CLI-RS (e.g., second reference signal), and UE 115-i may measure a second signal characteristic of the second CLI-RS at 940. Subsequently, at 945, UE 115-i may report the second signal characteristic measurements to base station 105-o to enable a CLI elimination 365 as described above with reference to FIG. 3.

[0191] However, alternative to process flow 800, base station 105-o may fix the periodicity of the CLI-RS transmission and measurement opportunities (e.g., transmitting CLI-RSs for measuring an RSSI value and/or RSRP value) from the transmission perspective. However, the measurement perspective of the CLI-RSs to determine the RSSI and/or RSRP values may occur at extensible or fixed periodicity. In some cases, the RSSI and RSRP

measurements may occur at extensible periodicity, while the CLI-RS transmissions for the RSSI and RSRP measurements may occur at a fixed periodicity. Additionally or alternatively, base station 105-o may synchronize the CLI-RS transmissions for the RSSI and RSRP measurements (e.g., at the aggressor wireless devices) to the RSSI and RSRP measurements (e.g., at the victim wireless devices) with a same periodicity.

[0192] As shown, base station 105-p may transmit the CLI-RSs at a fixed periodicity across each stage 905 of the CLI measurement procedure. However, UE 115-i may monitor for the CLI-RSs based on an extendible periodicity based on the CLI-RS measurements from a previous stage 905 as described above with reference to FIG. 8. In some cases, the first stage 905-a may include an initial periodicity configured for UE 115-i and base station 105-p.

[0193] FIG. 10 shows a diagram 1000 of a device 1005 that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure. The device 1005 may be an example of aspects of a UE 115 or base station 105 as described herein. The device 1005 may include a receiver 1010, a communications manager 1015, and a transmitter 1020. The device 1005 may also include a processor. Each of these components may be in communication with one another (e.g., via one or more buses).

[0194] Receiver 1010 may receive information such as packets, user data, or control information associated with various information channels (e.g., control channels, data channels, and information related to two stage CLI transmission and measurement, etc.). Information may be passed on to other components of the device 1005. The receiver 1010 may be an example of aspects of the transceiver 1320 or 1420 as described with reference to FIGs. 13 and 14. The receiver 1010 may utilize a single antenna or a set of antennas.

[0195] The communications manager 1015 may receive, from a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure. Additionally, the communications manager 1015 may receive, from a second wireless device (e.g., an aggressor wireless device), a first reference signal during a first measurement period of the CLI measurement procedure. In some cases, the communications manager 1015 may measure a first signal characteristic of the first reference signal. Additionally, the communications manager 1015 may receive, from the second wireless device, a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of the first signal characteristic to a threshold value. In some cases,

the communications manager 1015 may measure a second signal characteristic of the second reference signal, the second signal characteristic different from the first signal characteristic. Accordingly, the communications manager 1015 may determine a CLI value based on the second signal characteristic.

5 **[0196]** Additionally or alternatively, the communications manager 1015 may receive a configuration to transmit reference signals of a CLI measurement procedure. Accordingly, the communications manager 1015 may transmit, to a first wireless device (e.g., a victim wireless device) in a first serving cell, a first reference signal during a first measurement period of the CLI measurement procedure. In some cases, the communications manager 1015
10 may identify resources to use to transmit a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of a first signal characteristic of the transmitted first reference signal to a threshold value, and transmit, to the first wireless device using the identified resources, the second reference signal for measurement of a second signal characteristic during the second measurement period. The
15 communications manager 1015 may be an example of aspects of the communications manager 1310 or 1410 as described herein.

[0197] In some examples, the communications manager 1015 as described herein may be implemented to realize one or more potential advantages for a wireless device, such as a UE 115 (e.g., or a base station 105). For example, by performing a CLI measurement procedure
20 in two or more steps where two or more signal characteristics are measured, the communications manager 1015 may enable the UE 115 to more efficiently measure the CLI and provide the measurements to a network device (e.g., a base station 105). The CLI measurement procedure may include a more efficient use of resources (e.g., when measuring an RSSI of the CLI) while also providing a more accurate measurement of the CLI (e.g.,
25 when measuring an RSRP of the CLI). Accordingly, based on the accurate measurements of the CLI while using the resources efficiently for the measurements, the network device may manage or mitigate the CLI more efficiently.

[0198] The communications manager 1015, or its sub-components, may be implemented in hardware, code (e.g., software or firmware) executed by a processor, or any combination
30 thereof. If implemented in code executed by a processor, the functions of the communications manager 1015, or its sub-components may be executed by a general-purpose processor, a

digital signal processor (DSP), an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described in the present disclosure.

5 **[0199]** The communications manager 1015, or its sub-components, may be physically located at various positions, including being distributed such that portions of functions are implemented at different physical locations by one or more physical components. In some examples, the communications manager 1015, or its sub-components, may be a separate and distinct component in accordance with various aspects of the present disclosure. In some
10 examples, the communications manager 1015, or its sub-components, may be combined with one or more other hardware components, including but not limited to an input/output (I/O) component, a transceiver, a network server, another computing device, one or more other components described in the present disclosure, or a combination thereof in accordance with various aspects of the present disclosure.

15 **[0200]** Transmitter 1020 may transmit signals generated by other components of the device 1005. In some examples, the transmitter 1020 may be collocated with a receiver 1010 in a transceiver module. For example, the transmitter 1020 may be an example of aspects of the transceiver 1320 or 1420 as described with reference to FIGs. 13 and 14. The transmitter 1020 may utilize a single antenna or a set of antennas.

20 **[0201]** **FIG. 11** shows a diagram 1100 of a device 1105 that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure. The device 1105 may be an example of aspects of a device 1005, a UE 115, or a base station 105 as described herein. The device 1105 may include a receiver 1110, a communications manager 1115, and a transmitter 1160. The device 1105 may also include a processor. Each
25 of these components may be in communication with one another (e.g., via one or more buses).

[0202] Receiver 1110 may receive information such as packets, user data, or control information associated with various information channels (e.g., control channels, data channels, and information related to two stage CLI transmission and measurement, etc.). Information may be passed on to other components of the device 1105. The receiver 1110
30 may be an example of aspects of the transceiver 1320 or 1420 as described with reference to FIGs. 13 and 14. The receiver 1110 may utilize a single antenna or a set of antennas.

[0203] The communications manager 1115 may be an example of aspects of the communications manager 1015 as described herein. The communications manager 1115 may include a first CLI-RS receiver 1120, a first CLI-RS measuring component 1125, a second CLI-RS receiver 1130, a second CLI-RS measuring component 1135, a CLI value determination component 1140, a first CLI-RS transmitter 1145, a second CLI-RS resource component 1150, and a second CLI-RS transmitter 1155. The communications manager 1115 may be an example of aspects of the communications manager 1310 or 1410 as described herein.

[0204] The first CLI-RS receiver 1120 may receive, from a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure. Additionally, the first CLI-RS receiver 1120 may receive, from a second wireless device (e.g., aggressor wireless device), a first reference signal during a first measurement period of the CLI measurement procedure.

[0205] The first CLI-RS measuring component 1125 may measure a first signal characteristic of the first reference signal.

[0206] The second CLI-RS receiver 1130 may receive, from the second wireless device, a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of the first signal characteristic to a threshold value.

[0207] The second CLI-RS measuring component 1135 may measure a second signal characteristic of the second reference signal, the second signal characteristic different from the first signal characteristic.

[0208] The CLI value determination component 1140 may determine a CLI value based on the second signal characteristic.

[0209] The first CLI-RS transmitter 1145 may receive a configuration to transmit reference signals of a CLI measurement procedure and may transmit, to a first wireless device (e.g., a victim wireless device) in a first serving cell, a first reference signal during a first measurement period of the CLI measurement procedure.

[0210] The second CLI-RS resource component 1150 may identify resources to use to transmit a second reference signal during a second measurement period of the CLI

measurement procedure based on a comparison of a first signal characteristic of the transmitted first reference signal to a threshold value.

[0211] The second CLI-RS transmitter 1155 may transmit, to the first wireless device using the identified resources, the second reference signal for measurement of a second signal characteristic during the second measurement period.

[0212] Based on techniques for transmitting and/or measuring multiple reference signals for determining a strength of a CLI, a processor of a wireless device, such as a UE 115 or a base station 105 (for example, controlling the receiver 1110, the transmitter 1160, or the transceiver 1320 or 1420 as described with reference to FIGs. 13 and 14, respectively) may more efficiently determine the strength of the CLI. For example, the when transmitting the reference signals, the processor may transmit same reference signals for the CLI measurements even though the receiver may perform different measurements for the CLI on the same reference signals, and the processor of the transmitting wireless device may reduce signaling complexity for determining different reference signals to transmit. Additionally, at the receiving side, a processor of the wireless device receiving the reference signals may more efficiently and more accurately measure the CLI, thereby reducing signaling overhead and/or power consumption at the wireless device by reducing the number of times the CLI is measured and measurements of the CLI are reported.

[0213] Transmitter 1160 may transmit signals generated by other components of the device 1105. In some examples, the transmitter 1160 may be collocated with a receiver 1110 in a transceiver module. For example, the transmitter 1160 may be an example of aspects of the transceiver 1320 or 1420 as described with reference to FIGs. 13 and 14. The transmitter 1160 may utilize a single antenna or a set of antennas.

[0214] FIG. 12 shows a diagram 1200 of a communications manager 1205 that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure. The communications manager 1205 may be an example of aspects of a communications manager 1015, a communications manager 1115, or a communications manager 1310 described herein. The communications manager 1205 may include a first CLI-RS receiver 1210, a first CLI-RS measuring component 1215, a second CLI-RS receiver 1220, a second CLI-RS measuring component 1225, a CLI value determination component 1230, a CLI reporting component 1235, a RSRP measurement component 1240, an event

trigger component 1245, a first CLI-RS transmitter 1250, a second CLI-RS resource component 1255, a second CLI-RS transmitter 1260, and an event trigger transmitter 1265. Each of these modules may communicate, directly or indirectly, with one another (e.g., via one or more buses).

5 **[0215]** The first CLI-RS receiver 1210 may receive from a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure. In some cases, the configuration to receive and measure reference signals of the CLI measurement procedure may include an indication triggering receiving the first reference signal, measuring the first signal characteristic, receiving the second reference signal,
10 measuring the second signal characteristic, or a combination thereof. Additionally, the configuration to receive and measure reference signals of the CLI measurement procedure may include a parameter for a measurement metric associated with the measuring the first signal characteristic, the second signal characteristic, or a combination thereof. In some cases, the configuration to receive and measure reference signals of the CLI measurement procedure
15 may include a parameter for a measurement metric associated with the measuring of the first signal characteristic, the second signal characteristic, or a combination thereof.

[0216] Additionally or alternatively, the configuration to receive and measure reference signals of the CLI measurement procedure may include an indication of a measurement periodicity for the measuring of the first signal characteristic, the second signal characteristic,
20 or a combination thereof. In some cases, the configuration to receive and measure reference signals of the CLI measurement procedure may include a resource configuration indicating time-domain and frequency-domain resources for the reference signals. Additionally or alternatively, the configuration to receive and measure reference signals of the CLI measurement procedure may include a reporting configuration indicating the threshold value,
25 a threshold event, or a combination thereof.

[0217] Additionally, the first CLI-RS receiver 1210 may receive, from a second wireless device (e.g., aggressor wireless device), a first reference signal during a first measurement period of the CLI measurement procedure. In some cases, the first reference signal may be received during the first measurement period according to a first periodicity. Additionally, the
30 second wireless device may be associated with the first serving cell. Alternatively, the second wireless device may be associated with a second serving cell different from the first serving

cell. In some cases, the first serving cell may be served by a base station, and the second serving cell may be served by the base station. Alternatively, the first serving cell may be served by a first base station, and the second serving cell may be served by a second base station.

5 **[0218]** The first CLI-RS measuring component 1215 may measure a first signal characteristic of the first reference signal. In some examples, the first CLI-RS measuring component 1215 may receive, on the first serving cell, a trigger for the first wireless device to measure the first signal characteristic during the first measurement period. In some cases, the first signal characteristic may include an RSSI or an SINR. Additionally or alternatively, the
10 first signal characteristic may include an RSRP.

[0219] The second CLI-RS receiver 1220 may receive, from the second wireless device, a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of the first signal characteristic to a threshold value. In some cases, the second reference signal may be received during the second measurement
15 period according to a second periodicity greater than the first periodicity based on the first signal characteristic failing to exceed the threshold value. Additionally or alternatively, the second reference signal may be received during the second measurement period according to a second periodicity less than the first periodicity based on the first signal characteristic exceeding the threshold value.

20 **[0220]** In some cases, the comparison of the first signal characteristic to the threshold value may include an RSSI being at or above the threshold value, the first signal characteristic including the RSSI; an SINR being at or below the threshold value, the first signal characteristic including the SINR; or a combination thereof.

[0221] The second CLI-RS measuring component 1225 may measure a second signal
25 characteristic of the second reference signal, the second signal characteristic different from the first signal characteristic. In some cases, the second signal characteristic may include an RSRP. Additionally or alternatively, the second signal characteristic may include an RSSI or an SINR.

[0222] The CLI value determination component 1230 may determine a CLI value based
30 on the second signal characteristic.

[0223] The first CLI-RS transmitter 1250 may receive a configuration to transmit reference signals of a CLI measurement procedure and may transmit, to a first wireless device (e.g., victim wireless device) in a first serving cell, a first reference signal during a first measurement period of the CLI measurement procedure. In some cases, the configuration to transmit reference signals of the CLI measurement procedure may include an indication triggering transmitting the first reference signal, transmitting the second reference signal, or a combination thereof. Additionally or alternatively, the configuration to transmit reference signals of the CLI measurement procedure may include an indication of a transmission periodicity for the reference signals. Additionally or alternatively, the configuration to transmit reference signals of the CLI measurement procedure may include a resource configuration indicating time-domain and frequency-domain resources for the reference signals.

[0224] In some examples, the first CLI-RS transmitter 1250 may receive a trigger for the second wireless device to transmit the first reference signal during the first measurement period, the second reference signal during the second measurement period, or a combination thereof. In some cases, a base station serving the first serving cell may determine that the first signal characteristic exceeds the threshold value.

[0225] Additionally, the first reference signal may be transmitted during the first measurement period according to a first periodicity. In some cases, the second wireless device may be associated with the first serving cell. Alternatively, the second wireless device may be associated with a second serving cell different from the first serving cell. In some cases, the first serving cell may be served by a base station, and the second serving cell may be served by the base station. Alternatively, the first serving cell may be served by a first base station, and the second serving cell may be served by a second base station. In some cases, the first signal characteristic may include an RSSI or an SINR. Alternatively, the first signal characteristic may include an RSRP.

[0226] The second CLI-RS resource component 1255 may identify resources to use to transmit a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of a first signal characteristic of the transmitted first reference signal to a threshold value. In some cases, the comparison of the first signal characteristic of the transmitted first reference signal to the threshold value may

include an RSSI being at or above the threshold value, the first signal characteristic including the RSSI; an SINR being at or below the threshold value, the first signal characteristic including the SINR; or a combination thereof.

[0227] The second CLI-RS transmitter 1260 may transmit, to the first wireless device
5 using the identified resources, the second reference signal for measurement of a second signal characteristic during the second measurement period. In some examples, the second CLI-RS transmitter 1260 may receive, on the first serving cell, a CLI measurement configuration indicating resources for the second wireless device to use to transmit the first reference signal during the first measurement period and the second reference signal during the second
10 measurement period. In some cases, the second reference signal may be transmitted during the second measurement period according to a second periodicity greater than the first periodicity based on the first signal characteristic failing to exceed the threshold value. Additionally or alternatively, the second reference signal may be transmitted during the second measurement period according to a second periodicity less than the first periodicity
15 based on the first signal characteristic exceeding the threshold value. In some cases, the second signal characteristic may include an RSRP. Alternatively, the second signal characteristic may include an RSSI or an SINR.

[0228] The CLI reporting component 1235 may report the first signal characteristic to the first serving cell. In some examples, the CLI reporting component 1235 may receive, on the
20 first serving cell in response to the reporting, an indication that the first wireless device is to measure the second signal characteristic during the second measurement period. In some cases, a base station serving the first serving cell may determine that the first signal characteristic exceeds the threshold value.

[0229] The RSRP measurement component 1240 may receive, on the first serving cell, a
25 CLI measurement configuration indicating resources for the first wireless device to use to receive the first reference signal during the first measurement period and the second reference signal during the second measurement period.

[0230] The event trigger component 1245 may receive, from the second wireless device, the second reference signal based on an event trigger. In some cases, the event trigger may
30 include an identification of a handover procedure, a signal quality for a wireless connection

between the first wireless device and the first serving cell falling below a signal quality threshold, or a combination thereof.

[0231] The event trigger transmitter 1265 may transmit, to the first wireless device, the second reference signal based on an event trigger. In some cases, the event trigger may include an identification of a handover procedure, a signal quality for a wireless connection between the first wireless device and the first serving cell falling below a signal quality threshold, or a combination thereof.

[0232] FIG. 13 shows a diagram of a system 1300 including a device 1305 that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure. The device 1305 may be an example of or include the components of device 1005, device 1105, or a UE 115 as described herein. The device 1305 may include components for bi-directional voice and data communications including components for transmitting and receiving communications, including a communications manager 1310, a transceiver 1320, an antenna 1325, memory 1330, a processor 1340, and an I/O controller 1350. These components may be in electronic communication via one or more buses (e.g., bus 1355).

[0233] The communications manager 1310 may receive, from a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure. Additionally, the communications manager 1310 may from a second wireless device (e.g., aggressor wireless device), a first reference signal during a first measurement period of the CLI measurement procedure. In some cases, the communications manager 1310 may measure a first signal characteristic of the first reference signal. Additionally, the communications manager 1310 may receive, from the second wireless device, a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of the first signal characteristic to a threshold value. In some cases, the communications manager 1310 may measure a second signal characteristic of the second reference signal, the second signal characteristic different from the first signal characteristic. Accordingly, the communications manager 1310 may determine a CLI value based on the second signal characteristic.

[0234] Additionally or alternatively, the communications manager 1310 may receive a configuration to transmit reference signals of a CLI measurement procedure. Accordingly, the communications manager 1310 may transmit, to a first wireless device (e.g., a victim

wireless device) in a first serving cell, a first reference signal during a first measurement period of the CLI measurement procedure. In some cases, the communications manager 1310 may identify resources to use to transmit a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of a first signal characteristic of the transmitted first reference signal to a threshold value. Additionally, the communications manager 1310 may transmit, to the first wireless device using the identified resources, the second reference signal for measurement of a second signal characteristic during the second measurement period.

[0235] Transceiver 1320 may communicate bi-directionally, via one or more antennas, wired, or wireless links as described above. For example, the transceiver 1320 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 1320 may also include a modem to modulate the packets and provide the modulated packets to the antennas for transmission, and to demodulate packets received from the antennas.

[0236] In some cases, the wireless device may include a single antenna 1325. However, in some cases the device may have more than one antenna 1325, which may be capable of concurrently transmitting or receiving multiple wireless transmissions.

[0237] The memory 1330 may include random-access memory (RAM), read-only memory (ROM), or a combination thereof. The memory 1330 may store computer-readable code 1335 including instructions that, when executed by a processor (e.g., the processor 1340) cause the device to perform various functions described herein. In some cases, the memory 1330 may contain, among other things, a basic I/O system (BIOS) which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[0238] The processor 1340 may include an intelligent hardware device, (e.g., a general-purpose processor, a DSP, a central processing unit (CPU), a microcontroller, an ASIC, an FPGA, a programmable logic device, a discrete gate or transistor logic component, a discrete hardware component, or any combination thereof). In some cases, the processor 1340 may be configured to operate a memory array using a memory controller. In other cases, a memory controller may be integrated into the processor 1340. The processor 1340 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 1330) to

cause the device 1305 to perform various functions (e.g., functions or tasks supporting two stage CLI transmission and measurement).

[0239] The I/O controller 1350 may manage input and output signals for the device 1305. The I/O controller 1350 may also manage peripherals not integrated into the device 1305. In some cases, the I/O controller 1350 may represent a physical connection or port to an external peripheral. In some cases, the I/O controller 1350 may utilize an operating system such as iOS®, ANDROID®, MS-DOS®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system. In other cases, the I/O controller 1350 may represent or interact with a modem, a keyboard, a mouse, a touchscreen, or a similar device. In some cases, the I/O controller 1350 may be implemented as part of a processor. In some cases, a user may interact with the device 1305 via the I/O controller 1350 or via hardware components controlled by the I/O controller 1350.

[0240] The code 1335 may include instructions to implement aspects of the present disclosure, including instructions to support wireless communications. The code 1335 may be stored in a non-transitory computer-readable medium such as system memory or other type of memory. In some cases, the code 1335 may not be directly executable by the processor 1340 but may cause a computer (e.g., when compiled and executed) to perform functions described herein.

[0241] FIG. 14 shows a diagram of a system 1400 including a device 1405 that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure. The device 1405 may be an example of or include the components of device 1005, device 1105, or a base station 105 as described herein. The device 1405 may include components for bi-directional voice and data communications including components for transmitting and receiving communications, including a communications manager 1410, a network communications manager 1415, a transceiver 1420, an antenna 1425, memory 1430, a processor 1440, and an inter-station communications manager 1445. These components may be in electronic communication via one or more buses (e.g., bus 1455).

[0242] The communications manager 1410 may receive, from a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure. Additionally, the communications manager 1410 may from a second wireless device (e.g., aggressor wireless device), a first reference signal during a first measurement period of the

CLI measurement procedure. In some cases, the communications manager 1410 may measure a first signal characteristic of the first reference signal. Additionally, the communications manager 1410 may receive, from the second wireless device, a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of the first signal characteristic to a threshold value. In some cases, the communications manager 1410 may measure a second signal characteristic of the second reference signal, the second signal characteristic different from the first signal characteristic. Accordingly, the communications manager 1410 may determine a CLI value based on the second signal characteristic.

[0243] Additionally or alternatively, the communications manager 1410 may receive a configuration to transmit reference signals of a CLI measurement procedure. Accordingly, the communications manager 1410 may transmit, to a first wireless device (e.g., victim wireless device) in a first serving cell, a first reference signal during a first measurement period of the CLI measurement procedure. In some cases, the communications manager 1410 may identify resources to use to transmit a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of a first signal characteristic of the transmitted first reference signal to a threshold value. Additionally, the communications manager 1410 may transmit, to the first wireless device using the identified resources, the second reference signal for measurement of a second signal characteristic during the second measurement period.

[0244] Network communications manager 1415 may manage communications with the core network (e.g., via one or more wired backhaul links). For example, the network communications manager 1415 may manage the transfer of data communications for client devices, such as one or more UEs 115.

[0245] Transceiver 1420 may communicate bi-directionally, via one or more antennas, wired, or wireless links as described above. For example, the transceiver 1420 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 1420 may also include a modem to modulate the packets and provide the modulated packets to the antennas for transmission, and to demodulate packets received from the antennas.

[0246] In some cases, the wireless device may include a single antenna 1425. However, in some cases the device may have more than one antenna 1425, which may be capable of concurrently transmitting or receiving multiple wireless transmissions.

[0247] The memory 1430 may include RAM, ROM, or a combination thereof. The memory 1430 may store computer-readable code 1435 including instructions that, when executed by a processor (e.g., the processor 1440) cause the device to perform various functions described herein. In some cases, the memory 1430 may contain, among other things, a BIOS which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[0248] The processor 1440 may include an intelligent hardware device, (e.g., a general-purpose processor, a DSP, a CPU, a microcontroller, an ASIC, an FPGA, a programmable logic device, a discrete gate or transistor logic component, a discrete hardware component, or any combination thereof). In some cases, the processor 1440 may be configured to operate a memory array using a memory controller. In other cases, a memory controller may be integrated into the processor 1440. The processor 1440 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 1430) to cause the device 1405 to perform various functions (e.g., functions or tasks supporting two stage CLI transmission and measurement).

[0249] Inter-station communications manager 1445 may manage communications with other base station 105, and may include a controller or scheduler for controlling communications with UEs 115 in cooperation with other base stations 105. For example, the inter-station communications manager 1445 may coordinate scheduling for transmissions to UEs 115 for various interference mitigation techniques such as beamforming or joint transmission. In some examples, inter-station communications manager 1445 may provide an X2 interface within an LTE/LTE-A wireless communication network technology to provide communication between base stations 105.

[0250] The code 1435 may include instructions to implement aspects of the present disclosure, including instructions to support wireless communications. The code 1435 may be stored in a non-transitory computer-readable medium such as system memory or other type of memory. In some cases, the code 1435 may not be directly executable by the processor 1440

but may cause a computer (e.g., when compiled and executed) to perform functions described herein.

[0251] FIG. 15 shows a diagram 1500 of a device 1505 that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure. The device 1505 may be an example of aspects of a base station 105 as described herein. The device 1505 may include a receiver 1510, a base station communications manager 1515, and a transmitter 1520. The device 1505 may also include a processor. Each of these components may be in communication with one another (e.g., via one or more buses).

[0252] The receiver 1510 may receive information such as packets, user data, or control information associated with various information channels (e.g., control channels, data channels, and information related to two stage CLI transmission and measurement, etc.). Information may be passed on to other components of the device 1505. The receiver 1510 may be an example of aspects of the transceiver 1820 described with reference to FIG. 18. The receiver 1510 may utilize a single antenna or a set of antennas.

[0253] The base station communications manager 1515 may transmit, to a first wireless device (e.g., victim wireless device) in a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure. In some cases, the base station communications manager 1515 may receive, from the first wireless device, a first signal characteristic of a first reference signal measured by the first wireless device during a first measurement period of the CLI measurement procedure, the first reference signal received from a second wireless device (e.g., aggressor wireless device). In some cases, the base station communications manager 1515 may compare the first signal characteristic to a threshold value. Additionally, the base station communications manager 1515 may transmit, to the first wireless device based on the comparing, an indication that the first wireless device is to measure a second signal characteristic of a second reference signal during a second measurement period of the CLI measurement procedure. In some cases, the base station communications manager 1515 may receive, from the first wireless device, the second signal characteristic of the second reference signal measured by the first wireless device during the second measurement period of the CLI measurement procedure. The base station communications manager 1515 may be an example of aspects of the base station communications manager 1810 described herein.

[0254] The base station communications manager 1515, or its sub-components, may be implemented in hardware, code (e.g., software or firmware) executed by a processor, or any combination thereof. If implemented in code executed by a processor, the functions of the base station communications manager 1515, or its sub-components may be executed by a
5 general-purpose processor, a DSP, an ASIC, a FPGA or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described in the present disclosure.

[0255] The base station communications manager 1515, or its sub-components, may be physically located at various positions, including being distributed such that portions of
10 functions are implemented at different physical locations by one or more physical components. In some examples, the base station communications manager 1515, or its sub-components, may be a separate and distinct component in accordance with various aspects of the present disclosure. In some examples, the base station communications manager 1515, or its sub-components, may be combined with one or more other hardware components,
15 including but not limited to an I/O component, a transceiver, a network server, another computing device, one or more other components described in the present disclosure, or a combination thereof in accordance with various aspects of the present disclosure.

[0256] The transmitter 1520 may transmit signals generated by other components of the device 1505. In some examples, the transmitter 1520 may be collocated with a receiver 1510
20 in a transceiver module. For example, the transmitter 1520 may be an example of aspects of the transceiver 1820 described with reference to FIG. 18. The transmitter 1520 may utilize a single antenna or a set of antennas.

[0257] FIG. 16 shows a diagram 1600 of a device 1605 that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure. The
25 device 1605 may be an example of aspects of a device 1505, or a base station 105 as described herein. The device 1605 may include a receiver 1610, a base station communications manager 1615, and a transmitter 1640. The device 1605 may also include a processor. Each of these components may be in communication with one another (e.g., via one or more buses).

[0258] The receiver 1610 may receive information such as packets, user data, or control information associated with various information channels (e.g., control channels, data

channels, and information related to two stage CLI transmission and measurement, etc.). Information may be passed on to other components of the device 1605. The receiver 1610 may be an example of aspects of the transceiver 1820 described with reference to FIG. 18. The receiver 1610 may utilize a single antenna or a set of antennas.

5 **[0259]** The base station communications manager 1615 may be an example of aspects of the base station communications manager 1515 as described herein. The base station communications manager 1615 may include a first signal characteristic component 1620, a signal characteristic comparison component 1625, a second signal characteristic indicator 1630, and a second signal characteristic receiver 1635. The base station communications
10 manager 1615 may be an example of aspects of the base station communications manager 1810 described herein.

[0260] The first signal characteristic component 1620 may transmit, to a first wireless device (e.g., victim wireless device) in a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure and may receive, from the first
15 wireless device, a first signal characteristic of a first reference signal measured by the first wireless device during a first measurement period of the CLI measurement procedure, the first reference signal received from a second wireless device (e.g., aggressor wireless device).

[0261] The signal characteristic comparison component 1625 may compare the first signal characteristic to a threshold value.

20 **[0262]** The second signal characteristic indicator 1630 may transmit, to the first wireless device based on the comparing, an indication that the first wireless device is to measure a second signal characteristic of a second reference signal during a second measurement period of the CLI measurement procedure.

[0263] The second signal characteristic receiver 1635 may receive, from the first wireless
25 device, the second signal characteristic of the second reference signal measured by the first wireless device during the second measurement period of the CLI measurement procedure.

[0264] The transmitter 1640 may transmit signals generated by other components of the device 1605. In some examples, the transmitter 1640 may be collocated with a receiver 1610 in a transceiver module. For example, the transmitter 1640 may be an example of aspects of

the transceiver 1820 described with reference to FIG. 18. The transmitter 1640 may utilize a single antenna or a set of antennas.

[0265] FIG. 17 shows a diagram 1700 of a base station communications manager 1705 that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure. The base station communications manager 1705 may be an example of aspects of a base station communications manager 1515, a base station communications manager 1615, or a base station communications manager 1810 described herein. The base station communications manager 1705 may include a first signal characteristic component 1710, a signal characteristic comparison component 1715, a second signal characteristic indicator 1720, a second signal characteristic receiver 1725, and a periodicity indicator 1730. Each of these modules may communicate, directly or indirectly, with one another (e.g., via one or more buses).

[0266] The first signal characteristic component 1710 may transmit, to a first wireless device (e.g., victim wireless device) in a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure and may receive, from the first wireless device, a first signal characteristic of a first reference signal measured by the first wireless device during a first measurement period of the CLI measurement procedure, the first reference signal received from a second wireless device (e.g., aggressor wireless device). In some examples, the first signal characteristic component 1710 may transmit, to the first wireless device, a trigger for the first wireless device to measure the first signal characteristic during the first measurement period. Additionally or alternatively, the first signal characteristic component 1710 may transmit, to the first wireless device, a trigger for the first wireless device to measure the second signal characteristic during the second measurement period.

[0267] In some cases, the second wireless device may be associated with the first serving cell. Alternatively, the second wireless device may be associated with a second serving cell different from the first serving cell. In some cases, the first serving cell may be served by the base station, and the second serving cell may be served by the base station. Alternatively, the first serving cell may be served by a first base station, and the second serving cell may be served by a second base station. In some cases, the first signal characteristic may include an RSSI or an SINR. Alternatively, the first signal characteristic may include an RSRP.

[0268] The signal characteristic comparison component 1715 may compare the first signal characteristic to a threshold value. In some cases, comparing the first signal characteristic to the threshold value may include an RSSI being at or above the threshold value, the first signal characteristic including the RSSI; an SINR being at or below the threshold value, the first signal characteristic including the SINR; or a combination thereof.

[0269] The second signal characteristic indicator 1720 may transmit, to the first wireless device based on the comparing, an indication that the first wireless device is to measure a second signal characteristic of a second reference signal during a second measurement period of the CLI measurement procedure. In some examples, the second signal characteristic indicator 1720 may transmit, to the second wireless device, a CLI transmission configuration indicating that the second wireless device is to continue to transmit the second reference signal regardless of whether the first signal characteristic exceeds the threshold value.

[0270] Additionally or alternatively, the second signal characteristic indicator 1720 may transmit, to the first wireless device, a CLI measurement configuration indicating that the second wireless device is to continue to transmit the second reference signal regardless of whether the first signal characteristic exceeds the threshold value. In some examples, the second signal characteristic indicator 1720 may transmit, to the second wireless device, a trigger for the second wireless device to transmit the first reference signal for measurement by the first wireless device during the first measurement period. In some examples, the second signal characteristic indicator 1720 may transmit, to the second wireless device based on the determining, a trigger for the second wireless device to transmit the second reference signal for measurement by the first wireless device during the second measurement period.

[0271] The second signal characteristic receiver 1725 may receive, from the first wireless device, the second signal characteristic of the second reference signal measured by the first wireless device during the second measurement period of the CLI measurement procedure. In some cases, the second signal characteristic may include an RSRP. Alternatively, the second signal characteristic may include an RSSI or an SINR.

[0272] The periodicity indicator 1730 may transmit, to the first wireless device, a CLI measurement configuration indicating resources for the first wireless device to use to receive the first reference signal during the first measurement period and the second reference signal during the second measurement period. In some cases, the CLI measurement configuration

further may indicate that the first reference signal is to be transmitted during the first measurement period according to a first periodicity, and that the second reference signal is to be transmitted during the second measurement period according to a second periodicity greater than the first periodicity based on the first signal characteristic failing to exceed the threshold value. Additionally or alternatively, the CLI measurement configuration may further indicate that the first reference signal is to be transmitted during the first measurement period according to a first periodicity and that the second reference signal is to be transmitted during the second measurement period according to a second periodicity greater than the first periodicity based on the first signal characteristic exceeding the threshold value.

[0273] FIG. 18 shows a diagram of a system 1800 including a device 1805 that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure. The device 1805 may be an example of or include the components of device 1505, device 1605, or a base station 105 as described herein. The device 1805 may include components for bi-directional voice and data communications including components for transmitting and receiving communications, including a base station communications manager 1810, a network communications manager 1815, a transceiver 1820, an antenna 1825, memory 1830, a processor 1840, and an inter-station communications manager 1845. These components may be in electronic communication via one or more buses (e.g., bus 1855).

[0274] The base station communications manager 1810 may transmit, to a first wireless device (e.g., victim wireless device) in a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure. In some cases, the base station communications manager 1810 may receive, from the first wireless device, a first signal characteristic of a first reference signal measured by the first wireless device during a first measurement period of a CLI measurement procedure, the first reference signal received from a second wireless device (e.g., aggressor wireless device). In some cases, the base station communications manager 1810 may compare the first signal characteristic to a threshold value. Additionally, the base station communications manager 1810 may transmit, to the first wireless device based on the comparing, an indication that the first wireless device is to measure a second signal characteristic of a second reference signal during a second measurement period of the CLI measurement procedure. In some cases, the base station communications manager 1810 may receive, from the first wireless device, the second signal

characteristic of the second reference signal measured by the first wireless device during the second measurement period of the CLI measurement procedure.

[0275] The network communications manager 1815 may manage communications with the core network (e.g., via one or more wired backhaul links). For example, the network communications manager 1815 may manage the transfer of data communications for client devices, such as one or more UEs 115.

[0276] The transceiver 1820 may communicate bi-directionally, via one or more antennas, wired, or wireless links as described above. For example, the transceiver 1820 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 1820 may also include a modem to modulate the packets and provide the modulated packets to the antennas for transmission, and to demodulate packets received from the antennas.

[0277] In some cases, the wireless device may include a single antenna 1825. However, in some cases the device may have more than one antenna 1825, which may be capable of concurrently transmitting or receiving multiple wireless transmissions.

[0278] The memory 1830 may include RAM, ROM, or a combination thereof. The memory 1830 may store computer-readable code 1835 including instructions that, when executed by a processor (e.g., the processor 1840) cause the device to perform various functions described herein. In some cases, the memory 1830 may contain, among other things, a BIOS which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[0279] The processor 1840 may include an intelligent hardware device, (e.g., a general-purpose processor, a DSP, a CPU, a microcontroller, an ASIC, an FPGA, a programmable logic device, a discrete gate or transistor logic component, a discrete hardware component, or any combination thereof). In some cases, the processor 1840 may be configured to operate a memory array using a memory controller. In some cases, a memory controller may be integrated into processor 1840. The processor 1840 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 1830) to cause the device 1805 to perform various functions (e.g., functions or tasks supporting two stage CLI transmission and measurement).

[0280] The inter-station communications manager 1845 may manage communications with other base station 105 and may include a controller or scheduler for controlling communications with UEs 115 in cooperation with other base stations 105. For example, the inter-station communications manager 1845 may coordinate scheduling for transmissions to UEs 115 for various interference mitigation techniques such as beamforming or joint transmission. In some examples, the inter-station communications manager 1845 may provide an X2 interface within an LTE/LTE-A wireless communication network technology to provide communication between base stations 105.

[0281] The code 1835 may include instructions to implement aspects of the present disclosure, including instructions to support wireless communications. The code 1835 may be stored in a non-transitory computer-readable medium such as system memory or other type of memory. In some cases, the code 1835 may not be directly executable by the processor 1840 but may cause a computer (e.g., when compiled and executed) to perform functions described herein.

[0282] FIG. 19 shows a flowchart illustrating a method 1900 that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure. The operations of method 1900 may be implemented by a UE 115 or base station 105 (e.g., a victim wireless device) or its components as described herein. For example, the operations of method 1900 may be performed by a communications manager as described with reference to FIGs. 10 through 14. In some examples, a UE or base station may execute a set of instructions to control the functional elements of the UE or base station to perform the functions described below. Additionally or alternatively, a UE or base station may perform aspects of the functions described below using special-purpose hardware.

[0283] At 1905, the UE or base station may receive, from a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure. The operations of 1905 may be performed according to the methods described herein. In some examples, aspects of the operations of 1905 may be performed by a first CLI-RS receiver as described with reference to FIGs. 10 through 14

[0284] At 1910, the UE or base station may receive, from a second wireless device (e.g., aggressor wireless device), a first reference signal during a first measurement period of the CLI measurement procedure. The operations of 1910 may be performed according to the

methods described herein. In some examples, aspects of the operations of 1910 may be performed by a first CLI-RS receiver as described with reference to FIGs. 10 through 14.

[0285] At 1915, the UE or base station may measure a first signal characteristic of the first reference signal. The operations of 1915 may be performed according to the methods described herein. In some examples, aspects of the operations of 1915 may be performed by a first CLI-RS measuring component as described with reference to FIGs. 10 through 14.

[0286] At 1920, the UE or base station may receive, from the second wireless device, a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of the first signal characteristic to a threshold value. The operations of 1920 may be performed according to the methods described herein. In some examples, aspects of the operations of 1920 may be performed by a second CLI-RS receiver as described with reference to FIGs. 10 through 14.

[0287] At 1925, the UE or base station may measure a second signal characteristic of the second reference signal, the second signal characteristic different from the first signal characteristic. The operations of 1925 may be performed according to the methods described herein. In some examples, aspects of the operations of 1925 may be performed by a second CLI-RS measuring component as described with reference to FIGs. 10 through 14.

[0288] At 1930, the UE or base station may determine a CLI value based on the second signal characteristic. The operations of 1930 may be performed according to the methods described herein. In some examples, aspects of the operations of 1930 may be performed by a CLI value determination component as described with reference to FIGs. 10 through 14.

[0289] FIG. 20 shows a flowchart illustrating a method 2000 that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure. The operations of method 2000 may be implemented by a UE 115 or base station 105 (e.g., an aggressor wireless device) or its components as described herein. For example, the operations of method 2000 may be performed by a communications manager as described with reference to FIGs. 10 through 14. In some examples, a UE or base station may execute a set of instructions to control the functional elements of the UE or base station to perform the functions described below. Additionally or alternatively, a UE or base station may perform aspects of the functions described below using special-purpose hardware.

[0290] At 2005, the UE or base station may receive a configuration to transmit reference signals of a CLI measurement procedure. The operations of 2005 may be performed according to the methods described herein. In some examples, aspects of the operations of 2005 may be performed by a first CLI-RS transmitter as described with reference to FIGs. 10 through 14.

[0291] At 2010, the UE or base station may transmit, to a first wireless device (e.g., victim wireless device) in a first serving cell, a first reference signal during a first measurement period of the CLI measurement procedure. The operations of 2010 may be performed according to the methods described herein. In some examples, aspects of the operations of 2010 may be performed by a first CLI-RS transmitter as described with reference to FIGs. 10 through 14.

[0292] At 2015, the UE or base station may identify resources to use to transmit a second reference signal during a second measurement period of the CLI measurement procedure based on a comparison of a first signal characteristic of the transmitted first reference signal to a threshold value. The operations of 2015 may be performed according to the methods described herein. In some examples, aspects of the operations of 2015 may be performed by a second CLI-RS resource component as described with reference to FIGs. 10 through 14.

[0293] At 2020, the UE or base station may transmit, to the first wireless device using the identified resources, the second reference signal for measurement of a second signal characteristic during the second measurement period. The operations of 2020 may be performed according to the methods described herein. In some examples, aspects of the operations of 2020 may be performed by a second CLI-RS transmitter as described with reference to FIGs. 10 through 14.

[0294] FIG. 21 shows a flowchart illustrating a method 2100 that supports two stage CLI transmission and measurement in accordance with aspects of the present disclosure. The operations of method 2100 may be implemented by a base station 105 or its components as described herein. For example, the operations of method 2100 may be performed by a base station communications manager as described with reference to FIGs. 15 through 18. In some examples, a base station may execute a set of instructions to control the functional elements of the base station to perform the functions described below. Additionally or alternatively, a

base station may perform aspects of the functions described below using special-purpose hardware.

[0295] At 2105, the base station may transmit, to a first wireless device (e.g., victim wireless device) in a first serving cell, a configuration to receive and measure reference signals of a CLI measurement procedure. The operations of 2105 may be performed according to the methods described herein. In some examples, aspects of the operations of 2105 may be performed by a first signal characteristic component as described with reference to FIGs. 15 through 18.

[0296] At 2110, the base station may receive, from the first wireless device, a first signal characteristic of a first reference signal measured by the first wireless device during a first measurement period of the CLI measurement procedure, the first reference signal received from a second wireless device (e.g., aggressor wireless device). The operations of 2110 may be performed according to the methods described herein. In some examples, aspects of the operations of 2110 may be performed by a first signal characteristic component as described with reference to FIGs. 15 through 18.

[0297] At 2115, the base station may compare the first signal characteristic to a threshold value. The operations of 2115 may be performed according to the methods described herein. In some examples, aspects of the operations of 2115 may be performed by a signal characteristic comparison component as described with reference to FIGs. 15 through 18.

[0298] At 2120, the base station may transmit, to the first wireless device based on the comparing, an indication that the first wireless device is to measure a second signal characteristic of a second reference signal during a second measurement period of the CLI measurement procedure. The operations of 2120 may be performed according to the methods described herein. In some examples, aspects of the operations of 2120 may be performed by a second signal characteristic indicator as described with reference to FIGs. 15 through 18.

[0299] At 2125, the base station may receive, from the first wireless device, the second signal characteristic of the second reference signal measured by the first wireless device during the second measurement period of the CLI measurement procedure. The operations of 2125 may be performed according to the methods described herein. In some examples, aspects of the operations of 2125 may be performed by a second signal characteristic receiver as described with reference to FIGs. 15 through 18.

[0300] It should be noted that the methods described herein describe possible implementations, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible. Further, aspects from two or more of the methods may be combined.

5 **[0301]** Techniques described herein may be used for various wireless communications systems such as CDMA, TDMA, FDMA, OFDMA, single carrier frequency division multiple access (SC-FDMA), and other systems. A CDMA system may implement a radio technology such as CDMA2000, Universal Terrestrial Radio Access (UTRA), etc. CDMA2000 covers
10 IS-2000, IS-95, and IS-856 standards. IS-2000 Releases may be commonly referred to as CDMA2000 1X, 1X, etc. IS-856 (TIA-856) is commonly referred to as CDMA2000 1xEV-DO, High Rate Packet Data (HRPD), etc. UTRA includes Wideband CDMA (WCDMA) and other variants of CDMA. A TDMA system may implement a radio technology such as Global System for Mobile Communications (GSM).

[0302] An OFDMA system may implement a radio technology such as Ultra Mobile
15 Broadband (UMB), Evolved UTRA (E-UTRA), Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, Flash-OFDM, etc. UTRA and E-UTRA are part of Universal Mobile Telecommunications System (UMTS). LTE, LTE-A, and LTE-A Pro are releases of UMTS that use E-UTRA. UTRA, E-UTRA, UMTS, LTE, LTE-A, LTE-A Pro, NR, and GSM are described in documents from the
20 organization named “3rd Generation Partnership Project” (3GPP). CDMA2000 and UMB are described in documents from an organization named “3rd Generation Partnership Project 2” (3GPP2). The techniques described herein may be used for the systems and radio technologies mentioned herein as well as other systems and radio technologies. While aspects of an LTE, LTE-A, LTE-A Pro, or NR system may be described for purposes of example,
25 and LTE, LTE-A, LTE-A Pro, or NR terminology may be used in much of the description, the techniques described herein are applicable beyond LTE, LTE-A, LTE-A Pro, or NR applications.

[0303] A macro cell generally covers a relatively large geographic area (e.g., several kilometers in radius) and may allow unrestricted access by UEs with service subscriptions
30 with the network provider. A small cell may be associated with a lower-powered base station, as compared with a macro cell, and a small cell may operate in the same or different (e.g.,

licensed, unlicensed, etc.) frequency bands as macro cells. Small cells may include pico cells, femto cells, and micro cells according to various examples. A pico cell, for example, may cover a small geographic area and may allow unrestricted access by UEs with service subscriptions with the network provider. A femto cell may also cover a small geographic area (e.g., a home) and may provide restricted access by UEs having an association with the femto cell (e.g., UEs in a closed subscriber group (CSG), UEs for users in the home, and the like). An eNB for a macro cell may be referred to as a macro eNB. An eNB for a small cell may be referred to as a small cell eNB, a pico eNB, a femto eNB, or a home eNB. An eNB may support one or multiple (e.g., two, three, four, and the like) cells, and may also support communications using one or multiple component carriers.

[0304] The wireless communications systems described herein may support synchronous or asynchronous operation. For synchronous operation, the base stations may have similar frame timing, and transmissions from different base stations may be approximately aligned in time. For asynchronous operation, the base stations may have different frame timing, and transmissions from different base stations may not be aligned in time. The techniques described herein may be used for either synchronous or asynchronous operations.

[0305] Information and signals described herein may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[0306] The various illustrative blocks and modules described in connection with the disclosure herein may be implemented or performed with a general-purpose processor, a DSP, an ASIC, an FPGA, or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices (e.g., a combination of a DSP and a microprocessor, multiple microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration).

[0307] The functions described herein may be implemented in hardware, software executed by a processor, firmware, or any combination thereof. If implemented in software executed by a processor, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Other examples and implementations are within the scope of the disclosure and appended claims. For example, due to the nature of software, functions described herein can be implemented using software executed by a processor, hardware, firmware, hardwiring, or combinations of any of these. Features implementing functions may also be physically located at various positions, including being distributed such that portions of functions are implemented at different physical locations.

[0308] Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that can be accessed by a general purpose or special purpose computer. By way of example, and not limitation, non-transitory computer-readable media may include RAM, ROM, electrically erasable programmable ROM (EEPROM), flash memory, compact disk (CD) ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other non-transitory medium that can be used to carry or store desired program code means in the form of instructions or data structures and that can be accessed by a general-purpose or special-purpose computer, or a general-purpose or special-purpose processor. Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. Disk and disc, as used herein, include CD, laser disc, optical disc, digital versatile disc (DVD), floppy disk and Blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above are also included within the scope of computer-readable media.

[0309] As used herein, including in the claims, the term “and/or,” when used in a list of two or more items, means that any one of the listed items can be employed by itself, or any combination of two or more of the listed items can be employed. For example, if a composition is described as containing components A, B, and/or C, the composition can

contain A alone; B alone; C alone; A and B in combination; A and C in combination; B and C in combination; or A, B, and C in combination. Also as used herein, including in the claims, “or” as used in a list of items (e.g., a list of items prefaced by a phrase such as “at least one of” or “one or more of”) indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C). Also, as used herein, the phrase “based on” shall not be construed as a reference to a closed set of conditions. For example, an exemplary step that is described as “based on condition A” may be based on both a condition A and a condition B without departing from the scope of the present disclosure. In other words, as used herein, the phrase “based on” shall be construed in the same manner as the phrase “based at least in part on.”

[0310] In the appended figures, similar components or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label by a dash and a second label that distinguishes among the similar components. If just the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label, or other subsequent reference label.

[0311] The description set forth herein, in connection with the appended drawings, describes example configurations and does not represent all the examples that may be implemented or that are within the scope of the claims. The term “exemplary” used herein means “serving as an example, instance, or illustration,” and not “preferred” or “advantageous over other examples.” The detailed description includes specific details for the purpose of providing an understanding of the described techniques. These techniques, however, may be practiced without these specific details. In some instances, well-known structures and devices are shown in block diagram form in order to avoid obscuring the concepts of the described examples.

[0312] The description herein is provided to enable a person skilled in the art to make or use the disclosure. Various modifications to the disclosure will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein, but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

CLAIMS

What is claimed is:

1 1. A method for wireless communications at a first wireless device
2 associated with a first serving cell, comprising:
3 receiving, from the first serving cell, a configuration to receive and measure
4 reference signals of a cross-link interference measurement procedure;
5 receiving, from a second wireless device, a first reference signal during a first
6 measurement period of the cross-link interference measurement procedure;
7 measuring a first signal characteristic of the first reference signal;
8 receiving, from the second wireless device, a second reference signal during a
9 second measurement period of the cross-link interference measurement procedure based at
10 least in part on a comparison of the first signal characteristic to a threshold value;
11 measuring a second signal characteristic of the second reference signal, the
12 second signal characteristic different from the first signal characteristic; and
13 determining a cross-link interference value based at least in part on the second
14 signal characteristic.

1 2. The method of claim 1, wherein the configuration to receive and
2 measure reference signals of the cross-link interference measurement procedure comprises an
3 indication triggering receiving the first reference signal, or measuring the first signal
4 characteristic, or receiving the second reference signal, or measuring the second signal
5 characteristic, or a combination thereof.

1 3. The method of claim 1, wherein the configuration to receive and
2 measure reference signals of the cross-link interference measurement procedure comprises a
3 parameter for a measurement metric associated with the measuring the first signal
4 characteristic, or the second signal characteristic, or a combination thereof.

1 4. The method of claim 1, wherein the configuration to receive and
2 measure reference signals of the cross-link interference measurement procedure comprises a
3 parameter for a measurement metric associated with the measuring of the first signal
4 characteristic, or the second signal characteristic, or a combination thereof.

1 5. The method of claim 1, wherein the configuration to receive and
2 measure reference signals of the cross-link interference measurement procedure comprises an
3 indication of a measurement periodicity for the measuring of the first signal characteristic, or
4 the second signal characteristic, or a combination thereof.

1 6. The method of claim 1, wherein the configuration to receive and
2 measure reference signals of the cross-link interference measurement procedure comprises a
3 resource configuration indicating time-domain and frequency-domain resources for the
4 reference signals.

1 7. The method of claim 1, wherein the configuration to receive and
2 measure reference signals of the cross-link interference measurement procedure comprises a
3 reporting configuration indicating the threshold value, or a threshold event, or a combination
4 thereof.

1 8. The method of claim 1, further comprising:
2 reporting the first signal characteristic to the first serving cell; and
3 receiving, on the first serving cell in response to the reporting, an indication
4 that the first wireless device is to measure the second signal characteristic during the second
5 measurement period.

1 9. The method of claim 8, wherein a base station serving the first serving
2 cell determines that the first signal characteristic exceeds the threshold value.

1 10. The method of claim 1, further comprising:
2 receiving, on the first serving cell, a trigger for the first wireless device to
3 measure the first signal characteristic during the first measurement period.

1 11. The method of claim 1, wherein:
2 the first reference signal is received during the first measurement period
3 according to a first periodicity; and
4 the second reference signal is received during the second measurement period
5 according to a second periodicity greater than the first periodicity based at least in part on the
6 first signal characteristic failing to exceed the threshold value.

1 12. The method of claim 1, wherein:
2 the first reference signal is received during the first measurement period
3 according to a first periodicity; and
4 the second reference signal is received during the second measurement period
5 according to a second periodicity less than the first periodicity based at least in part on the
6 first signal characteristic exceeding the threshold value.

1 13. The method of claim 1, further comprising:
2 receiving, on the first serving cell, a cross-link interference measurement
3 configuration indicating resources for the first wireless device to use to receive the first
4 reference signal during the first measurement period and the second reference signal during
5 the second measurement period.

1 14. The method of claim 1, further comprising:
2 receiving, from the second wireless device, the second reference signal based
3 at least in part on an event trigger.

1 15. The method of claim 14, wherein the event trigger comprises an
2 identification of a handover procedure, or a signal quality for a wireless connection between
3 the first wireless device and the first serving cell falling below a signal quality threshold, or a
4 combination thereof.

1 16. The method of claim 1, wherein the second wireless device is
2 associated with the first serving cell.

1 17. The method of claim 1, wherein the second wireless device is
2 associated with a second serving cell different from the first serving cell.

1 18. The method of claim 1, wherein:
2 the first signal characteristic comprises a received signal strength indicator or
3 a signal to interference noise ratio; and
4 the second signal characteristic comprises a reference signal received power.

1 19. The method of claim 1, wherein:
2 the first signal characteristic comprises a reference signal received power; and

the second signal characteristic comprises a received signal strength indicator or a signal to interference noise ratio.

20. The method of claim 1, wherein the comparison of the first signal characteristic to the threshold value comprises:

a received signal strength indicator being at or above the threshold value, the first signal characteristic comprising the received signal strength indicator; or

a signal to interference noise ratio being at or below the threshold value, the first signal characteristic comprising the signal to interference noise ratio; or

a combination thereof.

21. A method for wireless communications at a second wireless device, comprising:

receiving a configuration to transmit reference signals of a cross-link interference measurement procedure;

transmitting, to a first wireless device in a first serving cell, a first reference signal during a first measurement period of the cross-link interference measurement procedure;

identifying resources to use to transmit a second reference signal during a second measurement period of the cross-link interference measurement procedure based at least in part on a comparison of a first signal characteristic of the transmitted first reference signal to a threshold value; and

transmitting, to the first wireless device using the identified resources, the second reference signal for measurement of a second signal characteristic during the second measurement period.

22. The method of claim 21, wherein the configuration to transmit reference signals of the cross-link interference measurement procedure comprises:

an indication triggering transmitting the first reference signal, or transmitting the second reference signal, or a combination thereof; or

an indication of a transmission periodicity for the reference signals; or a resource configuration indicating time-domain and frequency-domain resources for the reference signals; or

a combination thereof.

1 23. The method of claim 21, further comprising:
2 receiving a trigger for the second wireless device to transmit the first reference
3 signal during the first measurement period, or the second reference signal during the second
4 measurement period, or a combination thereof.

1 24. The method of claim 21, wherein:
2 the first reference signal is transmitted during the first measurement period
3 according to a first periodicity; and
4 the second reference signal is transmitted during the second measurement
5 period according to a second periodicity greater than the first periodicity based at least in part
6 on the first signal characteristic failing to exceed the threshold value.

1 25. The method of claim 21, wherein:
2 the first reference signal is transmitted during the first measurement period
3 according to a first periodicity; and
4 the second reference signal is transmitted during the second measurement
5 period according to a second periodicity less than the first periodicity based at least in part on
6 the first signal characteristic exceeding the threshold value.

1 26. The method of claim 21, further comprising:
2 receiving, on the first serving cell, a cross-link interference measurement
3 configuration indicating resources for the second wireless device to use to transmit the first
4 reference signal during the first measurement period and the second reference signal during
5 the second measurement period.

1 27. The method of claim 21, further comprising:
2 transmitting, to the first wireless device, the second reference signal based at
3 least in part on an event trigger, wherein the event trigger comprises an identification of a
4 handover procedure, or a signal quality for a wireless connection between the first wireless
5 device and the first serving cell falling below a signal quality threshold, or a combination
6 thereof.

1 28. The method of claim 21, wherein the comparison of the first signal
2 characteristic to the threshold value comprises:

3 a received signal strength indicator being at or above the threshold value, the
4 first signal characteristic comprising the received signal strength indicator; or;
5 a signal to interference noise ratio being at or below the threshold value, the
6 first signal characteristic comprising the signal to interference noise ratio; or; and
7 a combination thereof.

1 29. An apparatus for wireless communications at a first wireless device
2 associated with a first serving cell, comprising:
3 a processor,
4 memory in electronic communication with the processor; and
5 instructions stored in the memory and executable by the processor to cause the
6 apparatus to:
7 receive, from the first serving cell, a configuration to receive and
8 measure reference signals of a cross-link interference measurement procedure;
9 receive, from a second wireless device, a first reference signal during a
10 first measurement period of the cross-link interference measurement procedure;
11 measure a first signal characteristic of the first reference signal;
12 receive, from the second wireless device, a second reference signal
13 during a second measurement period of the cross-link interference measurement
14 procedure based at least in part on a comparison of the first signal characteristic to a
15 threshold value;
16 measure a second signal characteristic of the second reference signal,
17 the second signal characteristic different from the first signal characteristic; and
18 determine a cross-link interference value based at least in part on the
19 second signal characteristic.

1 30. An apparatus for wireless communications at a second wireless device,
2 comprising:
3 a processor,
4 memory in electronic communication with the processor; and
5 instructions stored in the memory and executable by the processor to cause the
6 apparatus to:

7 receive a configuration to transmit reference signals of a cross-link
8 interference measurement procedure;
9 transmit, to a first wireless device in a first serving cell, a first
10 reference signal during a first measurement period of the cross-link interference
11 measurement procedure;
12 identify resources to use to transmit a second reference signal during a
13 second measurement period of the cross-link interference measurement procedure
14 based at least in part on a comparison of a first signal characteristic of the transmitted
15 first reference signal to a threshold value; and
16 transmit, to the first wireless device using the identified resources, the
17 second reference signal for measurement of a second signal characteristic during the
18 second measurement period.

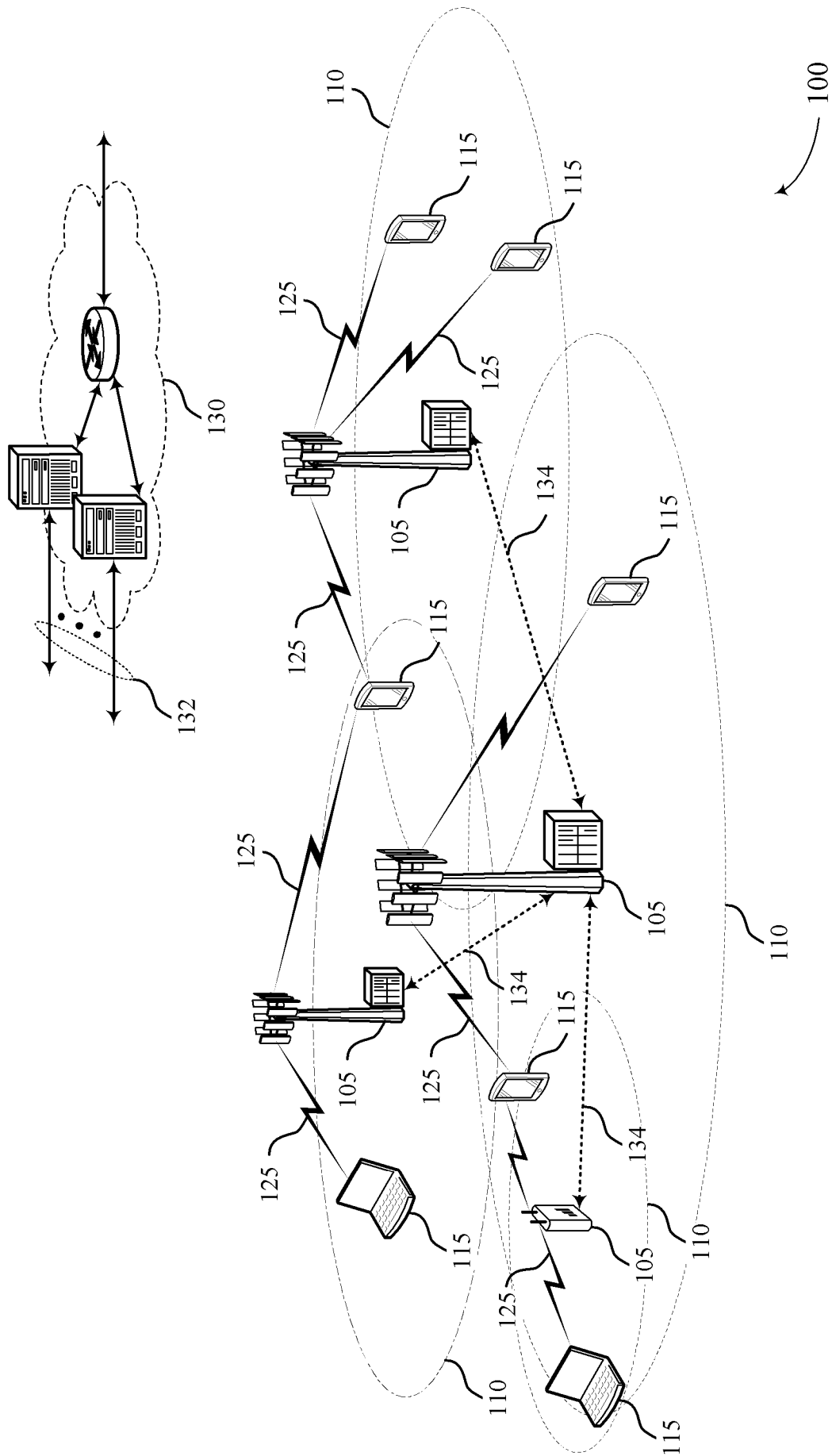


FIG. 1

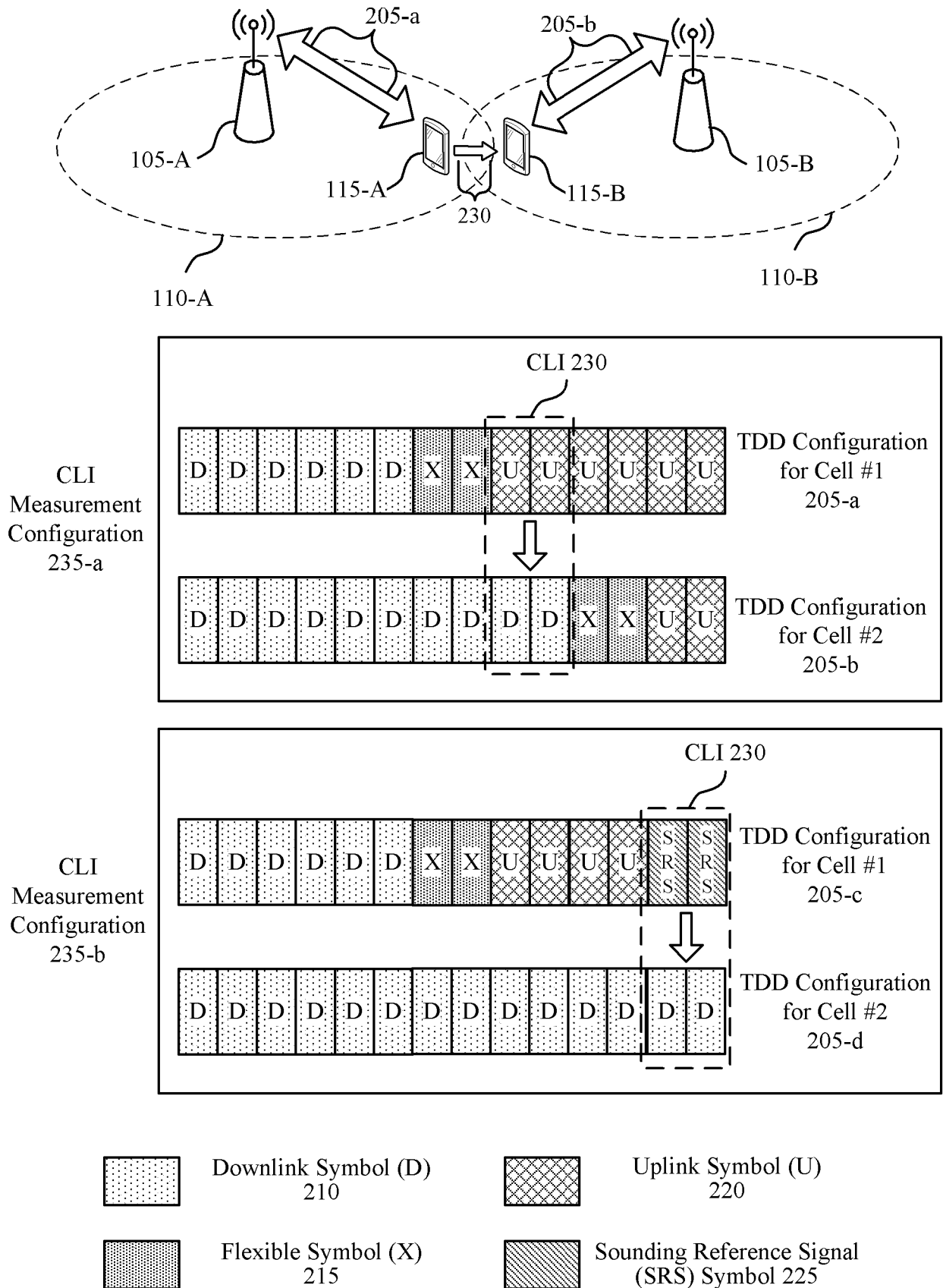


FIG. 2

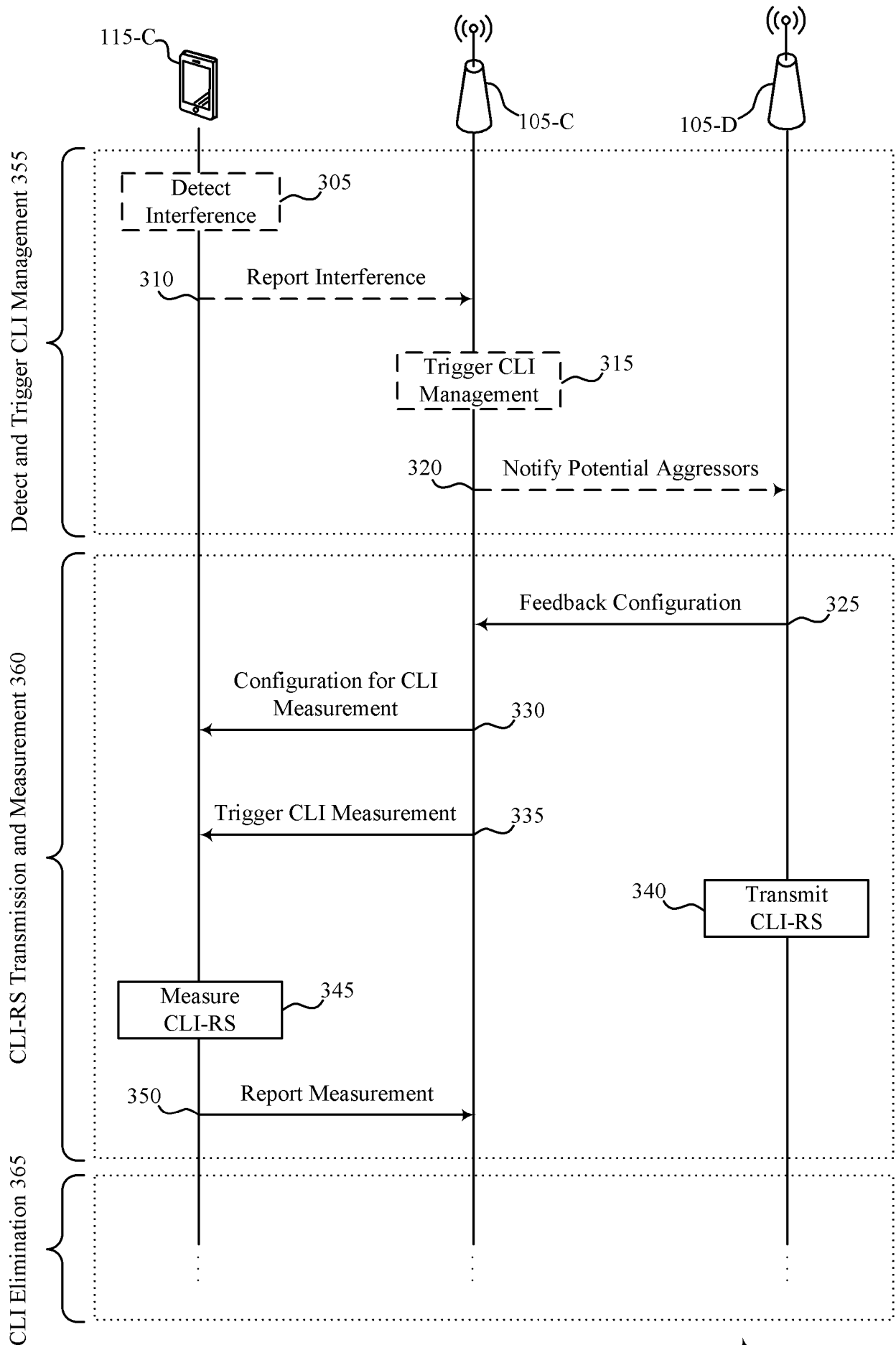


FIG. 3

300

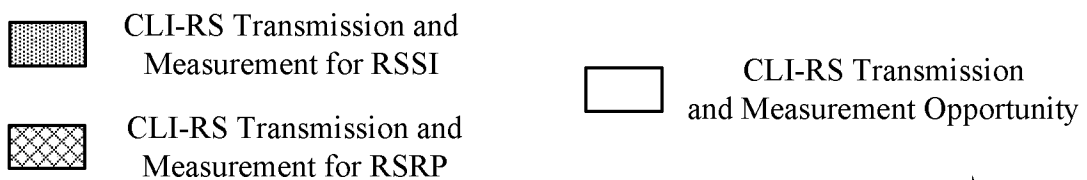
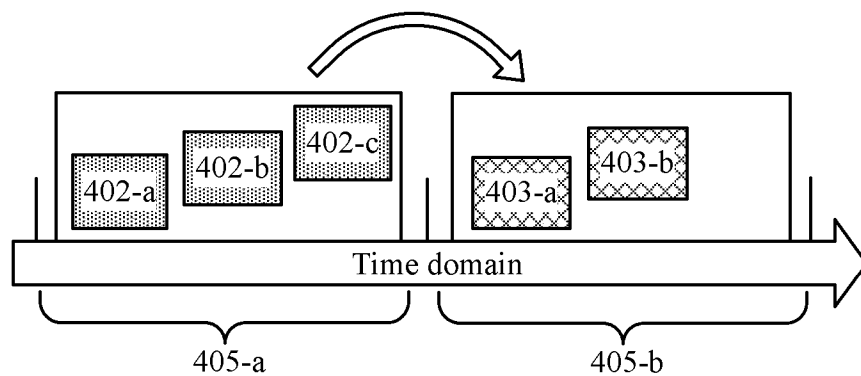
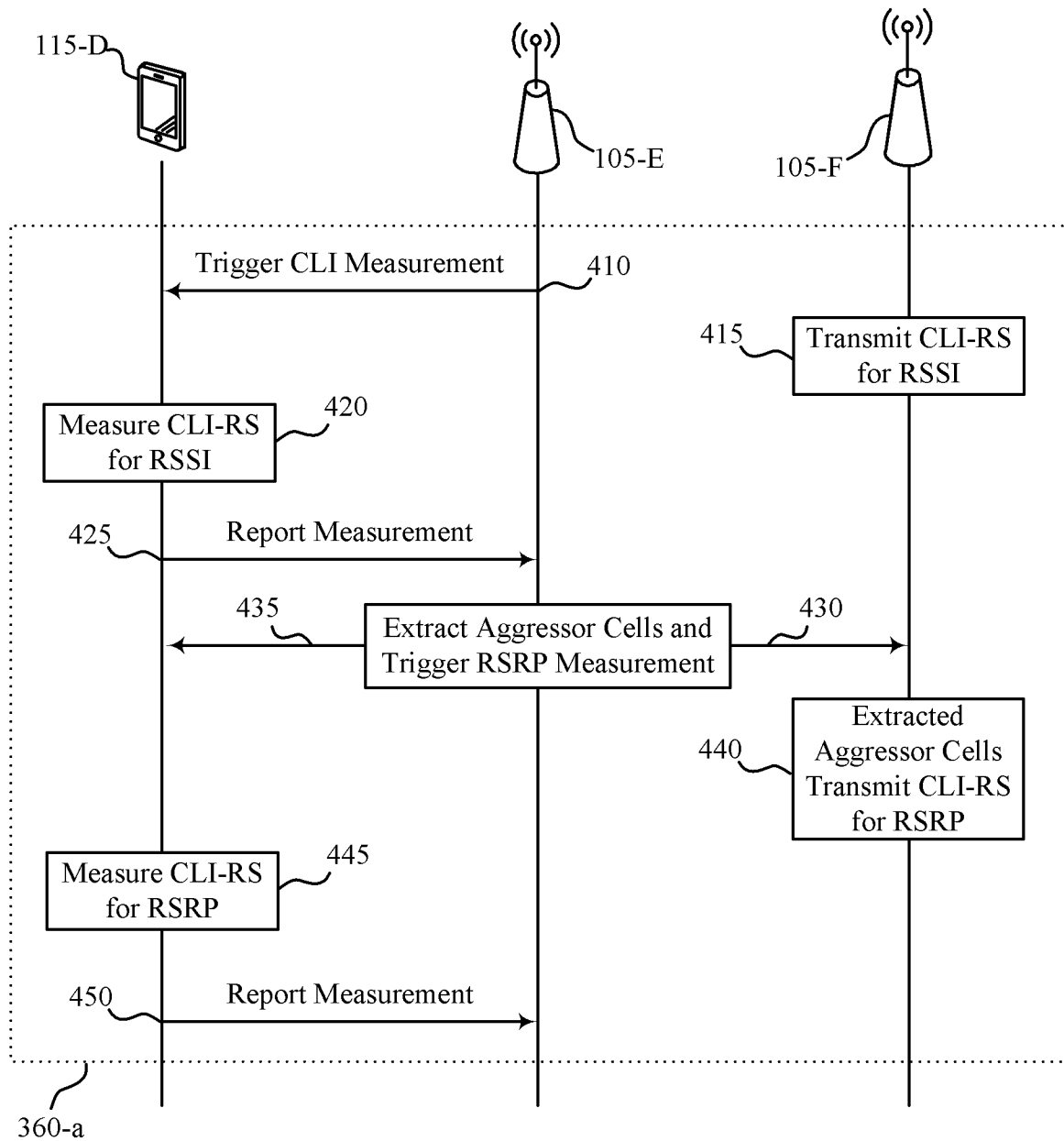


FIG. 4

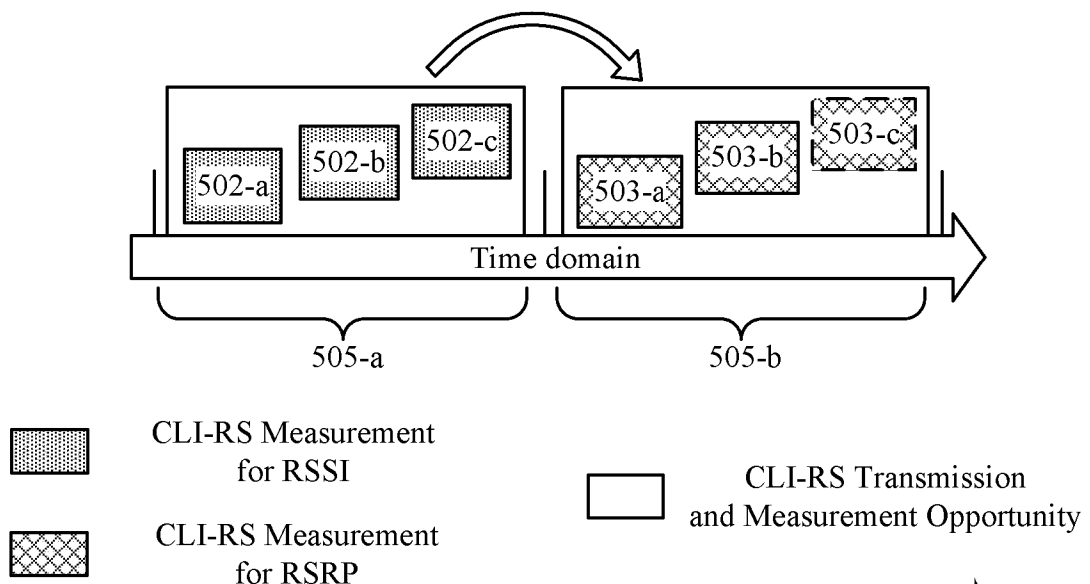
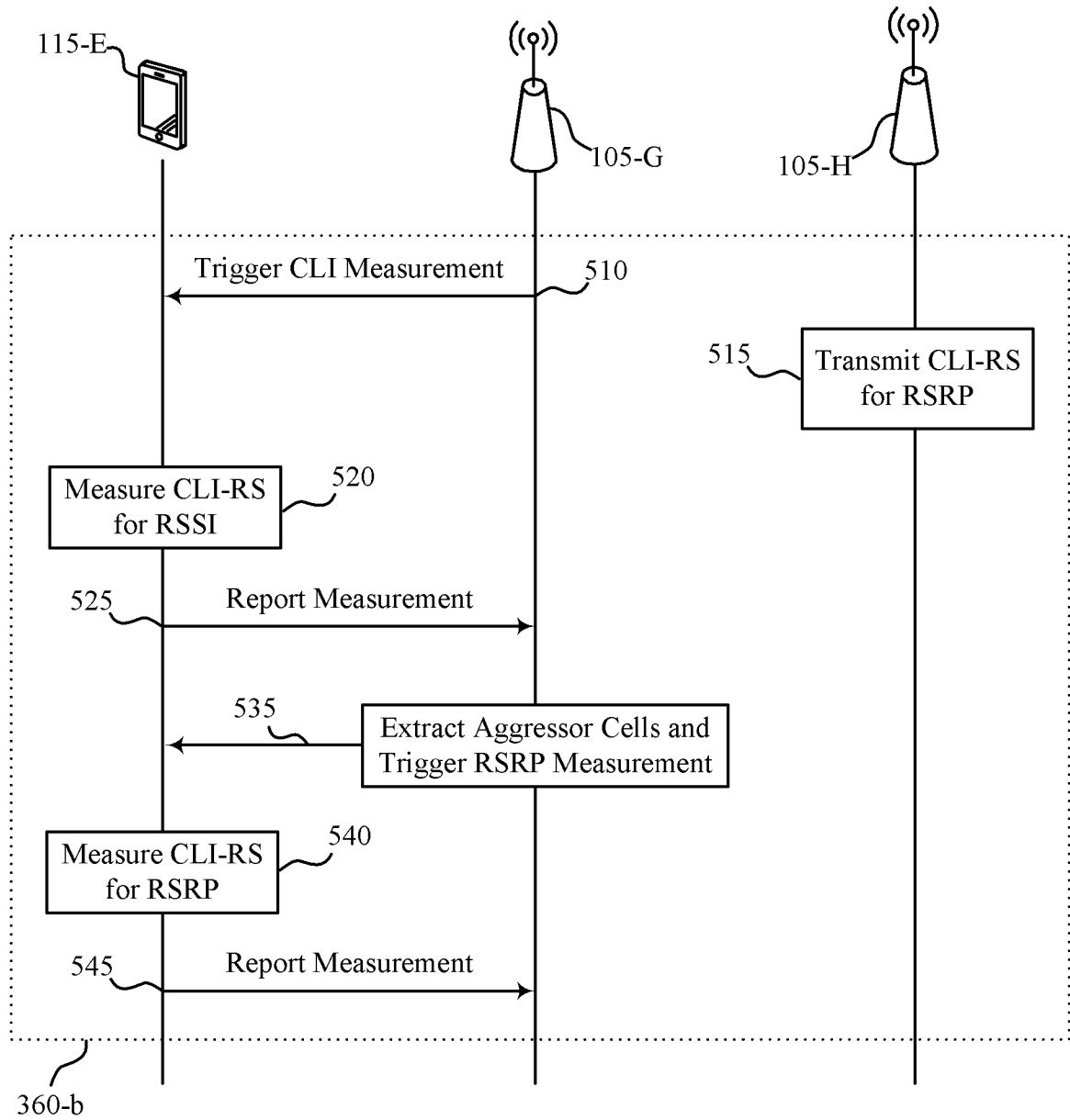


FIG. 5

500

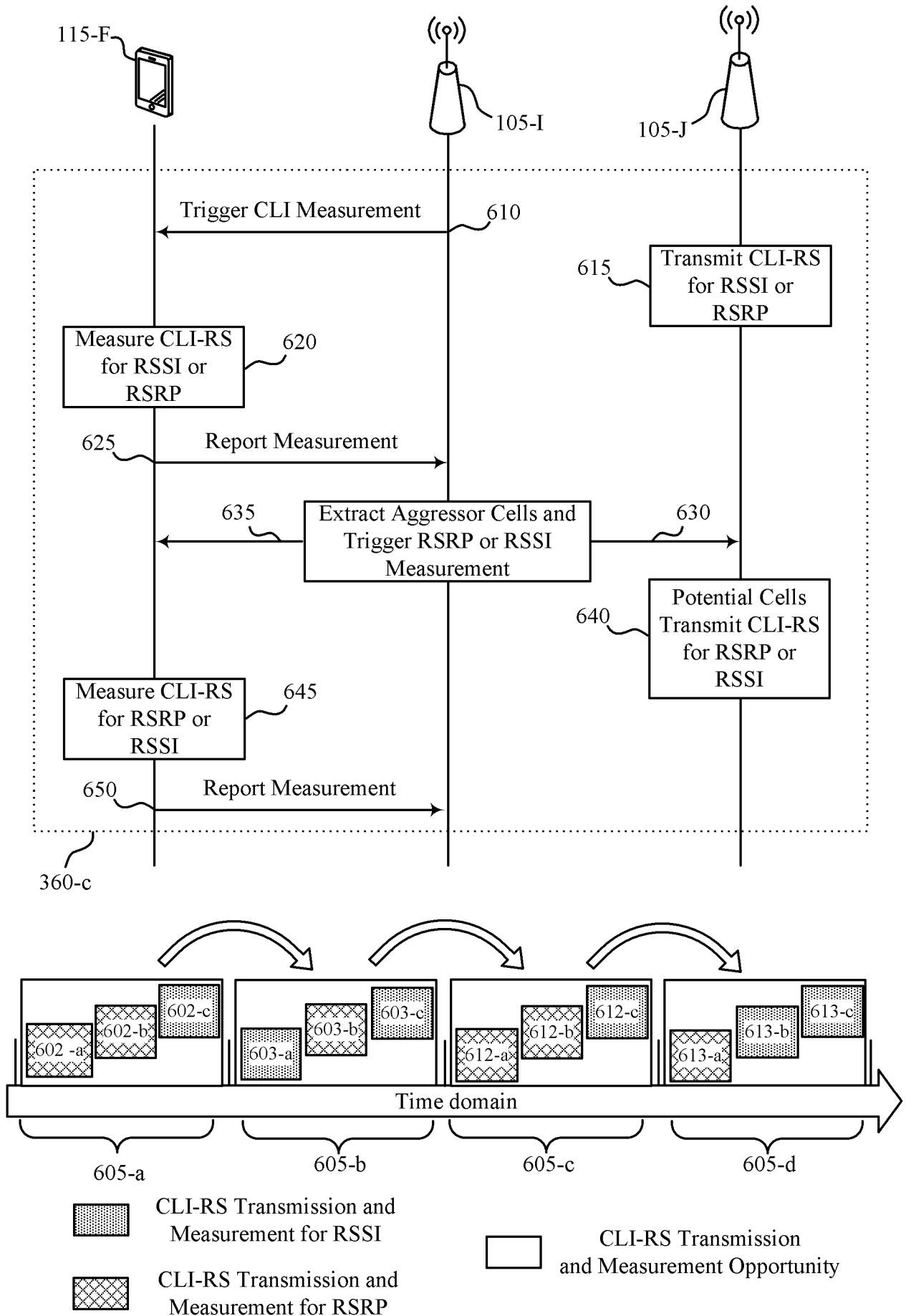


FIG. 6

600

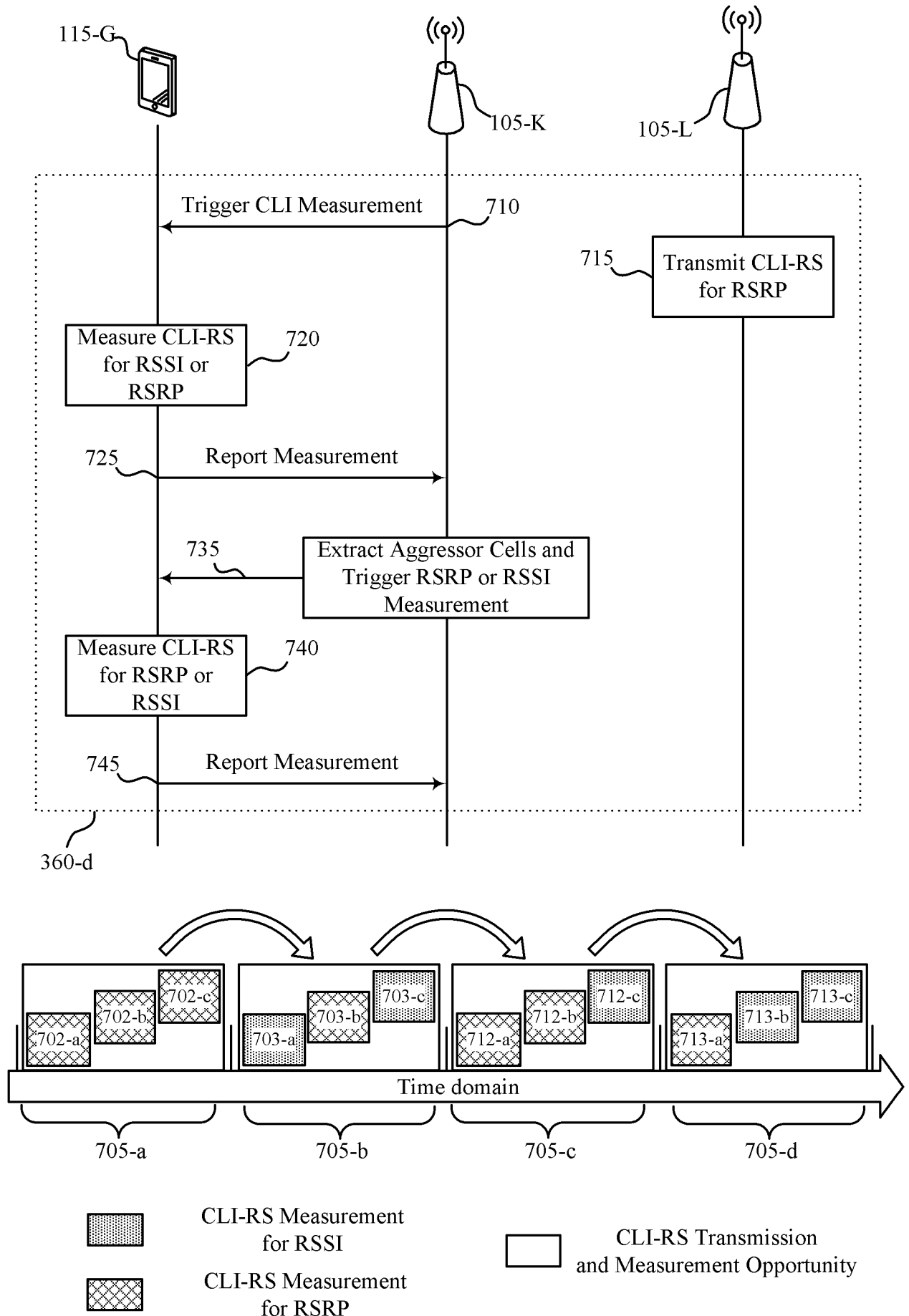


FIG. 7

700

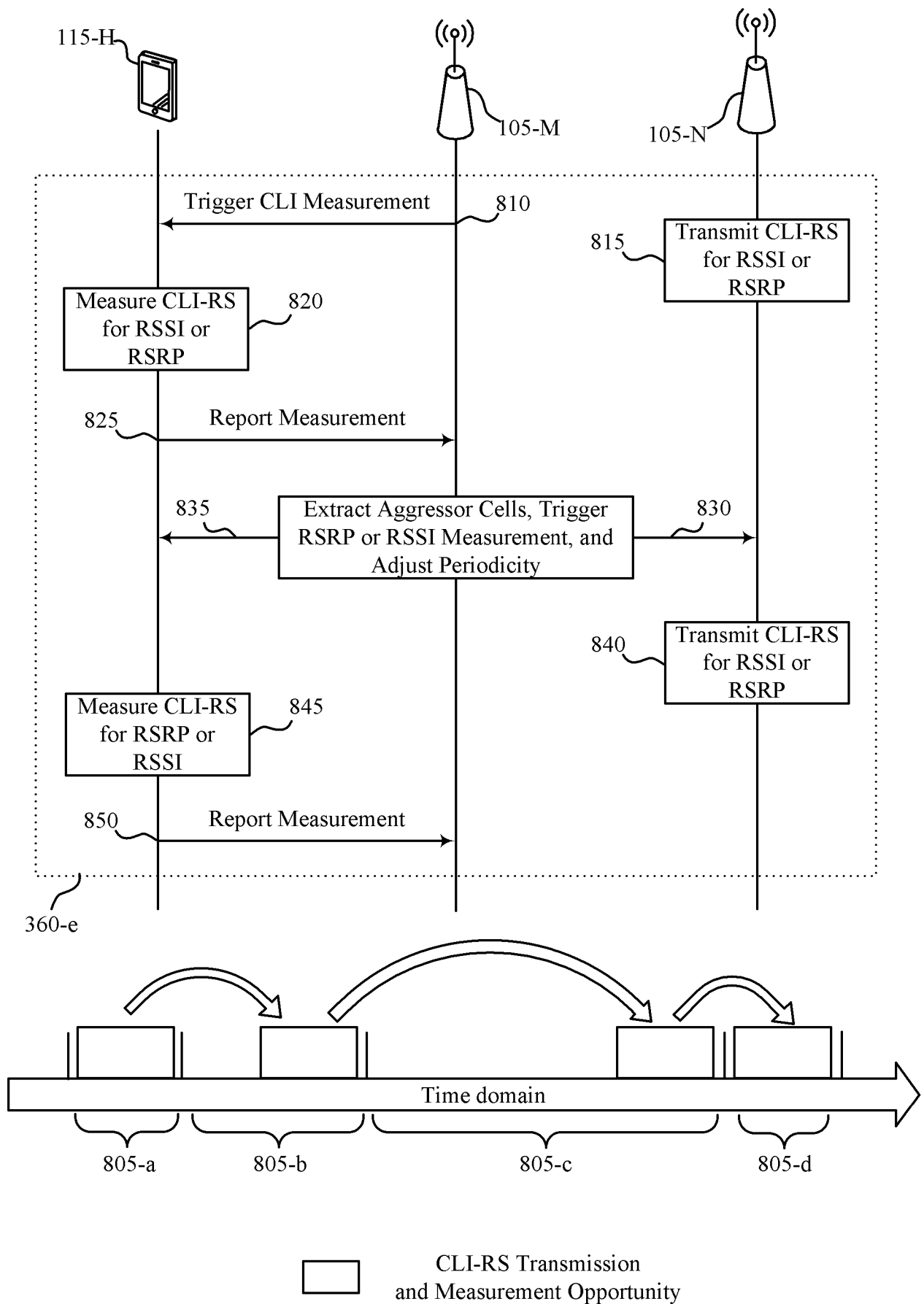


FIG. 8

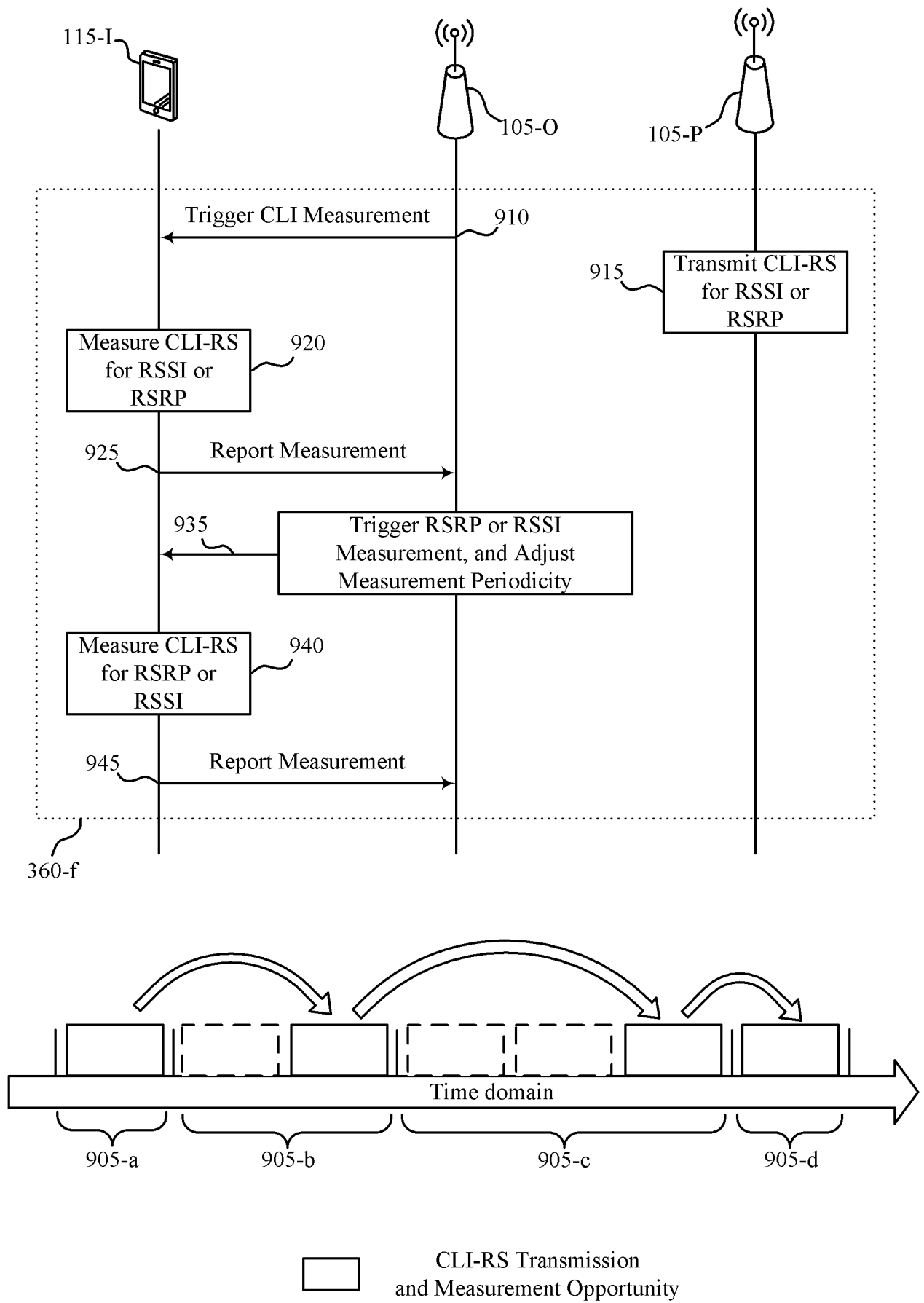


FIG. 9

900

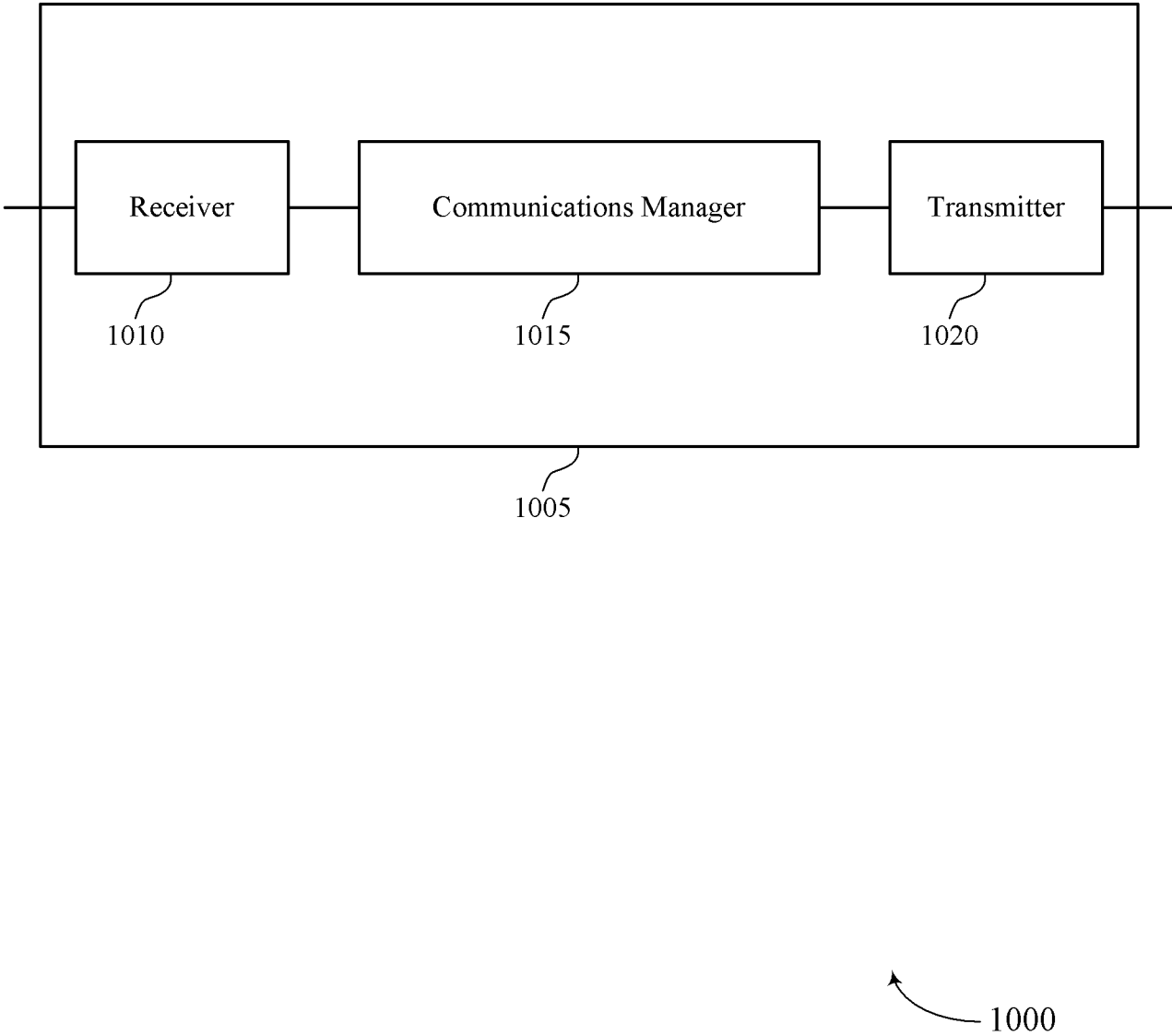


FIG. 10

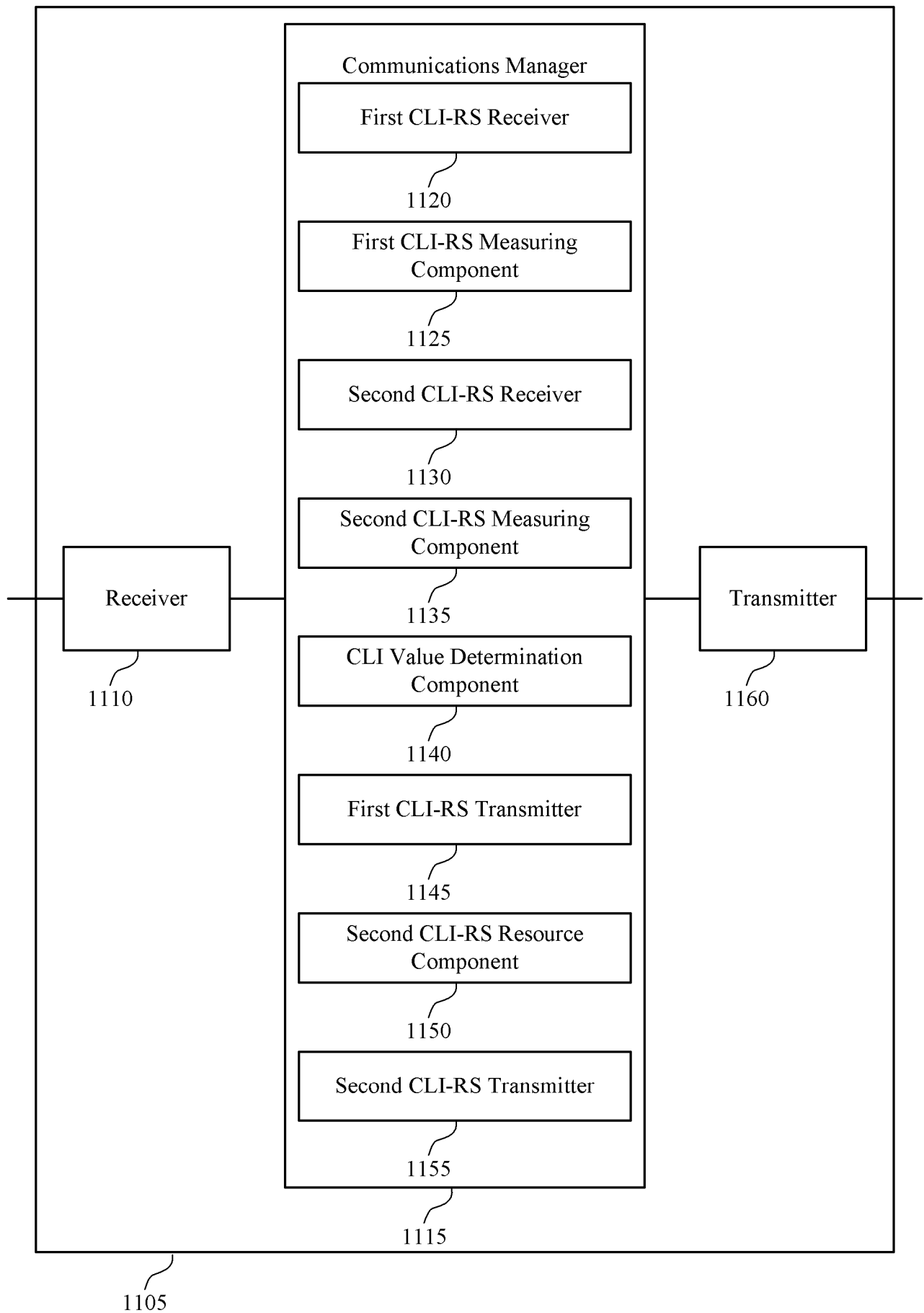


FIG. 11

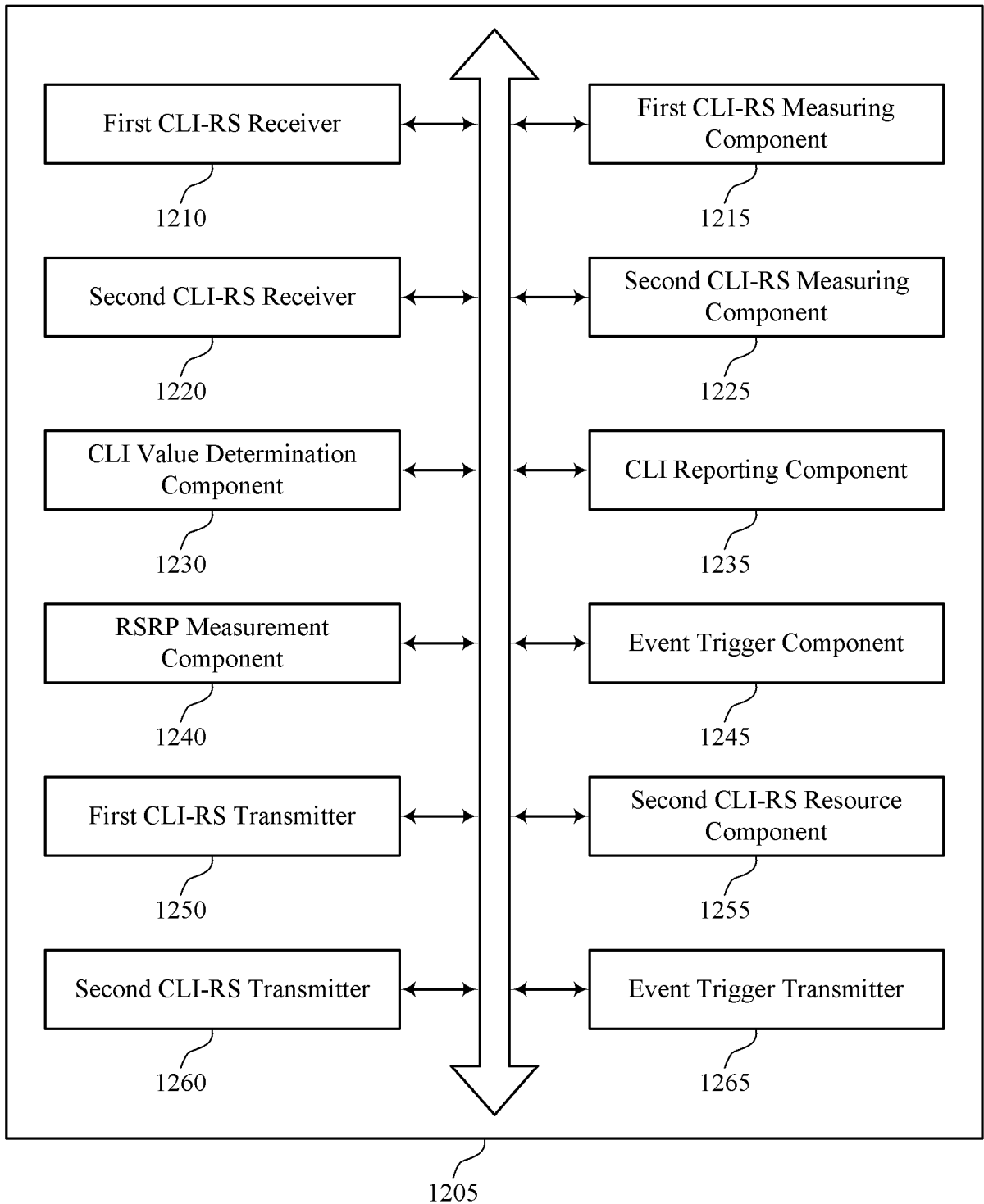


FIG. 12

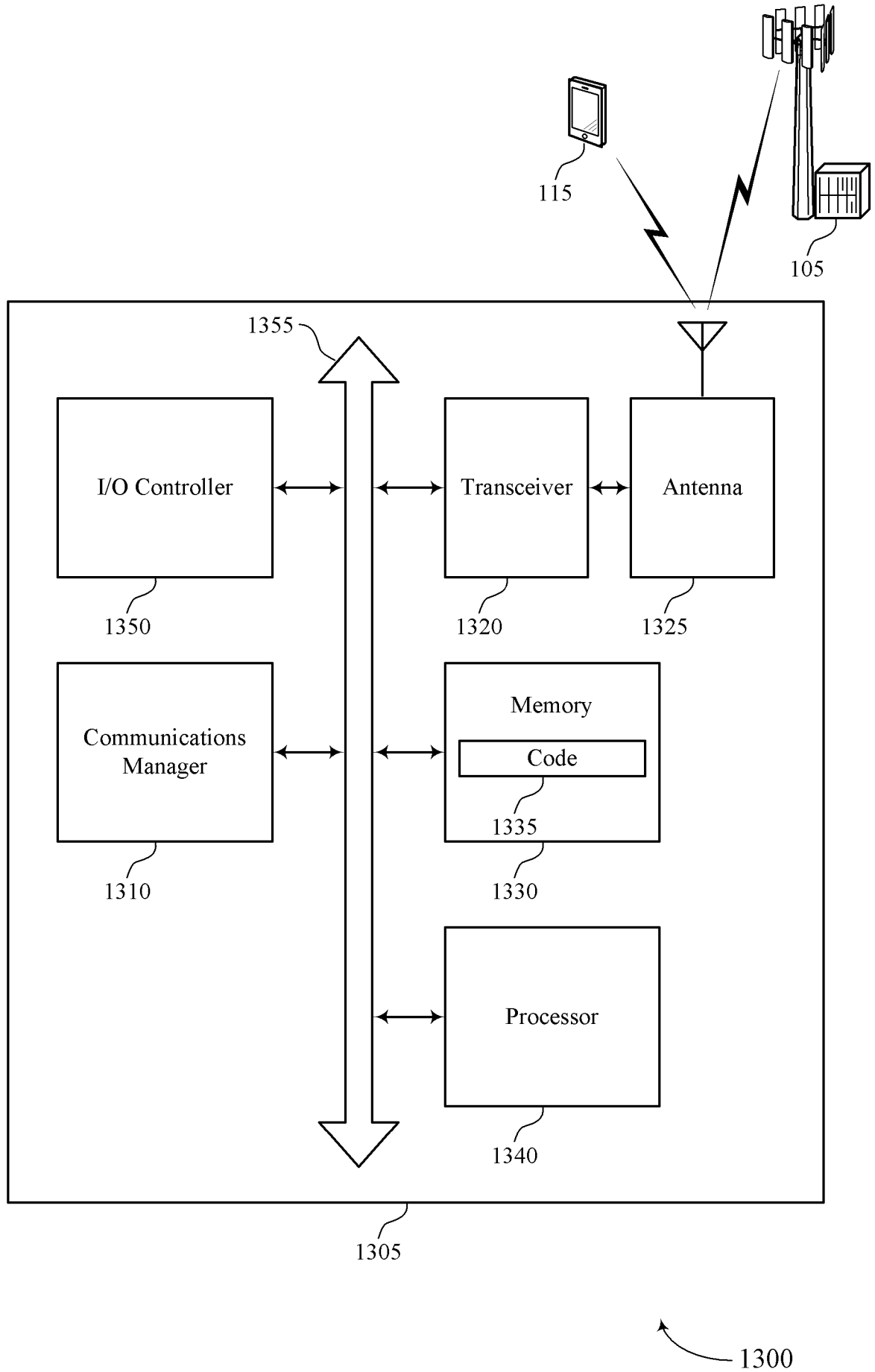


FIG. 13

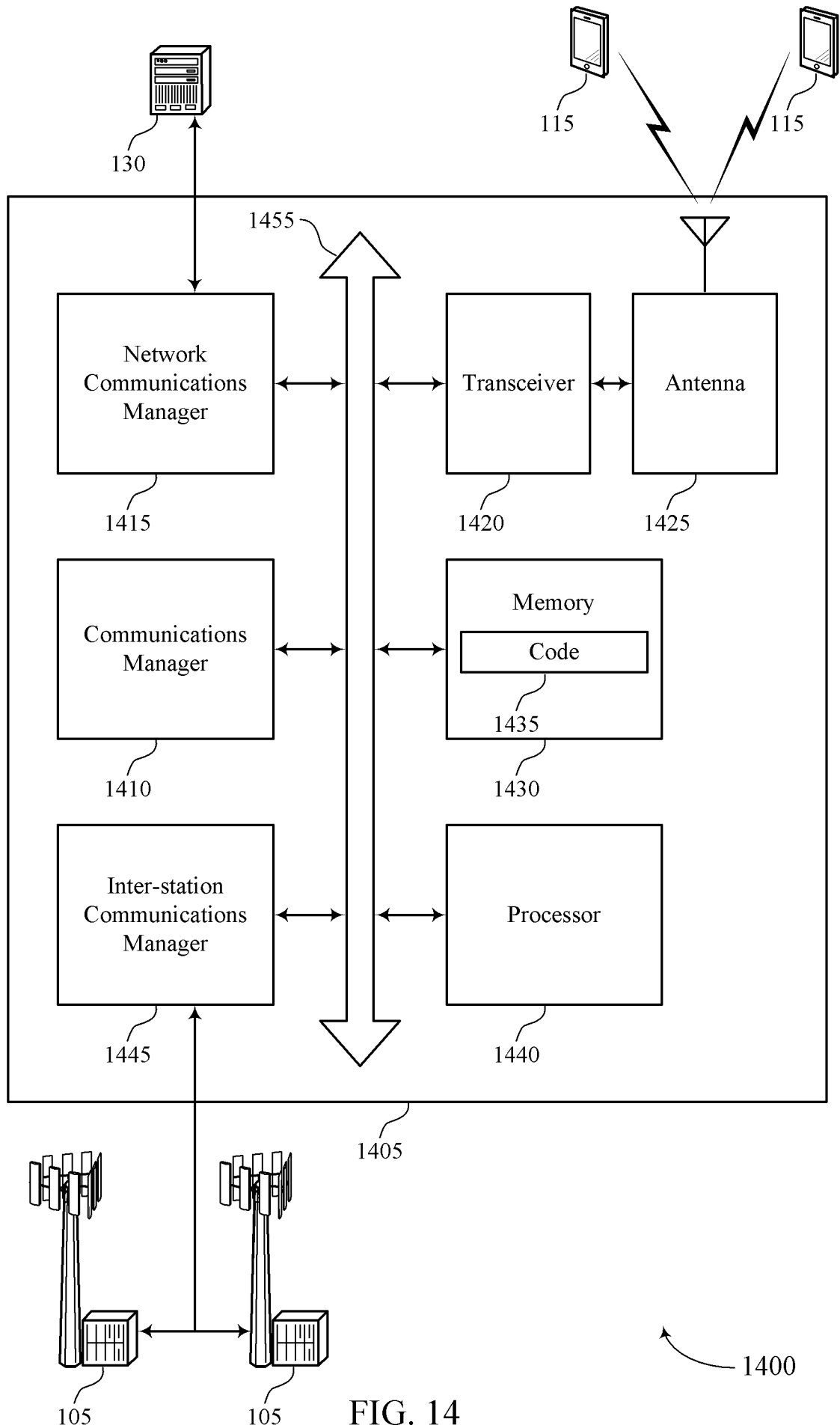
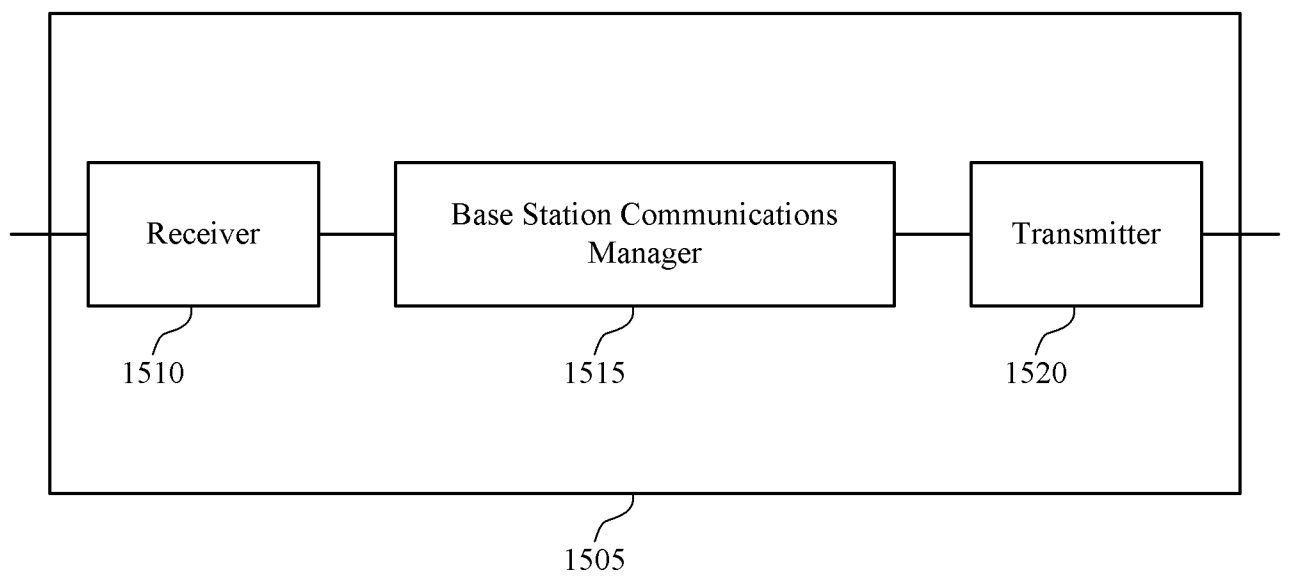


FIG. 14



1500

FIG. 15

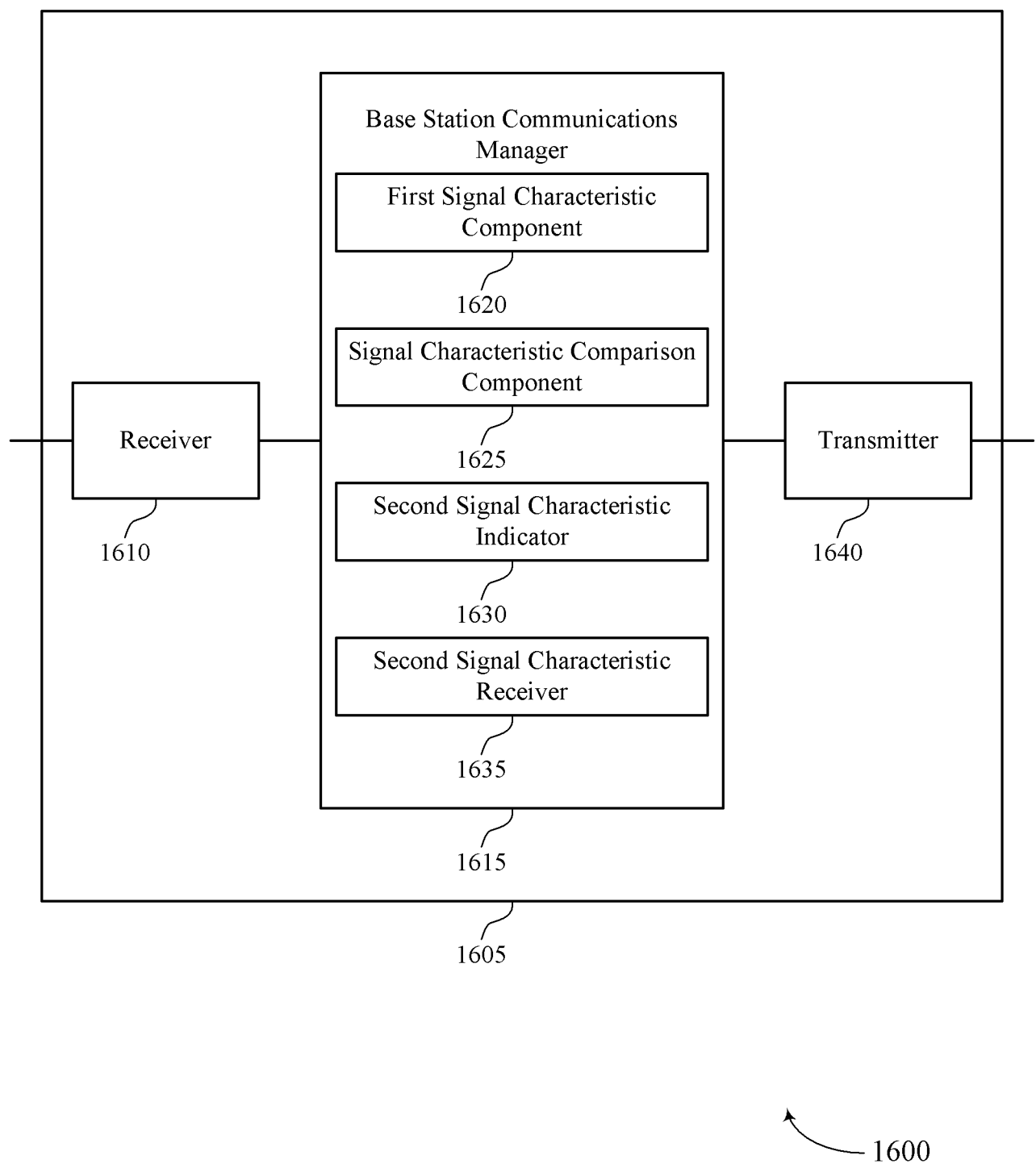


FIG. 16

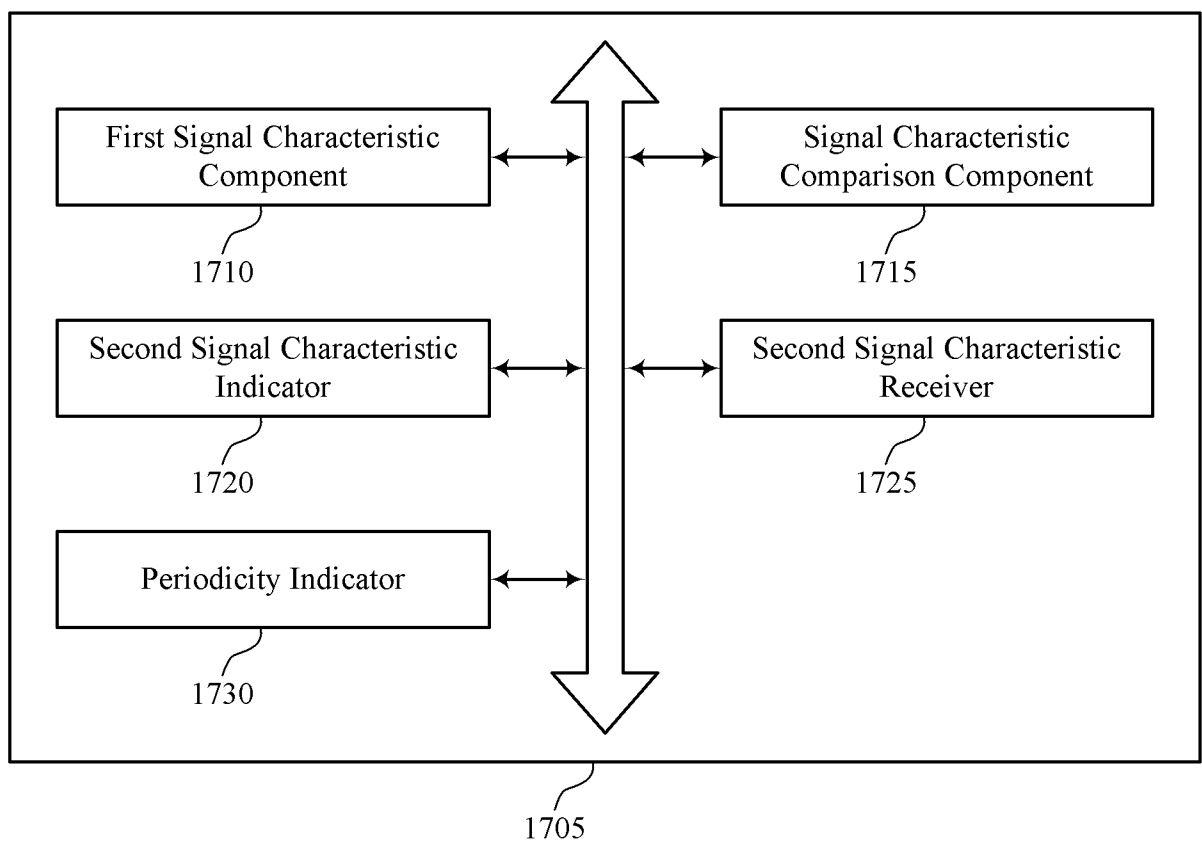


FIG. 17

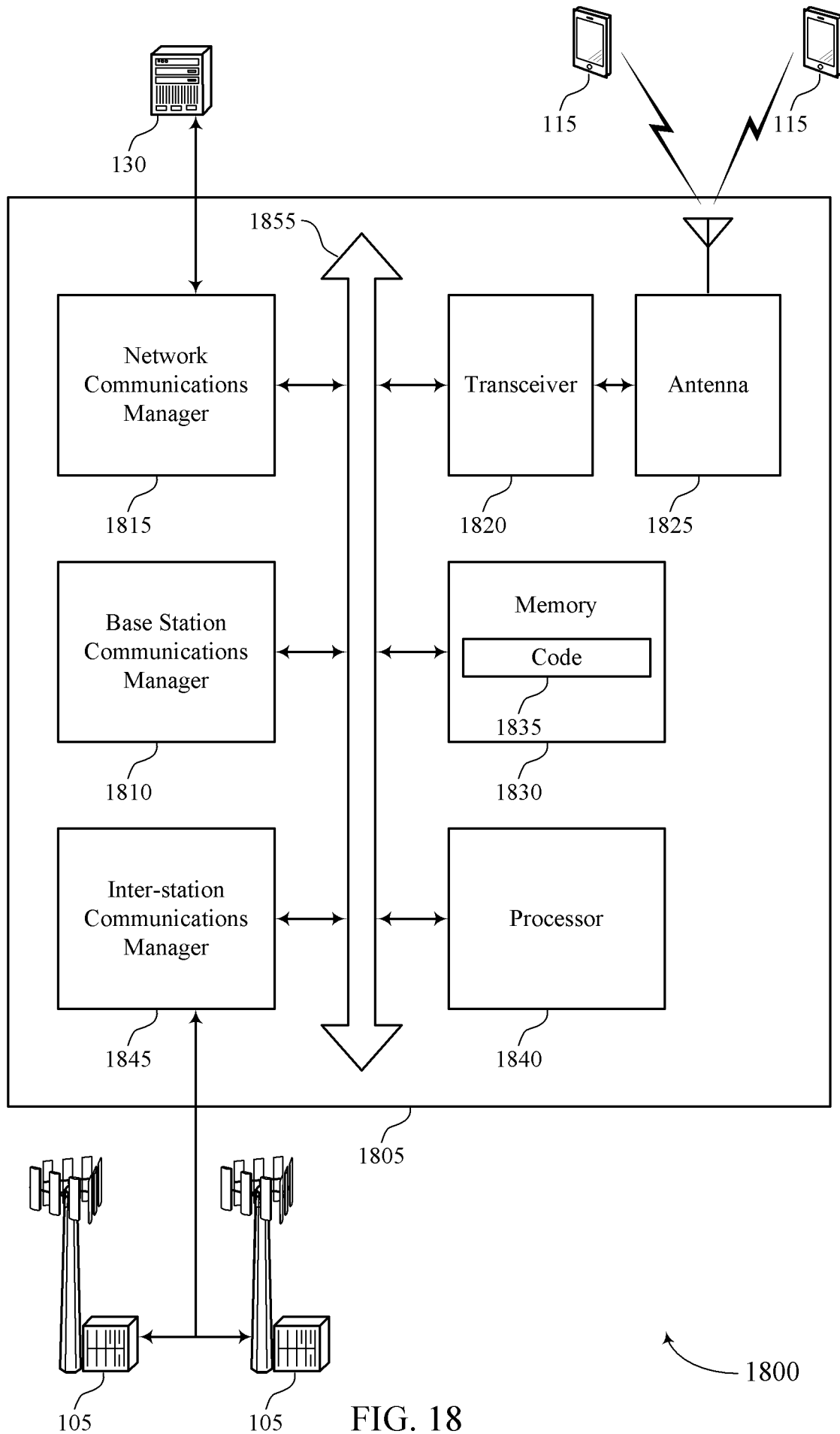


FIG. 18

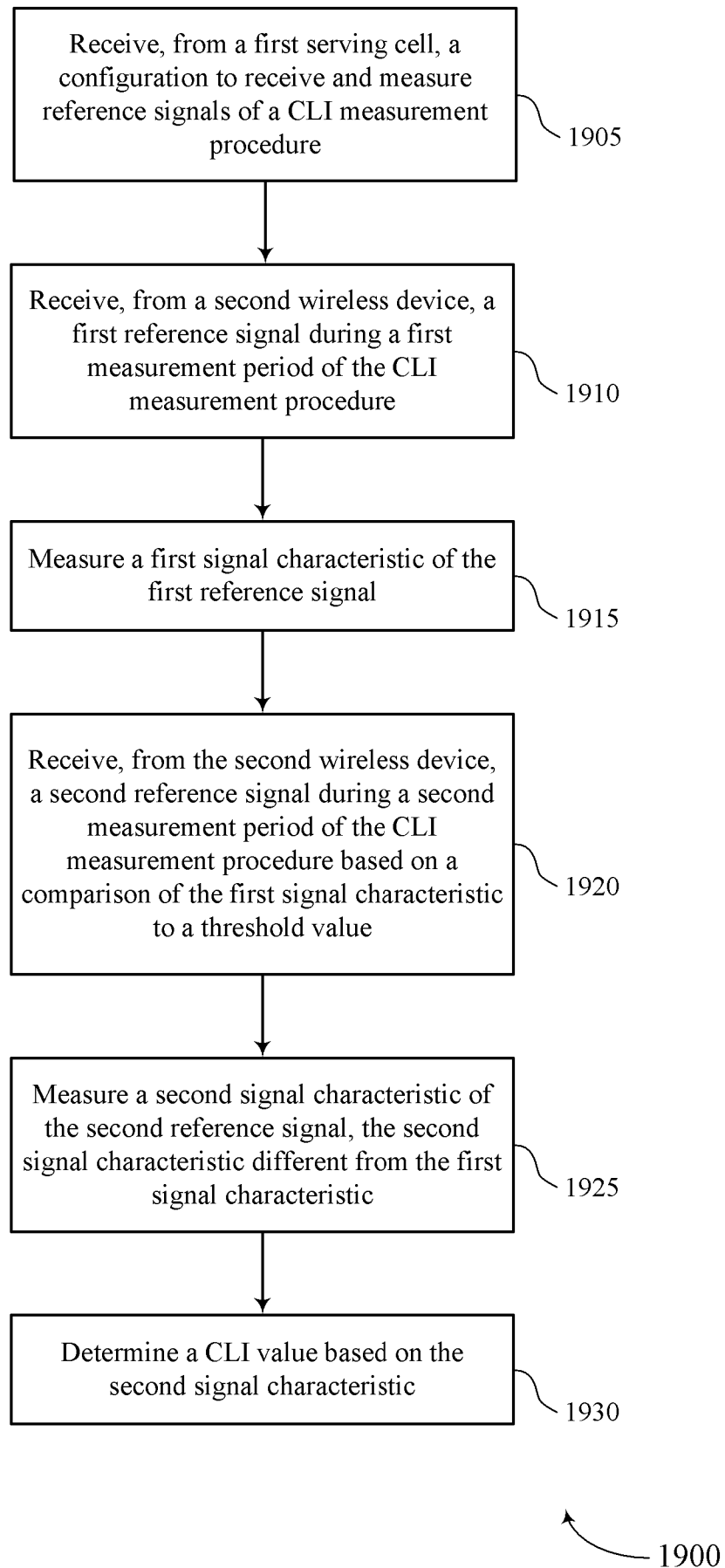


FIG. 19

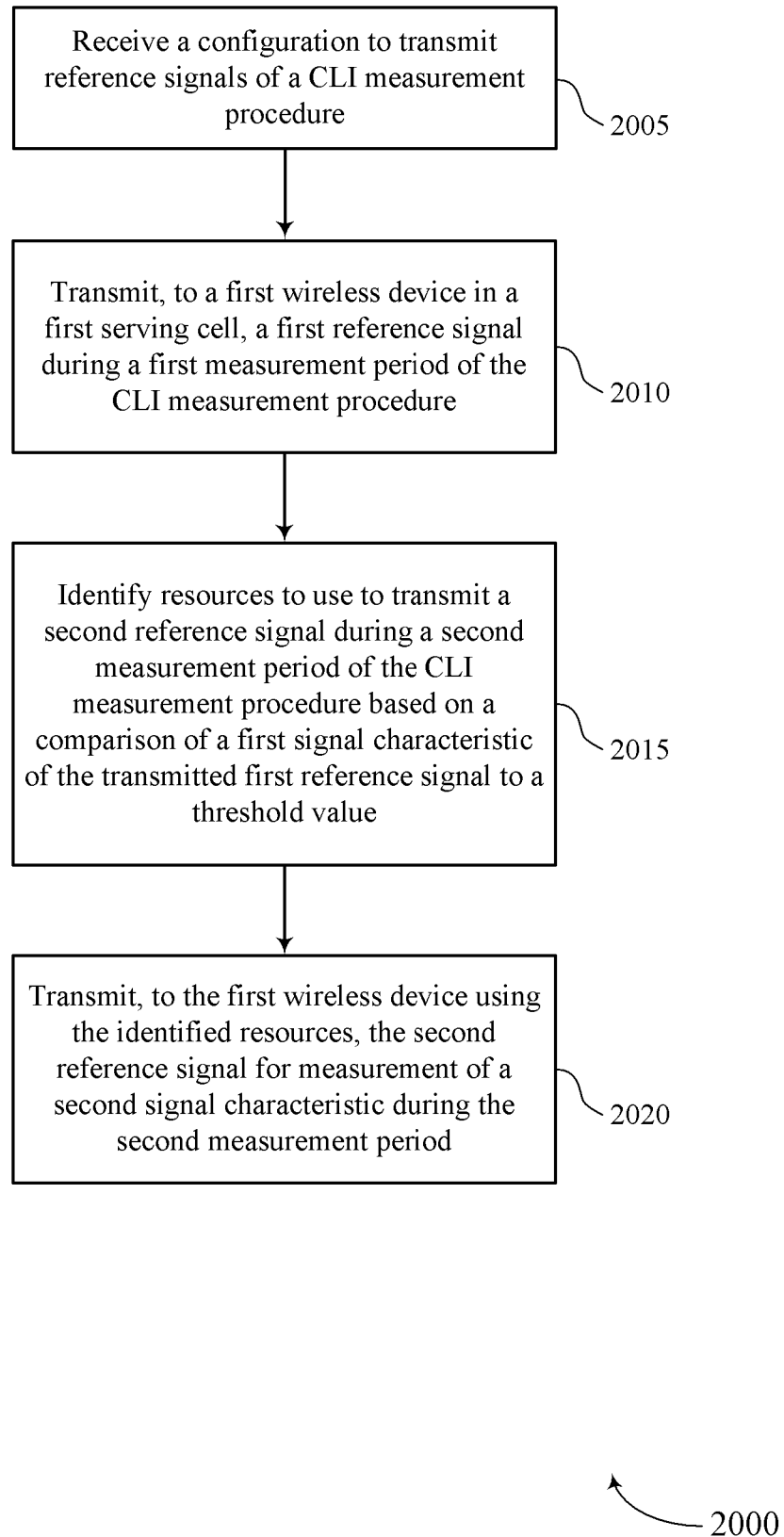


FIG. 20

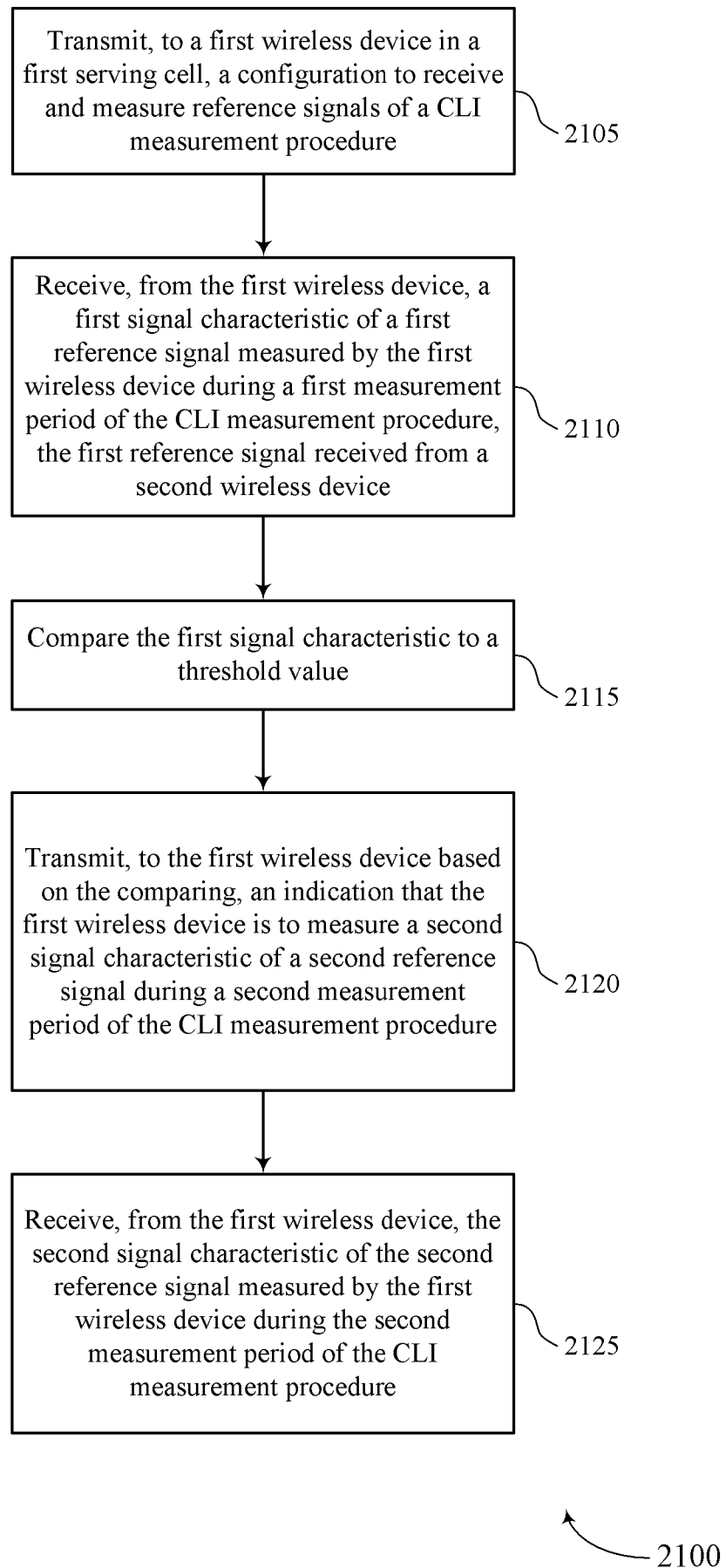


FIG. 21

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/074810

A. CLASSIFICATION OF SUBJECT MATTER

H04W 24/00(2009.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W H04Q H04B H04L

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

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

CNPAT,WPI,EPODOC,CNKI,3GPP :second, RSSI, signal, CLI, SINR, LINK, CROSS, RSRP, reference signal, threshold, crosslink interference, RS, INTERFERENCE, CSI, CQI, CSI-RS,SNR

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	LG ELECTRONICS. "Summary#2 of Issues on UE-UE CLI measurements and Network Coordination Mechanism" <i>R1-1901373</i> , 3GPP TSG RAN WG1 Ad-Hoc Meeting 1901, 23 January 2019 (2019-01-23), sections 2.2-2.8	1-30
Y	CN 105375962 A (ZTE CORPORATION) 02 March 2016 (2016-03-02) description, paragraphs 0075-0100, and figures 1-2	1-30
Y	ZTE. "Channel sensing based schemes for cross-link interference mitigation in NR" <i>R1-1710129</i> , 3GPP TSG RAN WG1 NR Ad-Hoc#2, 16 June 2017 (2017-06-16), section 2	1-30
Y	CN 108289311 A (ZTE CORPORATION) 17 July 2018 (2018-07-17) description, paragraphs 0040-0159, 0224-0461, and figures 1-3, and 6-8	1-30
Y	ZTE. "TRP-to-TRP measurement as an enabler for CLI mitigation schemes" <i>R1-1712283</i> , 3GPP TSG RAN WG1 Meeting #90, 11 August 2017 (2017-08-11), section 2	1-30
A	CN 109152063 A (HUAWEI TECHNOLOGIES CO., LTD.) 04 January 2019 (2019-01-04) the whole document	1-30



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

19 March 2020

Date of mailing of the international search report

24 April 2020

Name and mailing address of the ISA/CN

National Intellectual Property Administration, PRC
6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing
100088
China

Authorized officer

ZHANG, Jiakai

Facsimile No. (86-10)62019451

Telephone No. 86-(10)-53961760

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/074810

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2018213578 A1 (QUALCOMM INC.) 22 November 2018 (2018-11-22) the whole document	1-30

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2020/074810

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	105375962	A	02 March 2016	WO	2015184918	A1	10 December 2015
				US	2017302420	A1	19 October 2017
				CN	105375962	B	26 April 2019
CN	108289311	A	17 July 2018	WO	2018126792	A1	12 July 2018
CN	109152063	A	04 January 2019	EP	2922341	A4	02 December 2015
				US	2015288490	A1	08 October 2015
				CN	104067662	A	24 September 2014
				CN	104067662	B	06 November 2018
				EP	2922341	B1	28 February 2018
				US	9942012	B2	10 April 2018
				WO	2014094195	A1	26 June 2014
				EP	3373649	A1	12 September 2018
				US	2018191474	A1	05 July 2018
				EP	2922341	A1	23 September 2015
WO	2018213578	A1	22 November 2018	US	2018337756	A1	22 November 2018
				CN	110622462	A	27 December 2019