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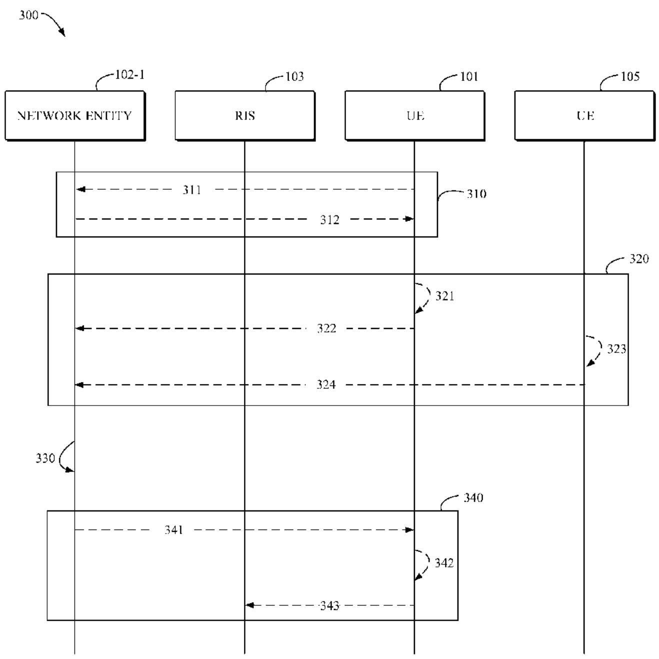


FIG. 3

(57) **Abstract:** Various aspects of the present disclosure relate to devices and methods of communication. In one aspect, when a handover of a control node of a RIS from a BS is triggered, a UE performs a measurement of a link between the UE and the RIS, and transmit the measurement to the BS. Upon obtaining a set of measurements of a set of links between a set of UEs and the RIS, the BS determines a UE from the first set of UEs at least based on the set of measurements. Upon CN authorizing the determined UE to control and configured RIS, the BS performs handover of the control node of the RIS from the BS to the determined UE. In this way, by obtaining measurements of links between UEs and the RIS, the handover of the control node of the RIS from the BS to the UE may be carried out, and continuous communication for a RIS-assisted network may be ensured.

WO 2024/198532 A1

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# DEVICES AND METHODS OF COMMUNICATION

## TECHNICAL FIELD

**[0001]** The present disclosure relates to wireless communications, and more specifically to devices and methods of communication for a reconfigurable intelligent surface (RIS)-assisted network.

## BACKGROUND

**[0002]** A wireless communications system may include one or multiple network communication devices, such as base stations (BSs), which may be otherwise known as an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. Each network communication devices, such as a base station may support wireless communications for one or multiple user communication devices, which may be otherwise known as user equipment (UE), or other suitable terminology. The wireless communications system may support wireless communications with one or multiple user communication devices by utilizing resources of the wireless communication system (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers). Additionally, the wireless communications system may support wireless communications across various radio access technologies including third generation (3G) radio access technology, fourth generation (4G) radio access technology, fifth generation (5G) radio access technology, among other suitable radio access technologies beyond 5G (e.g., sixth generation (6G)).

**[0003]** Deploying RISs on surfaces of various objects in wireless transmission environments is expected to break through uncontrollability of traditional wireless channels, builds an intelligent programmable wireless environment, and introduces a new paradigm for future wireless communication. As identified by researchers from at home and abroad, a RIS may be deployed with a stationary manner (e.g., RIS is deployed at facades of buildings or indoor walls/ceilings) and with a non-stationary manner. Currently, a solution of controlling a RIS is still incomplete and needs to be further developed.

## SUMMARY

[0004] The present disclosure relates to methods, apparatuses, and systems that support a control of a RIS. By obtaining measurements of links between UEs and a RIS, and/or initiating an authorization for a UE to control a RIS, a handover of a control node of a RIS from a BS to a UE may be carried out.

[0005] In one aspect, some implementations of the method and apparatuses described herein comprise: in accordance with a determination that a handover of a control node of a RIS from the base station is triggered, obtaining a set of measurements of a set of links between a first set of UEs and the RIS; determining a first UE from the first set of UEs at least based on the set of measurements; and performing the handover of the control node of the RIS from the base station to the first UE.

[0006] Some implementations of the method and apparatuses described herein further comprise: determining that the handover of the control node of the RIS is triggered by at least one of the following: receiving, via a transceiver, an indication of the handover of the control node of the RIS from a second set of UEs served by the RIS, quality of service (QoS) requirements of the second set of UEs being unsatisfied; or transmitting, via the transceiver, a request for the handover of the control node of the RIS to a third set of UEs served by the RIS based on at least one of the following: no resources are available to transmit control information to the RIS, capability of transmitting the control information to the RIS is limited, the RIS moves out of coverage of the base station, or signal quality of a link between the base station and the RIS is lower than or equal to a quality threshold.

[0007] In some implementations of the method and apparatuses described herein, obtaining the set of measurements may comprise: determining control information of the RIS; transmitting, to the RIS via the transceiver, the control information for forwarding of a reference signal, the reference signal being transmitted from a UE in the first set of UEs to the RIS; and receiving, from the UE or a further base station serving the UE via the transceiver, a measurement on the reference signal forwarded to the UE.

[0008] In some implementations of the method and apparatuses described herein, determining the control information may comprise: determining information of a direction of the reference signal from the UE to the RIS; and deriving the control information from the information of the direction of the reference signal.

**[0009]** In some implementations of the method and apparatuses described herein, determining the information of the direction of the reference signal may comprise: transmitting, to the UE or the further base station via the transceiver, a request for location information of the UE, the request comprising location information of the RIS; and receiving, from the UE or the further base station via the transceiver, the information of the direction of the reference signal.

**[0010]** In some implementations of the method and apparatuses described herein, determining the information of the direction of the reference signal may comprise: transmitting, to the UE or the further base station via the transceiver, a request for location information of the UE, the request comprising location information of the RIS; receiving, from the UE or the further base station via the transceiver, the location information of the UE; and deriving the information of the direction of the reference signal based on the location information of the UE and the location information of the RIS. Some implementations of the method and apparatuses described herein further comprises: transmitting the information of the direction of the reference signal to the UE or the further base station via the transceiver.

**[0011]** In some implementations of the method and apparatuses described herein, the location information of the RIS may comprise at least one of the following: a location of the RIS; refresh time of the location of the RIS; validity time of the location of the RIS; a fluctuation of the location of the RIS within an area; or a moving state of the RIS.

**[0012]** In some implementations of the method and apparatuses described herein, the location information of the UE is received from the further base station, and comprises at least one of the following: a set of UE lists, a set of identities of UEs in a UE list in the set of UE lists, or location information of a UE in the UE list.

**[0013]** In some implementations of the method and apparatuses described herein, the information of the direction of the reference signal is received from the further base station, and comprises at least one of the following: a set of UE lists, a set of identities of UEs in a UE list in the set of UE lists, or the information of the direction of the reference signal for a UE in the UE list.

**[0014]** In some implementations of the method and apparatuses described herein, the information of the direction of the reference signal may comprise at least one of the following: a horizontal angle of the reference signal; or a vertical angle of the reference signal.

**[0015]** In some implementations of the method and apparatuses described herein, determining the control information may comprise: transmitting, to the UE via the transceiver, a further reference signal comprising location information of the RIS; receiving, from the UE via the transceiver, a further measurement on the further reference signal; and deriving the control information based on the further measurement on the further reference signal.

**[0016]** Some implementations of the method and apparatuses described herein may further comprise: transmitting a first configuration of the reference signal to the UE or the further base station via the transceiver.

**[0017]** Some implementations of the method and apparatuses described herein may further comprise: transmitting a set of resources available for the reference signal to the UE or the further base station via the transceiver, and receiving a second configuration of the reference signal from the UE or the further base station via the transceiver.

**[0018]** Some implementations of the method and apparatuses described herein may further comprise: receiving moving information of the first set of UEs. In some implementations of the method and apparatuses described herein, determining the first UE may comprise: selecting the first UE from the first set of UEs based on the set of measurements and the moving information of the first set of UEs.

**[0019]** In some implementations of the method and apparatuses described herein, the moving information of the first set of UEs may comprise at least one of the following: a moving speed of a UE in the first set of UEs; or a moving direction of the UE in the first set of UEs.

**[0020]** In some implementations of the method and apparatuses described herein, performing the handover of the control node of the RIS may comprise at least one of the following: transmitting, to the first UE or a further base station serving the first UE via the transceiver, a request for the handover; receiving, from the first UE or the further base station via the transceiver, a response to the request for the handover, the response comprising a request for information associated with the RIS; or transmitting the information associated with the RIS to the first UE or the further base station via the transceiver.

**[0021]** In some implementations of the method and apparatuses described herein, the information associated with the RIS may comprise at least one of the following: information of the RIS; information of capability of the RIS; or information of capability of a controller of the RIS.

**[0022]** In some implementations of the method and apparatuses described herein, the information of the RIS may comprise at least one of the following: moving information of the RIS; number of elements of the RIS; or an operation mode of the RIS.

**[0023]** In some implementations of the method and apparatuses described herein, the information of capability of the RIS may comprise an indication of whether a coefficient and a property of the RIS is capable to be tuned according to control information.

**[0024]** In some implementations of the method and apparatuses described herein, the information of capability of the controller may comprise at least one of the following: an indication of whether the controller is capable to receive control information; or an indication of whether the controller is capable to transmit a positive or negative acknowledgement for the reception of the control information.

**[0025]** In another aspect, some implementations of the method and apparatuses described herein comprise: in accordance with a determination that a handover of a control node of a RIS from a base station is triggered, performing a measurement of a link between the UE and the RIS; and transmitting the measurement to the base station via the transceiver.

**[0026]** In some implementations of the method and apparatuses described herein, determining that the handover of the control node of the RIS is triggered may comprise at least one of the following: in accordance with a determination that QoS requirements of the UE are unsatisfied, transmitting, to the base station via the transceiver, an indication of the handover of the control node of the RIS; or receiving, from the base station via the transceiver, a request for the handover of the control node of the RIS.

**[0027]** In some implementations of the method and apparatuses described herein, performing the measurement may comprise: determining information of a direction of a reference signal from the UE to the RIS; transmitting the reference signal to the RIS based on the information of the direction of the reference signal; and performing the measurement on the reference signal forwarded from the RIS.

**[0028]** In some implementations of the method and apparatuses described herein, determining the information of the direction of the reference signal may comprise: receiving, from the base station or a further base station serving the UE via the transceiver, a request for location information of the UE, the request comprising location information of the RIS; and determining the information of the direction of the reference signal based on the location information of the UE and the location information of the RIS.

**[0029]** Some implementations of the method and apparatuses described herein may further comprise: transmitting, to the base station or the further base station via the transceiver, the information of the direction of the reference signal.

**[0030]** In some implementations of the method and apparatuses described herein, determining the information of the direction of the reference signal may comprise: receiving, from the base station or a further base station serving the UE via the transceiver, a request for location information of the UE, the request comprising location information of the RIS; transmitting, to the base station or the further base station via the transceiver, the location information of the UE; and receiving, from the base station or the further base station via the transceiver, the information of the direction of the reference signal.

**[0031]** In some implementations of the method and apparatuses described herein, the location information of the RIS may comprise at least one of the following: a location of the RIS; refresh time of the location of the RIS; validity time of the location of the RIS; a fluctuation of the location of the RIS within an area; or a moving state of the RIS.

**[0032]** In some implementations of the method and apparatuses described herein, the information of the direction of the reference signal may comprise at least one of the following: a horizontal angle of the reference signal; or a vertical angle of the reference signal.

**[0033]** In some implementations of the method and apparatuses described herein, determining the information of the direction of the reference signal may comprise: receiving, from the base station via the transceiver, a further reference signal comprising location information of the RIS; and determining the information of the direction of the reference signal based on location information of the UE and the location information of the RIS.

**[0034]** Some implementations of the method and apparatuses described herein may further comprise: receiving a first configuration of the reference signal from the base station via the transceiver.

**[0035]** Some implementations of the method and apparatuses described herein may further comprise: receiving a set of resources available for the reference signal from the base station via the transceiver; determining a second configuration of the reference signal based on the set of resources; and transmitting the second configuration of the reference signal to the base station via the transceiver.

**[0036]** Some implementations of the method and apparatuses described herein may further comprise: transmitting moving information of the UE to the base station via the transceiver.

**[0037]** In some implementations of the method and apparatuses described herein, the moving information of the UE may comprise at least one of the following: a moving speed of the UE; or a moving direction of the UE.

**[0038]** Some implementations of the method and apparatuses described herein may further comprise at least one of the following: receiving a request for the handover from the base station or a further base station serving the UE via the transceiver; transmitting, to the base station or the further base station via the transceiver, a response to the request for the handover, the response comprising a request for information associated with the RIS; receiving the information associated with the RIS from the base station or the further base station via the transceiver; determining a configuration for control information of the RIS based on the information associated with the RIS; or transmitting, to the RIS via the transceiver, the configuration for the control information of the RIS and information of the UE.

[0039] In some implementations of the method and apparatuses described herein, the information associated with the RIS may comprise at least one of the following: information of the RIS; information of capability of the RIS; or information of capability of a controller of the RIS. In some implementations of the method and apparatuses described herein, the information of the RIS may comprise at least one of the following: moving information of the RIS; number of elements of the RIS; or an operation mode of the RIS.

[0040] In some implementations of the method and apparatuses described herein, the information of capability of the RIS may comprise an indication of whether a coefficient and a property of the RIS is capable to be tuned according to control information.

[0041] In some implementations of the method and apparatuses described herein, the information of capability of the controller may comprise at least one of the following: an indication of whether the controller is capable to receive control information; or an indication of whether the controller is capable to transmit a positive or negative acknowledgement for the reception of the control information.

[0042] In some implementations of the method and apparatuses described herein, determining the configuration of the control information of the RIS may comprise: receiving the configuration of the control information from the further base station.

[0043] In some implementations of the method and apparatuses described herein, the configuration of the control information may comprise at least one of the following: phase, amplitude, directivity, or beamforming information; uplink or downlink time division duplexing (TDD) configuration information for resource allocation and interference management; timing configuration for transmission alignment; on or off information for energy and interference management; operation mode indication; or feedback information.

[0044] In some implementations of the method and apparatuses described herein, the information of the UE may comprise at least one of the following: an identity of the UE; or location information of the UE.

[0045] In another aspect, some implementations of the method and apparatuses described herein comprise: in accordance with a determination that a handover of a control node of a RIS from the base station to a UE is to be performed, transmitting, to the UE via a transceiver, a request for capability information of the UE related to the RIS; receiving, from the UE via the transceiver, the capability information of the UE; and initiating an authorization for the UE to control the RIS based on the capability information of the UE.

**[0046]** In some implementations of the method and apparatuses described herein, the capability information may comprise at least one of the following: capability of the RIS supported by the UE; or capability of configuring control information of the RIS.

**[0047]** In some implementations of the method and apparatuses described herein, initiating the authorization may comprise at least one of the following: transmitting, to the UE via the transceiver, first information of the RIS for the authorization; transmitting, to a core network element via the transceiver, second information of the RIS for the authorization; receiving, from the core network element via the transceiver, an indication of whether the UE is authorized for controlling the RIS; or transmitting the indication to the UE via the transceiver.

**[0048]** In some implementations of the method and apparatuses described herein, the first information may comprise at least one of the following: identity information of the RIS; location information of the RIS; identity information of a cell in which the RIS is camping; or an indication of the core network element supporting the RIS.

**[0049]** In some implementations of the method and apparatuses described herein, the second information may comprise at least one of the following: identity information of the RIS; location information of the RIS; identity information of a cell in which the RIS is camping; identity information of the UE; location information of the UE; or identity information of a cell in which the UE is camping.

**[0050]** Some implementations of the method and apparatuses described herein may further comprise: receiving, from the RIS via the transceiver, a request of a registration with a core network element, registration information for the authorization being generated based on the request, the registration information comprising at least one of the following: a list of base stations that have capability to control the RIS; a list of UEs that have capability to control the RIS; a list of RISs that are only controlled by the UE; a list of RISs that are only controlled by the base station; or a list of RISs that are controlled by the UE and the base station.

**[0051]** In another aspect, some implementations of the method and apparatuses described herein may comprise: receiving, from a base station via a transceiver, a request for capability information of the UE related to a RIS; transmitting, to the base station via the transceiver, the capability information of the UE; and obtaining an authorization for the UE to control the RIS.

**[0052]** In some implementations of the method and apparatuses described herein, the capability information may comprise at least one of the following: capability of the RIS supported by the UE; or capability of configuring control information of the RIS.

**[0053]** In some implementations of the method and apparatuses described herein, obtaining the authorization may comprise at least one of the following: receiving, from the base station via the transceiver, first information of the RIS for the authorization; transmitting, to a core network element via the transceiver, third information of the RIS for the authorization; receiving, from the core network element via the transceiver, an indication of whether the UE is authorized for controlling the RIS; or receiving, from the base station via the transceiver, an indication of whether the UE is authorized for controlling the RIS.

**[0054]** In some implementations of the method and apparatuses described herein, the first information may comprise at least one of the following: identity information of the RIS; location information of the RIS; identity information of a cell in which the RIS is camping; or an indication of the core network element supporting the RIS.

**[0055]** In some implementations of the method and apparatuses described herein, the third information may comprise at least one of the following: identity information of the RIS; location information of the RIS; or identity information of a cell in which the RIS is camping.

BRIEF DESCRIPTION OF THE DRAWINGS

**[0056]** FIG. 1 illustrates an example of a wireless communications system that supports a control of a RIS in accordance with aspects of the present disclosure.

**[0057]** FIG. 2A illustrates a diagram illustrating example scenarios of a control of a RIS in which aspects of the present disclosure may be implemented.

**[0058]** FIG. 2B illustrates a diagram illustrating example scenarios of a switching of a control node of a RIS in which aspects of the present disclosure may be implemented.

**[0059]** FIG. 3 illustrates a signaling chart of a process of communication that supports a control of a RIS in accordance with aspects of the present disclosure.

**[0060]** FIG. 4 illustrates a signaling chart of a process of UE-RIS link measurement in accordance with aspects of the present disclosure.

**[0061]** FIG. 5 illustrates a signaling chart of another process of UE-RIS link measurement in accordance with aspects of the present disclosure.

**[0062]** FIG. 6 illustrates a signaling chart of a process of a handover of a control node of a RIS in accordance with aspects of the present disclosure.

**[0063]** FIG. 7 illustrates a signaling chart of another process of a handover of a control node of a RIS in accordance with aspects of the present disclosure.

**[0064]** FIG. 8 illustrates a signaling chart of another process of communication that supports a control of a RIS in accordance with aspects of the present disclosure.

**[0065]** FIG. 9 illustrates an example of a device that supports a control of a RIS in accordance with aspects of the present disclosure.

**[0066]** FIG. 10 illustrates an example of a processor that supports a control of a RIS in accordance with aspects of the present disclosure.

**[0067]** FIG. 11 illustrates a flowchart of a method that supports a control of a RIS in accordance with aspects of the present disclosure.

**[0068]** FIG. 12 illustrates a flowchart of another method that supports a control of a RIS in accordance with aspects of the present disclosure.

**[0069]** FIG. 13 illustrates a flowchart of another method that supports a control of a RIS in accordance with aspects of the present disclosure.

**[0070]** FIG. 14 illustrates a flowchart of another method that supports a control of a RIS in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

**[0071]** Principles of the present disclosure will now be described with reference to some embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitation as to the scope of the disclosure. The disclosure described herein may be implemented in various manners other than the ones described below.

**[0072]** In the following description and claims, unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

**[0073]** References in the present disclosure to "one embodiment," "an example embodiment," "an embodiment," "some embodiments," and the like indicate that the embodiment(s) described may include a particular feature, structure, or characteristic, but it is not necessary that every embodiment includes the particular feature, structure, or characteristic. Moreover, such phrases do not necessarily refer to the same embodiment(s). Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described. The term "embodiment" may be interchangeably used with "implementation".

**[0074]** It shall be understood that although the terms "first" and "second" or the like may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another element. For example, a first element could also be termed as a second element, and similarly, a second element could also be termed as a first element, without departing from the scope of implementations. As used herein, the term "and/or" includes any and all combinations of one or more of the listed terms.

**[0075]** The terminology used herein is for the purpose of describing particular implementations only and is not intended to be limiting of example implementations. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises", "comprising", "has", "having", "includes" and/or "including", when used herein, specify the presence of stated features, elements, and/or components etc., but do not preclude the presence or addition of one or more other features, elements, components and/ or combinations thereof.

**[0076]** Currently, for a non-stationary RIS (also referred as a moving RIS), it is mounted on top of vehicles or aerial platforms like balloon, unmanned aerial vehicle (UAV) or the like to help extend signal coverage from a ground source node (e.g., BS/access point (AP)) to a given target area (e.g., a hot spot in a cellular network or a remote area without cellular coverage). A moving RIS may be controlled by a BS to provide a service to UEs. When a control link between the BS and the moving RIS is broken or faded for some reasons, a control node of the moving RIS may be switched from the BS to another BS or a UE.

**[0077]** Embodiments of the present disclosure provide solutions of supporting a control of a RIS. In one aspect, if a handover of a control node of a RIS from a BS is triggered, a UE performs a measurement of a link between the UE and the RIS, and transmit the measurement to the BS. Upon obtaining a set of measurements of a set of links between a set of UEs and the RIS, the BS determines a UE from the first set of UEs at least based on the set of measurements, and perform a handover of the control node of the RIS from the BS to the determined UE. In this way, by obtaining measurements of links between UEs and the RIS, the handover of the control node of the RIS from the BS to the UE may be carried out, and continuous communication for a RIS-assisted network may be ensured.

**[0078]** In another aspect, if a handover of a control node of a RIS from a BS to a UE is to be performed, the BS transmits, to the UE, a request for capability information of the UE related to the RIS. Upon reception of the capability information of the UE, the BS initiates an authorization for the UE to control the RIS based on the capability information of the UE. Accordingly, the UE obtains the authorization for the UE to control the RIS. With the authorization for the UE to control the RIS, the handover of a control node of the RIS from the BS to the UE may be carried out, and continuous communication for a RIS-assisted network may be ensured.

**[0079]** The aspects of the present disclosure are described in the context of a wireless communications system.

**[0080]** FIG. 1 illustrates an example of a wireless communications system 100 that supports a control of a RIS in accordance with aspects of the present disclosure. The wireless communications system 100 may include one or more network entities (also referred to as network equipment (NE)). For convenience, network entities 102-1, 102-2 and 102-3 are shown and are collectively referred to as one or more network entities 102 hereinafter. The wireless communications system 100 may further include one or more UEs (such as UEs 101, 105 and 107), a RIS 103, a core network 106, and a packet data network 108. The wireless communications system 100 may support various radio access technologies. In some implementations, the wireless communications system 100 may be a 4G network, such as an LTE network or an LTE-advanced (LTE-A) network. In some other implementations, the wireless communications system 100 may be a 5G network, such as a new radio (NR) network. In other implementations, the wireless communications system 100 may be a combination of a 4G network and a 5G network, or other suitable radio access technology including institute of electrical and electronics engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20. The wireless communications system 100 may support radio access technologies beyond 5G. Additionally, the wireless communications system 100 may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

**[0081]** The one or more network entities 102 may be dispersed throughout a geographic region to form the wireless communications system 100. One or more of the network entities 102 described herein may be or include or may be referred to as a network node, a base station, a network element, a radio access network (RAN), a base transceiver station, an access point, a NodeB, an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. A network entity 102 and a UE may communicate via a communication link 110, which may be a wireless or wired connection. For example, a network entity 102 and a UE may perform wireless communication (e.g., receive signaling, transmit signaling) over a Uu interface.

**[0082]** A network entity 102 may provide one or more geographic coverage areas (also referred to as cells) for which the network entity 102 may support services (e.g., voice, video, packet data, messaging, broadcast, etc.) for one or more UEs within a geographic coverage area. For example, a network entity 102 and a UE may support wireless communication of signals related to services (e.g., voice, video, packet data, messaging, broadcast, etc.) according to one or multiple radio access technologies. In some implementations, a network entity 102 may be moveable, for example, a satellite associated with a non-terrestrial network. In some implementations, different geographic coverage areas associated with the same or different radio access technologies may overlap, but the different geographic coverage areas may be associated with different network entities 102. Information and signals described herein may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

**[0083]** The one or more UEs may be dispersed throughout a geographic region of the wireless communications system 100. A UE may include or may be referred to as a mobile device, a wireless device, a remote device, a remote unit, a handheld device, or a subscriber device, or some other suitable terminology. In some implementations, the UE may be referred to as a unit, a station, a terminal, or a client, among other examples. Additionally, or alternatively, the UE may be referred to as an Internet-of-things (IoT) device, an Internet-of-everything (IoE) device, or machine-type communication (MTC) device, among other examples. In some implementations, a UE may be stationary in the wireless communications system 100. In some other implementations, a UE may be mobile in the wireless communications system 100.

**[0084]** The one or more UEs may be devices in different forms or having different capabilities. Some examples of UEs are illustrated in FIG. 1. A UE may be capable of communicating with various types of devices, such as the network entities 102, other UEs, or network equipment (e.g., the core network 106, the packet data network 108, a relay device, an integrated access and backhaul (IAB) node, or another network equipment), as shown in FIG. 1. Additionally, or alternatively, a UE may support communication with other network entities 102 or UEs, which may act as relays in the wireless communications system 100.

**[0085]** A UE may also be able to support wireless communication directly with other UEs over a communication link 114. For example, a UE may support wireless communication directly with another UE over a device-to-device (D2D) communication link. In some implementations, such as vehicle-to-vehicle (V2V) deployments, vehicle-to-everything (V2X) deployments, or cellular-V2X deployments, the communication link 114 may be referred to as an SL. For example, a UE may support wireless communication directly with another UE over a PC5 interface.

**[0086]** A network entity 102 may support communications with the core network 106, or with another network entity 102, or both. For example, a network entity 102 may interface with the core network 106 through one or more backhaul links 116 (e.g., via an S1, N2, N2, or another network interface). The network entities 102 may communicate with each other over the backhaul links 116 (e.g., via an X2, Xn, or another network interface). In some implementations, the network entities 102 may communicate with each other directly (e.g., between the network entities 102). In some other implementations, the network entities 102 may communicate with each other or indirectly (e.g., via the core network 106). In some implementations, one or more network entities 102 may include subcomponents, such as an access network entity, which may be an example of an access node controller (ANC). An ANC may communicate with the one or more UEs through one or more other access network transmission entities, which may be referred to as a radio heads, smart radio heads, or transmission-reception points (TRPs).

**[0087]** As an example, the network entity 102-1 may provide a cell 112-1 and the network entity 102-2 may provide a cell 112-2. It is to be understood that each of the network entities 102-1 and 102-2 may provide more cells (not shown).

**[0088]** In an example, the network entity may be a satellite, for example, the network entity 102-3. The network entity 102-3 may have full or part of an eNB/gNB on board. The communication link 110 between the satellite 102-3 and the UE 105, the communication link 116 between the satellite 102-3 and the network entity 102-2, and the communication link 116 between the network entity 102-2 and the core network 106 may be used for a non-terrestrial network (NTN) transparent mode. The communication link 110 between the satellite 102-3 and the UE 105, and the communication link 116 between the satellite 102-3 (with a base station on board) and the core network 106 may be used for a NTN regenerative mode.

**[0089]** In some implementations, a network entity 102 may be configured in a disaggregated architecture, which may be configured to utilize a protocol stack physically or logically distributed among two or more network entities 102, such as an integrated access backhaul (IAB) network, an open RAN (O-RAN) (e.g., a network configuration sponsored by the O-RAN Alliance), or a virtualized RAN (vRAN) (e.g., a cloud RAN (C-RAN)). For example, a network entity 102 may include one or more of a central unit (CU), a distributed unit (DU), a radio unit (RU), a RAN Intelligent Controller (RIC) (e.g., a Near-Real Time RIC (Near-RT RIC), a Non-Real Time RIC (Non-RT RIC)), a Service Management and Orchestration (SMO) system, or any combination thereof.

**[0090]** An RU may also be referred to as a radio head, a smart radio head, a remote radio head (RRH), a remote radio unit (RRU), or a TRP. One or more components of the network entities 102 in a disaggregated RAN architecture may be co-located, or one or more components of the network entities 102 may be located in distributed locations (e.g., separate physical locations). In some implementations, one or more network entities 102 of a disaggregated RAN architecture may be implemented as virtual units (e.g., a virtual CU (VCU), a virtual DU (VDU), a virtual RU (VRU)).

**[0091]** Split of functionality between a CU, a DU, and an RU may be flexible and may support different functionalities depending upon which functions (e.g., network layer functions, protocol layer functions, baseband functions, radio frequency functions, and any combinations thereof) are performed at a CU, a DU, or an RU. For example, a functional split of a protocol stack may be employed between a CU and a DU such that the CU may support one or more layers of the protocol stack and the DU may support one or more different layers of the protocol stack. In some implementations, the CU may host upper protocol layer (e.g., a layer 3 (L3), a layer 2 (L2)) functionality and signaling (e.g., Radio Resource Control (RRC), service data adaption protocol (SDAP), Packet Data Convergence Protocol (PDCP)). The CU may be connected to one or more DUs or RUs, and the one or more DUs or RUs may host lower protocol layers, such as a layer 1 (L1) (e.g., physical (PHY) layer) or an L2 (e.g., radio link control (RLC) layer, medium access control (MAC) layer) functionality and signaling, and may each be at least partially controlled by the CU 160.

**[0092]** Additionally, or alternatively, a functional split of the protocol stack may be employed between a DU and an RU such that the DU may support one or more layers of the protocol stack and the RU may support one or more different layers of the protocol stack. The DU may support one or multiple different cells (e.g., via one or more RUs). In some implementations, a functional split between a CU and a DU, or between a DU and an RU may be within a protocol layer (e.g., some functions for a protocol layer may be performed by one of a CU, a DU, or an RU, while other functions of the protocol layer are performed by a different one of the CU, the DU, or the RU).

**[0093]** A CU may be functionally split further into CU control plane (CU-CP) and CU user plane (CU-UP) functions. A CU may be connected to one or more DUs via a midhaul communication link (e.g., F1, F1-c, F1-u), and a DU may be connected to one or more RUs via a fronthaul communication link (e.g., open fronthaul (FH) interface). In some implementations, a midhaul communication link or a fronthaul communication link may be implemented in accordance with an interface (e.g., a channel) between layers of a protocol stack supported by respective network entities 102 that are in communication via such communication links.

**[0094]** The core network 106 may support user authentication, access authorization, tracking, connectivity, and other access, routing, or mobility functions. The core network 106 may be an evolved packet core (EPC), or a 5G core (5GC), which may include a core network element 109. The core network element 109 may be a control plane entity that manages access and mobility (e.g., an LMF, a mobility management entity (MME), an access and mobility management functions (AMF)) or a user plane entity that routes packets or interconnects to external networks (e.g., a serving gateway (S-GW), a Packet Data Network (PDN) gateway (P-GW), or a user plane function (UPF)). In some implementations, the control plane entity may manage non-access stratum (NAS) functions, such as mobility, authentication, and bearer management (e.g., data bearers, signal bearers, etc.) for the one or more UEs served by the one or more network entities 102 associated with the core network 106.

**[0095]** The core network 106 may communicate with the packet data network 108 over one or more backhaul links 116 (e.g., via an S1, N2, N2, or another network interface). The packet data network 108 may include an application server 118. In some implementations, one or more UEs may communicate with the application server 118. A UE may establish a session (e.g., a protocol data unit (PDU) session, or the like) with the core network 106 via a network entity 102. The core network 106 may route traffic (e.g., control information, data, and the like) between the UE and the application server 118 using the established session (e.g., the established PDU session). The PDU session may be an example of a logical connection between the UE and the core network 106 (e.g., one or more network functions of the core network 106).

**[0096]** In the wireless communications system 100, the network entities 102 and the UEs may use resources of the wireless communications system 100 (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers)) to perform various operations (e.g., wireless communications). In some implementations, the network entities 102 and the UEs may support different resource structures. For example, the network entities 102 and the UEs may support different frame structures. In some implementations, such as in 4G, the network entities 102 and the UEs may support a single frame structure. In some other implementations, such as in 5G and among other suitable radio access technologies, the network entities 102 and the UEs may support various frame structures (i.e., multiple frame structures). The network entities 102 and the UEs may support various frame structures based on one or more numerologies.

**[0097]** One or more numerologies may be supported in the wireless communications system 100, and a numerology may include a subcarrier spacing and a cyclic prefix. A first numerology (e.g., $\mu$=0) may be associated with a first subcarrier spacing (e.g., 15 kHz) and a normal cyclic prefix. In some implementations, the first numerology (e.g., $\mu$=0) associated with the first subcarrier spacing (e.g., 15 kHz) may utilize one slot per subframe. A second numerology (e.g., $\mu$=1) may be associated with a second subcarrier spacing (e.g., 30 kHz) and a normal cyclic prefix. A third numerology (e.g., $\mu$=2) may be associated with a third subcarrier spacing (e.g., 60 kHz) and a normal cyclic prefix or an extended cyclic prefix. A fourth numerology (e.g., $\mu$=3) may be associated with a fourth subcarrier spacing (e.g., 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g., $\mu$=4) may be associated with a fifth subcarrier spacing (e.g., 240 kHz) and a normal cyclic prefix.

**[0098]** A time interval of a resource (e.g., a communication resource) may be organized according to frames (also referred to as radio frames). Each frame may have a duration, for example, a 10 millisecond (ms) duration. In some implementations, each frame may include multiple subframes. For example, each frame may include 10 subframes, and each subframe may have a duration, for example, a 1ms duration. In some implementations, each frame may have the same duration. In some implementations, each subframe of a frame may have the same duration.

**[0099]** Additionally or alternatively, a time interval of a resource (e.g., a communication resource) may be organized according to slots. For example, a subframe may include a number (e.g., quantity) of slots. The number of slots in each subframe may also depend on the one or more numerologies supported in the wireless communications system 100. For instance, the first, second, third, fourth, and fifth numerologies (i.e., $\mu$=0, $\mu$=1, $\mu$=2, $\mu$=3, $\mu$=4) associated with respective subcarrier spacings of 15 kHz, 30 kHz, 60 kHz, 120 kHz, and 240 kHz may utilize a single slot per subframe, two slots per subframe, four slots per subframe, eight slots per subframe, and 16 slots per subframe, respectively. Each slot may include a number (e.g., quantity) of symbols (e.g., OFDM symbols). In some implementations, the number (e.g., quantity) of slots for a subframe may depend on a numerology. For a normal cyclic prefix, a slot may include 14 symbols. For an extended cyclic prefix (e.g., applicable for 60 kHz subcarrier spacing), a slot may include 12 symbols. The relationship between the number of symbols per slot, the number of slots per subframe, and the number of slots per frame for a normal cyclic prefix and an extended cyclic prefix may depend on a numerology. It should be understood that reference to a first numerology (e.g., $\mu$=0) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

**[0100]** In the wireless communications system 100, an electromagnetic (EM) spectrum may be split, based on frequency or wavelength, into various classes, frequency bands, frequency channels, etc. By way of example, the wireless communications system 100 may support one or multiple operating frequency bands, such as frequency range designations FR1 (410 MHz – 7.125 GHz), FR2 (24.25 GHz – 52.6 GHz), FR3 (7.125 GHz – 24.25 GHz), FR4 (52.6 GHz – 114.25 GHz), FR4a or FR4-1 (52.6 GHz – 71 GHz), and FR5 (114.25 GHz – 300 GHz). In some implementations, the network entities 102 and the UEs 104 may perform wireless communications over one or more of the operating frequency bands. In some implementations, FR1 may be used by the network entities 102 and the UEs, among other equipment or devices for cellular communications traffic (e.g., control information, data). In some implementations, FR2 may be used by the network entities 102 and the UEs, among other equipment or devices for short-range, high data rate capabilities.

**[0101]** FR1 may be associated with one or multiple numerologies (e.g., at least three numerologies). For example, FR1 may be associated with a first numerology (e.g., $\mu$=0), which includes 15 kHz subcarrier spacing; a second numerology (e.g., $\mu$=1), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., $\mu$=2), which includes 60 kHz subcarrier spacing. FR2 may be associated with one or multiple numerologies (e.g., at least 2 numerologies). For example, FR2 may be associated with a third numerology (e.g., $\mu$=2), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., $\mu$=3), which includes 120 kHz subcarrier spacing.

**[0102]** With reference to FIG. 1, the RIS 103 may receive a signal from the network device 102 (e.g., the network device 102-1) and forward the signal to a UE (e.g., the UE 101). In some embodiments, the RIS 103 may comprise a plurality of RIS elements (also referred to as elements herein) and a RIS controller (also referred to as a controller herein) for controlling the RIS elements. In some embodiments, the RIS elements of the RIS 103 may be passive with a reflection mode or with both a reflection mode and a transmission mode. Reflection coefficients (also referred to as coefficients herein) of the RIS element may be set by the RIS controller, and the RIS controller may have a communication module with a node (also referred to as a control node herein), either a BS or a UE, to receive the coefficients. It is to be understood that although only one RIS is shown in FIG. 1, more RISs may be comprised in the wireless communications system 100.

**[0103]** FIG. 2A illustrates a diagram 200A illustrating example scenarios of a control of a RIS in which aspects of the present disclosure may be implemented. In this example, a RIS is a moving RIS. A scenario 210 shows an ideal control of the RIS and a scenario 220 shows a problem in a control of the RIS. In the example of FIG. 2A, there are two communication links between a BS and a UE: a direct communication link between the BS and the UE, and an indirect communication link between the BS and the UE via the RIS.

**[0104]** In the scenario 210, the BS may control the RIS via a control link 211 to provide a service to the UE. The BS may calculate coefficients of the RIS based on some dedicated channel status information-reference signal (CSI-RS) configurations. The BS may send the coefficients of the RIS via the control link 211 to a RIS controller of the RIS. The RIS controller may control a direction of a reflection link 212 between the RIS and the UE so as to forward the service from the BS to the UE correctly.

**[0105]** In the scenario 220, along with the RIS moving, the control link 211 between the BS and the RIS may be drastically changed or broken. The change of the control link 211 may cause the BS sending an incorrect RIS coefficient to the RIS controller of the RIS and further result in deviation of the direction of the reflection link from the BS to the UE, as shown by a reference sign 221. In this case, the broken control link may reduce quality and/or reliability of the indirect communication link between the BS and the UE via the RIS.

**[0106]** When the control link between the BS and the RIS is broken or faded for some reasons, there are totally two alternatives for handover of a control node of the RIS. As an alternative, the RIS may be switched to be controlled by another BS. In this case, inter-gNB handover signaling procedures may be reused when regarding the RIS as a special UE. As another alternative, the RIS may be switched to be controlled by a UE. In this case, there are two scenarios according to different UE roles. These scenarios will be described in connection with FIG. 2B below.

**[0107]** FIG. 2B illustrates a diagram 200B illustrating example scenarios of a switching of a control node of a RIS in which aspects of the present disclosure may be implemented. In this example, the control node of the RIS is switched from a BS to a UE. In a scenario 230 in FIG. 2B, a RIS may be switched to be controlled by a UE (also referred to as a serving UE herein) served by the RIS to continue providing service to itself. In some embodiments, the serving UE may calculate the optimal reflection coefficients itself and send the optimal reflection coefficients to the RIS, as shown by a reference sign 231. In some embodiments, as shown by a reference sign 232, the serving UE may receive the optimal reflection coefficients from the BS, and forward the received optimal reflection coefficients to the RIS.

**[0108]** In a scenario 240 in FIG. 2B, a RIS may be switched to be controlled by another UE that is served by the RIS or not served by the RIS to provide a service to the serving UE. In some embodiments, the non-serving UE may calculate the optimal reflection coefficients itself and send the optimal reflection coefficients to the RIS, as shown by a reference sign 241. In some embodiments, as shown by a reference sign

242, the non-serving UE may receive the optimal reflection coefficients from the BS, and forward the received optimal reflection coefficients to the RIS.

**[0109]** For example, the scenario 240 may be mainly for factory scenarios that a BS controls a RIS to provide high reliability and low latency communication to IoT devices in the factory, and there is no risk of privacy information exposure. Thus, one UE in the factory may control the RIS to provide a service to other UEs.

**[0110]** However, for the scenarios that a control node of a RIS is switched from a BS to a UE, there are some issues at least for a moving RIS. First, channel/link quality of UE-RIS link is needed for the BS to select a suitable UE to control the RIS. However, the BS may only obtain channel quality of gNB-RIS-UE link in addition to gNB-UE link according to a measurement report from the UE in a conventional solution. For the case that the RIS is not capable of performing channel measurement, how to obtain the channel/link quality for the UE-RIS link may be an important issue, especially considering that both RIS and UE can move.

**[0111]** Second, RIS identification may be done at BS side, and RIS authorization may be done at a core network (CN) side. While if a control node of the RIS is changed from the BS to the UE, the selected UE may need to know that a device will be controlled is a "RIS" and also require network authorizing the selected UE to control and configure the RIS.

**[0112]** Third, after completing RIS identification and RIS authorization, the selected UE may have no knowledge on RIS information, e.g., RIS operation mode, RIS capability, or RIS controller capability, etc. Hence, the UE may need to require knowing the RIS information from the BS so as to assist a configuration for control information of the RIS, and further exchange the configured control information to the RIS.

**[0113]** In view of this, embodiments of the present disclosure provide a solution of supporting a handover of a control node of a RIS and a solution of supporting an authorization of a UE for RIS control so as to overcome the above and other potential issues. It is to be understood that the solutions of the present disclosure may be applied to both a moving RIS and a stationary RIS.

**[0114]** First, the solution of supporting the handover of the control node of the RIS will be described in connection with FIGs. 3 to 7.

**[0115]** FIG. 3 illustrates a signaling chart of a process 300 of communication that supports a control of a RIS in accordance with aspects of the present disclosure. For the purpose of discussion, the process 300 will be described with reference to FIG. 1. The process 300 may involve the network entity 102-1, the RIS 103, and the UEs 101 and 105 as illustrated in FIG. 1. It is to be understood that the steps and the order of the steps in FIG. 3 are merely for illustration, and not for limitation. It is assumed that the network entity 102-1 and the UE 101 are communicated via the RIS 103, and the RIS 103 is controlled by the network entity 102-1. In this example, the UE 101 is served by the network entity 102-1 and the RIS 103, and the UE 105 is not served by the network entity 102-1 and the RIS 103. It is to be understood that more UEs may be served or not served by the RIS 103.

**[0116]** As shown in FIG. 3, the network entity 102-1 may determine 310 whether a handover of a control node of the RIS 103 is triggered.

**[0117]** With reference to FIG. 3, the network entity 102-1 may receive 311 an indication of the handover of the control node of the RIS 103 from a set of UEs (for convenience, also referred to as a second set of UEs herein, e.g., the UE 101) served by the RIS 103 when QoS requirements of the set of UEs are not satisfied. In other words, the network entity 102-1 may receive, from the UEs served by the RIS 103, an explicit request or indication to change the control node of the RIS 103 when QoS requirements of those UEs are not satisfied. Upon reception of the indication, the network entity 102-1 may determine that the handover of the control node of the RIS 103 is triggered. In this way, the network entity 102-1 may make a decision to handover the control node of the RIS 103 by receiving a request or indication from a UE served by the RIS 103.

**[0118]** With reference to FIG. 3, the network entity 102-1 may transmit 312 a request for the handover of the control node of the RIS 103 to one or more UEs (for convenience, also referred to as a third set of UEs herein, e.g., the UE 101) served by the RIS 103. In some embodiments, if no resources are available to transmit control information to the RIS 103, the network entity 102-1 may transmit the request to the one or more UEs served by the RIS 103. In some embodiments, if capability of transmitting the control information to the RIS 103 is limited, e.g., due to some reason, the network entity 102-1 may transmit the request to the one or more UEs served by the RIS 103. In some embodiments, if the RIS 103 moves out of coverage of the network entity 102-1, the network entity 102-1 may transmit the request to the one or more UEs served by the RIS 103. In some embodiments, if signal quality of the control link between the network entity 102-1 and the RIS 103 is lower than or equal to a quality threshold, the network entity 102-1 may transmit the request to the one or more UEs served by the RIS 103. It is to be understood that any other suitable conditions or combination of conditions may also be feasible for triggering the transmission of the request.

**[0119]** Upon transmission of the request, the network entity 102-1 may determine that the handover of the control node of the RIS 103 is triggered. In this way, the network entity 102-1 may make the decision to handover the control node of the RIS by monitoring quality of the control link between the network entity 102-1 and the RIS 103 or location information of the RIS 103.

**[0120]** Continuing to refer to FIG. 3, upon determination that the handover of the control node of the RIS 103 is triggered, the network entity 102-1 may obtain 320 a set of measurements of a set of links between a set of UEs (for convenience, also referred to as a first set of UEs herein, e.g., the UEs 101 and 105) and the RIS 103. The first set of UEs may comprise UEs surrounding the RIS 103. The first set of UEs may comprise one or more UEs served by the RIS 103, one or more UEs not served by the RIS 103, or both.

**[0121]** With reference to FIG. 3, upon determination that the handover of the control node of the RIS 103 is triggered (e.g., upon reception of a request or indication from the network entity 102-1), the UE 101 may perform 321 a measurement of a link between the UE 101 and the RIS 103 based on a configuration of RS measurement and reporting for the UE 101, and transmit 322 a result of the measurement to the network entity 102-1. Similarly, the UE 105 may perform 323 a measurement of a link between the UE 105 and the RIS 103 based on a configuration of RS measurement and reporting for the UE 105, and transmit 324 a result of the measurement to the network entity 102-1.

**[0122]** For illustration, some example embodiments of the UE-RIS link measurement will be detailed in connection with FIGs. 4 and 5 below. To perform UE-RIS link measurement, a UE is required to transmit an RS to a RIS and a network entity is required to control the RIS to forward the RS to the UE. Thus, the UE is required to determine information of a direction of the RS from the UE to the RIS for transmission of the RS, and the network entity is required to determine control information of the RIS for controlling the RIS to forward the RS.

**[0123]** FIG. 4 illustrates a signaling chart of a process 400 of UE-RIS link measurement in accordance with aspects of the present disclosure. For the purpose of discussion, the process 400 will be described with reference to FIG. 1. The process 400 may involve the network entity 102-1, the RIS 103 and the UE 101 as illustrated in FIG. 1. It is to be understood that the steps and the order of the steps in FIG. 4 are merely for illustration, and not for limitation. It is assumed that the network entity 102-1 and the UE 101 are communicated via the RIS 103, and the RIS 103 is controlled by the network entity 102-1. The UE 101 is served by the network entity 102-1 and the RIS 103. In the example of FIG. 4, a process of obtaining UE-RIS link measurement from a UE served by the network entity 102-1 is described.

**[0124]** As shown in FIG. 4, in some embodiments, the network entity 102-1 may determine 410 the control information of the RIS 103 based on location information or RS direction information provided by the UE 101.

**[0125]** With reference to FIG. 4, the network entity 102-1 may transmit 411, to the UE 101, a request for location information of the UE 101. In some embodiments, the request may comprise location information of the RIS 103.

**[0126]** In some embodiments, the location information of the RIS 103 may comprise a location of the RIS 103. For example, the location of the RIS 103 may comprise an approximate location of the RIS 103, e.g., a cell in which the RIS 103 is located, or the RIS 103 is located in cell edge or cell center of the cell. In some embodiments, the location information of the RIS 103 may comprise refresh time of the location of the RIS. In some embodiments, the location information of the RIS 103 may comprise validity time or average validity time of the location of the RIS. In some embodiments, the location information of the RIS 103 may comprise a fluctuation of the location of the RIS within an area. In some embodiments, the location information of the RIS 103 may comprise a moving state of the RIS, e.g., the RIS 103 moves at a very slow or constant speed. It is to be understood that any other suitable information or any combination of information may also be feasible.

[0127] With reference to FIG. 4, in some embodiments, upon reception of the request from the network entity 102-1, the UE 101 may determine 412 the information of the direction of the RS from the UE 101 to the RIS 103 based on the location information of the RIS 103 and the location information of the UE 101. In some embodiments, the information of the direction of the RS may comprise at least one of the following: a horizontal angle of the RS from the UE 101 to the RIS 103; or a vertical angle of the RS from the UE 101 to the RIS 103. It is to be understood that any other suitable RS direction information may also be feasible. With reference to FIG. 4, the UE 101 may transmit 413 the information of the direction of the RS to the network entity 102-1.

[0128] Continuing to refer to FIG. 4, in some alternative embodiments, upon reception of the request from the network entity 102-1, the UE 101 may transmit 412' the location information of the UE 101 to the network entity 102-1. For example, the location information of the UE 101 may comprise an approximate location of the UE 101, e.g., cell edge or cell center. In another example, the location information of the UE 101 may comprise accurate location information.

[0129] With reference to FIG. 4, the network entity 102-1 may determine 413' the information of the direction of the RS from the UE 101 to the RIS 103 based on the location information of the RIS 103 and the location information of the UE 101. In some embodiments, the information of the direction of the RS may comprise at least one of the following: a horizontal angle of the RS from the UE 101 to the RIS 103; or a vertical angle of the RS from the UE 101 to the RIS 103. It is to be understood that any other suitable RS direction information may also be feasible. With reference to FIG. 4, the network entity 102-1 may transmit 414' the information of the direction of the RS to the UE 101.

[0130] Continuing to refer to FIG. 4, the network entity 102-1 may derive 415 the control information of the RIS 103 from the information of the direction of the RS. In some embodiments, the network entity 102-1 may determine RIS coefficients of UE-RIS link, e.g., amplitude (denoted as $\beta$), phase (denoted as $\emptyset$) or number (denoted as N) of RIS elements. It is to be understood that the control information may comprise any suitable parameters, and the present disclosure does not limit this aspect.

**[0131]** As shown in FIG. 4, in some alternative embodiments, the network entity 102-1 may determine 420 the control information of the RIS 103 based on an RS measurement report from the UE 101.

**[0132]** With reference to FIG. 4, the network entity 102-1 may transmit 421, to the UE 101, an RS comprising the location information of the RIS 103, e.g., in the indirect link between the network entity 102-1 and the UE 101 via the RIS 103. In some embodiments, the RS may be a channel status information-reference signal (CSI-RS). In some embodiments, the RS may be a sounding reference signal (SRS). It is to be understood that any other suitable RSs may also be feasible. The UE 101 may determine 422 the information of the direction of the RS from the UE 101 to the RIS 103 based on the location information of the RIS 103 and the location information of the UE 101.

**[0133]** With reference to FIG. 4, the UE 101 may perform 423 a measurement on the RS in the indirect link, and transmit 424 the measurement result to the network entity 102-1. The network entity 102-1 may derive 425 the control information based on the measurement result. In some embodiments, the network entity 102-1 may store the best beam and the corresponding RIS coefficient of each UE according to the received measurement results from UE, and derive the RIS coefficient to control the reflection directions of an RS from UE to RIS.

**[0134]** Continuing to refer to FIG. 4, the network entity 102-1 and the UE 101 may configure 430 an RS for the UE-RIS link. It is to be understood that the RS may be a CSI-RS or a SRS or any other suitable RSs.

**[0135]** With reference to FIG. 4, in some embodiments, the network entity 102-1 may generate and transmit 431 a configuration (for convenience, also referred to as a first configuration herein) of the RS for the UE-RIS link to the UE 101.

**[0136]** With reference to FIG. 4, in some alternative embodiments, the network entity 102-1 may transmit 431' a set of resources available for the RS of the UE-RIS link to the UE 101. The UE 101 may determine 432' a configuration (for convenience, also referred to as a second configuration herein) of the RS for the UE-RIS link, e.g., according to characteristic of the UE 101 such as traffic pattern or the like. The UE 101 may transmit 433' the second configuration to the network entity 102-1.

**[0137]** Continuing to refer to FIG. 4, the UE 101 may transmit 440 the RS to the RIS 103 based on the information of the direction of the RS and the configuration of the RS. Based on the configuration of the RS, the network entity 102-1 may transmit 450 the control information of the RIS 103 to the RIS 103. Based on the control information, the RIS 103 may forward 460 the received RS to the UE 101. In this way, the UE 101 may perform a measurement on the UE-RIS link based on the RS.

**[0138]** As shown in FIG. 4, the UE 101 may report 470 the measurement result to the network entity 102-1 based on the configuration of the RS. In some embodiments, the UE 101 may also transmit moving information of the UE 101 in the report. In some embodiments, the moving information of the UE may comprise at least one of a moving trajectory, a moving speed or a moving direction of the UE. It is to be understood that any other suitable moving information or combination of information is also feasible.

**[0139]** So far, the network entity 102-1 may obtain the UE-RIS link measurement result from the UE 101 served by the network entity 102-1.

**[0140]** FIG. 5 illustrates a signaling chart of another process 500 of UE-RIS link measurement in accordance with aspects of the present disclosure. For the purpose of discussion, the process 500 will be described with reference to FIG. 1. The process 500 may involve the network entity 102-1, the RIS 103, the network entity 102-2 and the UE 105 as illustrated in FIG. 1. It is to be understood that the steps and the order of the steps in FIG. 5 are merely for illustration, and not for limitation. It is assumed that the network entity 102-1 and the UE 101 are communicated via the RIS 103, and the RIS 103 is controlled by the network entity 102-1. The UE 105 is served by the network entity 102-2. In the example of FIG. 5, a process of obtaining UE-RIS link measurement from a UE not served by the network entity 102-1 is described.

**[0141]** As shown in FIG. 5, in some embodiments, the network entity 102-1 may determine 510 the control information of the RIS 103 based on location information or RS direction information provided by the UE 105.

**[0142]** With reference to FIG. 5, the network entity 102-1 may transmit 511, to the network entity 102-2, a request for location information of a UE. In some embodiments, the request may comprise the location information of the RIS 103. Details of the location information of the RIS 103 are the same as that described in FIG. 4, and thus are not repeated here for conciseness.

**[0143]** With reference to FIG. 5, the network entity 102-2 may determine 512 a set of UEs surrounding the RIS 103 and served by the network entity 102-2. The network entity 102-2 may transmit 513, to each UE in the set of UEs (e.g., the UE 105), the request of location information of the UE. The request may comprise the location information of the RIS 103.

**[0144]** Upon reception of the request from the network entity 102-2, the UE 105 may determine 514 the information of the direction of the RS from the UE 105 to the RIS 103 based on the location information of the RIS 103 and the location information of the UE 105. In some embodiments, the information of the direction of the RS may comprise at least one of the following: a horizontal angle of the RS from the UE 105 to the RIS 103; or a vertical angle of the RS from the UE 105 to the RIS 103. It is to be understood that any other suitable RS direction information may also be feasible. With reference to FIG. 5, the UE 105 may transmit 515 the information of the direction of the RS to the network entity 102-2.

**[0145]** With reference to FIG. 5, upon reception of the information of the direction of the RS from the set of UEs, the network entity 102-2 may transmit 516 the information of the direction of the RS corresponding to the set of UEs to the network entity 102-1. In some embodiments, the network entity 102-2 may transmit the information of the direction of the RS corresponding to the set of UEs by transmitting at least one of the following: a set of UE lists, a set of identities of UEs in a UE list in the set of UE lists, or the information of the direction of the RS for a UE in the UE list.

**[0146]** Continuing to refer to FIG. 5, in some alternative embodiments, upon reception of the request from the network entity 102-2, the UE 105 may transmit 514' the location information of the UE 105 to the network entity 102-2. For example, the location information of the UE 105 may comprise an approximate location of the UE 105, e.g., cell edge or cell center. In another example, the location information of the UE 105 may comprise accurate location information.

**[0147]** With reference to FIG. 5, upon reception of the location information of each UE in the set of UEs, the network entity 102-2 may transmit 515' the location information of the set of UEs to the network entity 102-1. In some embodiments, the network entity 102-2 may transmit the location information of the set of UEs by transmitting at least one of the following: a set of UE lists, a set of identities of UEs in a UE list in the set of UE lists, or the location information for a UE in the UE list.

**[0148]** With reference to FIG. 5, the network entity 102-1 may determine 516' the information of the direction of the RS from the UE 105 to the RIS 103 based on the location information of the RIS 103 and the location information of the UE 105. In some embodiments, the information of the direction of the RS may comprise at least one of the following: a horizontal angle of the RS from the UE 105 to the RIS 103; or a vertical angle of the RS from the UE 105 to the RIS 103. It is to be understood that any other suitable RS direction information may also be feasible. With reference to FIG. 5, the network entity 102-1 may transmit 517' the information of the direction of the RS to the network entity 102-2, and the network entity 102-2 may transmit 518' the information of the direction of the RS to the UE 105.

**[0149]** Continuing to refer to FIG. 5, the network entity 102-1 may derive 519 the control information of the RIS 103 from the information of the direction of the RS. In some embodiments, the network entity 102-1 may determine RIS coefficients of UE-RIS link, e.g., amplitude (denoted as $\beta$), phase (denoted as $\emptyset$) or number (denoted as N) of RIS elements. It is to be understood that the control information may comprise any suitable parameters, and the present disclosure does not limit this aspect.

**[0150]** As shown in FIG. 5, in some alternative embodiments, the network entity 102-1 may determine 520 the control information of the RIS 103 based on RS direction information provided by the network entity 102-2.

**[0151]** With reference to FIG. 5, the network entity 102-2 may determine 521 the information of the direction of the RS for each UE in the set of UEs based on the location information of the corresponding UE and the location information of the RIS 103. The network entity 102-2 may transmit 522 the information of the direction of the RS to the corresponding UE (e.g., the UE 105). The network entity 102-2 may transmit 523 the information of the direction of the RS for the set of UEs to the network entity 102-1. In some embodiments, the network entity 102-2 may transmit the information of the direction of the RS for the set of UEs by transmitting at least one of the following: a set of UE lists, a set of identities of UEs in a UE list in the set of UE lists, or the information of the direction of the RS for a UE in the UE list.

**[0152]** Continuing to refer to FIG. 5, the network entity 102-1 may derive 524 the control information of the RIS 103 from the information of the direction of the RS. In some embodiments, the network entity 102-1 may determine RIS coefficients of UE-RIS link, e.g., amplitude (denoted as $\beta$), phase (denoted as $\emptyset$) or number (denoted as N) of RIS elements. It is to be understood that the control information may comprise any suitable parameters, and the present disclosure does not limit this aspect.

**[0153]** Continuing to refer to FIG. 5, the network entity 102-1, the network entity 102-2 and the UE 105 may configure 530 an RS for the UE-RIS link. It is to be understood that the RS may be a CSI-RS or a SRS or any other suitable RSs.

**[0154]** With reference to FIG. 5, in some embodiments, the network entity 102-1 may transmit 531 a configuration request of the RS for the UE-RIS link to the network entity 102-2.

**[0155]** With reference to FIG. 5, in some alternative embodiments, the network entity 102-2 may generate and transmit 532 a configuration of the RS for the UE-RIS link to the UE 105. The network entity 102-2 may transmit 533 the configuration of the RS for the UE-RIS link to the network entity 102-1.

**[0156]** In some alternative embodiments, the network entity 102-2 may transmit 534 a set of resources available for the RS of the UE-RIS link to the UE 105. The UE 105 may determine a configuration of the RS for the UE-RIS link, e.g., according to characteristic of the UE 105 such as traffic pattern or the like. The UE 105 may transmit 535 the configuration to the network entity 102-2, and the network entity 102-2 transmit 536 the configuration to the network entity 102-1.

**[0157]** Continuing to refer to FIG. 5, the UE 105 may transmit 540 the RS to the RIS 103 based on the information of the direction of the RS and the configuration of the RS. Based on the configuration of the RS, the network entity 102-1 may transmit 550 the control information of the RIS 103 to the RIS 103. Based on the control information, the RIS 103 may forward 560 the received RS to the UE 105. In this way, the UE 105 may perform a measurement on the UE-RIS link based on the RS.

**[0158]** As shown in FIG. 5, the UE 105 may report 570 the measurement result to the network entity 102-1 based on the configuration of the RS. In some embodiments, the UE 105 may transmit 571 the measurement result to the network entity 102-2 and the network entity 102-2 may forward 572 the measurement result to the network entity 102-1. In some embodiments, the UE 105 may transmit 573 the measurement result to the network entity 102-1 directly, e.g., via Msg1 or Msg3 in a random access procedure.

**[0159]** In some embodiments, the UE 101 may also transmit moving information of the UE 105 in the report. In some embodiments, the moving information of the UE may comprise at least one of a moving trajectory, a moving speed or a moving direction of the UE 105. It is to be understood that any other suitable moving information or combination of information is also feasible.

**[0160]** So far, the network entity 102-1 may obtain the UE-RIS link measurement result from the UE 105 not served by the network entity 102-1.

**[0161]** Referring back to FIG. 3, upon reception of the set of measurements from the first set of UEs, the network entity 102-1 may determine 330 a UE (for convenience, also referred to as a first UE herein) from the first set of UEs at least based on the set of measurements. In some embodiments, the network entity 102-1 may rank the set of measurements, and select a UE corresponding to a predetermined rank. In some embodiments, the network entity 102-1 may select a UE having the best measurement (i.e., the highest quality of a UE-RIS link).

**[0162]** In some embodiments, the network entity 102-1 may receive moving information of a UE (e.g., each UE) in the first set of UEs. In some embodiments, the moving information may be received with the set of measurements. In some embodiments, the moving information may be received separately from the set of measurements. In some embodiments, the moving information of the UE may comprise at least one of a moving trajectory, a moving speed or a moving direction of the UE. It is to be understood that any other suitable moving information or combination of information is also feasible.

**[0163]** Based on the set of measurements and the moving information of the first set of UEs, the network entity 102-1 may select the first UE from the first set of UEs. In some embodiments, the network entity 102-1 may determine one or more UEs having moving trajectories same as or similar to that of the RIS 103, and select, as the first UE, a UE having the best measurement among the one or more UEs. It is to be understood that any other suitable ways for selecting the first UE are also feasible.

**[0164]** Continuing to refer to FIG. 3, the network entity 102-1 may perform 340 the handover of the control node of the RIS 103 from the network entity 102-1 to the first UE. In some embodiments, the first UE may be a UE served by the RIS 103 (e.g., the UE 101). In some embodiments, the first UE may be a UE not served by the RIS 103 (e.g., the UE 105). For illustration, the first UE is shown as the UE 101 in FIG. 3.

**[0165]** With reference to FIG. 3, the network entity 102-1 may transmit 341 information associated with the RIS 103 to the first UE (e.g., the UE 101). In some embodiments, the information associated with the RIS may comprise at least one of the following: information of the RIS (denoted as Type#0 herein); information of capability of the RIS (denoted as Type#1 herein); or information of capability of a controller of the RIS (denoted as Type#2 herein).

**[0166]** In some embodiments, the information of the RIS may comprise moving information of the RIS. For example, the moving information of the RIS may comprise a moving trajectory of the RIS, e.g., velocity information of the RIS, or direction information of the RIS, or both. In some embodiments, the information of the RIS may comprise number of elements of the RIS (i.e., RIS elements). In some embodiments, the information of the RIS may comprise an operation mode of the RIS, e.g., a reflection mode. It is to be understood that any other suitable RIS information is also feasible.

**[0167]** In some embodiments, the information of capability of the RIS may comprise an indication of whether a coefficient and a property of the RIS or RIS elements is capable to be tuned according to control information. It is to be understood that any other suitable RIS capability information is also feasible.

**[0168]** In some embodiments, the information of capability of the controller of the RIS may comprise at least one of the following: an indication of whether the controller is capable to receive control information; or an indication of whether the controller is capable to transmit a positive acknowledgement (ACK) or negative acknowledgement (NACK) for the reception of the control information. It is to be understood that any other suitable RIS controller capability information is also feasible.

**[0169]** With reference to FIG. 3, based on the information associated with the RIS, the first UE (e.g., the UE 101) may determine 342 a configuration for control information of the RIS. In some embodiments, the first UE may receive the configuration for the control information from a network entity serving the first UE. In some embodiments, the first UE may generate the configuration for the control information by itself. In this way, the control information of the RIS may be reconfigured.

**[0170]** In some embodiments, the configuration of the control information may comprise phase, amplitude, directivity, or beamforming information, e.g., in an explicit or implicit way. In some embodiments, the configuration of the control information may comprise uplink or downlink TDD configuration information for resource allocation and interference management. In some embodiments, the configuration of the control information may comprise a timing configuration for transmission alignment. In some embodiments, the configuration of the control information may comprise on or off information for energy and interference management. In some embodiments, the configuration of the control information may comprise an indication of an operation mode of the RIS 103. In some embodiments, the configuration of the control information may comprise feedback information. It is to be understood that the configuration of the control information may comprise any other suitable information, and the present disclosure does not limit this aspect.

**[0171]** With reference to FIG. 3, the first UE (e.g., the UE 101) may transmit 343, to the RIS 103, the configuration for the control information of the RIS and information of the first UE (i.e., new control node information). In some embodiments, the information of the first UE may comprise an identity of the first UE. In some embodiments, the information of the first UE may comprise location information of the UE. It is to be understood that any other suitable UE information is also feasible. So far, the RIS 103 may switch to the new control node.

**[0172]** For illustration, some example embodiments of the handover will be detailed in connection with FIGs. 6 and 7 below.

**[0173]** FIG. 6 illustrates a signaling chart of a process 600 of a handover of a control node of a RIS in accordance with aspects of the present disclosure. For the purpose of discussion, the process 600 will be described with reference to FIG. 1. The process 600 may involve the network entity 102-1, the RIS 103 and the UE 101 as illustrated in FIG. 1. It is to be understood that the steps and the order of the steps in FIG. 6 are merely for illustration, and not for limitation. It is assumed that the UE 101 is served by the network entity 102-1 and a control node of the RIS 103 is to be handed over from the network entity 102-1 to a UE served by the network entity 102-1.

**[0174]** As shown in FIG. 6, the network entity 102-1 may decide 610 to perform a handover of the control node of the RIS 103 to the UE 101. The network entity 102-1 may transmit 620 a handover request to the UE 101. The UE 101 may judge 630 whether the UE 101 is allowed to admission.

**[0175]** With reference to FIG. 6, if the UE 101 is allowed to admission, the UE 101 may perform 640 RIS information exchange with the network entity 102-1. As shown in FIG. 6, the UE 101 may transmit 641, to the network entity 102-1, a response to the handover request comprising a request for the information associated with the RIS 103. The network entity 102-1 may transmit 642 the information associated with the RIS 103 to the UE 101. Details of the information associated with the RIS 103 are the same as that described in FIG. 3, and thus are not repeated here for conciseness.

**[0176]** Continuing to refer to FIG. 6, the UE 101 may determine 650 a configuration for control information of the RIS 103 based on the information associated with the RIS. With reference to FIG. 6, the UE 101 may transmit 660, to the RIS 103, the configuration for the control information of the RIS and information of the UE 101. Details of the configuration for the control information of the RIS 103 and the information of the UE 101 are the same as that described in FIG. 3, and thus are not repeated here for conciseness.

**[0177]** As shown in FIG. 6, the RIS 103 may switch 670 to a new control node (i.e., the UE 101), and reply 680 with handover complete information to response the configuration of the control information from the UE 101.

**[0178]** As such, a selected UE that is served by an old control node may be enabled to know RIS information to assist RIS control information configuration, and thus the selected UE may be ensured to control the RIS to provide better service.

**[0179]** FIG. 7 illustrates a signaling chart of another process 700 of a handover of a control node of a RIS in accordance with aspects of the present disclosure. For the purpose of discussion, the process 700 will be described with reference to FIG. 1. The process 700 may involve the network entity 102-1, the RIS 103, the network entity 102-2 and the UE 105 as illustrated in FIG. 1. It is to be understood that the steps and the order of the steps in FIG. 7 are merely for illustration, and not for limitation. It is assumed that the UE 105 is served by the network entity 102-2 and a control node of the RIS 103 is to be handed over from the network entity 102-1 to a UE not served by the network entity 102-1.

**[0180]** As shown in FIG. 7, the network entity 102-1 may decide 710 to perform a handover of the control node of the RIS 103 to the UE 105. The network entity 102-1 may transmit 720 a handover request to the UE 105 via the network entity 102-2. The UE 105 may judge 730 whether the UE 105 is allowed to admission.

**[0181]** With reference to FIG. 7, if the UE 105 is allowed to admission, the UE 105 may perform 740 RIS information exchange with the network entity 102-1. As shown in FIG. 7, the UE 105 may transmit 741, to the network entity 102-1 via the network entity 102-2, a response to the handover request comprising a request for the information associated with the RIS 103. The network entity 102-1 may transmit 742 the information associated with the RIS 103 to the UE 105 via the network entity 102-2. Details of the information associated with the RIS 103 are the same as that described in FIG. 3, and thus are not repeated here for conciseness.

**[0182]** Continuing to refer to FIG. 7, the network entity 102-2 may determine 750 a configuration for control information of the RIS 103 based on the information associated with the RIS. With reference to FIG. 7, the network entity 102-2 may transmit 760, to the RIS 103, the configuration for the control information of the RIS and information of the UE 105. The network entity 102-2 may also transmit 770, to the UE 105, the configuration for the control information of the RIS and information of the UE 105. Details of the configuration for the control information of the RIS 103 and the information of the UE 105 are similar as that described in FIG. 3, and thus are not repeated here for conciseness.

**[0183]** As shown in FIG. 7, the RIS 103 may switch 780 to a new control node (i.e., the UE 105), and reply 790 with handover complete information to response the configuration of the control information from the UE 101.

**[0184]** As such, a selected UE that is not served by an old control node may be enabled to know RIS information to assist RIS control information configuration, and thus the selected UE may be ensured to control the RIS to provide better service.

[0185] Next, the solution of supporting the authorization of the UE for RIS control will be described in connection with FIG. 8.

[0186] FIG. 8 illustrates a signaling chart of another process 800 of communication that supports a control of a RIS in accordance with aspects of the present disclosure. For the purpose of discussion, the process 800 will be described with reference to FIG. 1. The process 800 may involve the network entity 102-1, the RIS 103, the UE 101 and the core network element 109 as illustrated in FIG. 1. It is to be understood that the steps and the order of the steps in FIG. 8 are merely for illustration, and not for limitation. It is assumed that a control node of the RIS 103 is the network entity 102-1. The UE 101 is served or not served by the network entity 102-1.

[0187] As shown in FIG. 8, the RIS 103 may register 810 with core network (CN). With reference to FIG. 8, the RIS 103 may transmit 811, to the network entity 102-1, a request of a registration with core network (CN). In some embodiments, a registration type may be “initial registration”. RIS identification may be done at the network entity 102-1. RIS authorization may be done at CN side.

[0188] With reference to FIG. 8, the network entity 102-1 may forward 812 the request of the registration with CN to the core network element 109. After authorization (e.g., AMF and other core-network entities do further authorization), the core network element 109 may generate 813 registration information at CN side. In some embodiments, the registration information may comprise at least one of the following: a list of network entities that have capability to control the RIS 103; a list of UEs that have capability to control the RIS 103; a list of RISs that are only controlled by the UE 101; a list of RISs that are only controlled by the network entity 102-1; or a list of RISs that are controlled by the UE 101 and the network entity 102-1.

[0189] With reference to FIG. 8, the network entity 102-1 may determine 820 that a handover of a control node of the RIS 103 from the network entity 102-1 to the UE 101 is to be performed. In other words, the network entity 102-1 may select the UE 101 as a new control node. It is to be understood that the selection of the new control node may be carried out in any suitable ways and the present disclosure does not limit this aspect.

[0190] With reference to FIG. 8, the network entity 102-1 may transmit 830, to the UE 101, a request for capability information of the UE 101 related to the RIS 103. The UE 101 may transmit 840 the capability information of the UE 101 to the network entity

102-1. In other words, UE 101 may transfer its RIS-related capabilities to the network entity 102-1. In some embodiments, the capability information may comprise at least one of the following: capability of the RIS 103 supported by the UE 101; or capability of configuring control information of the RIS 103.

**[0191]** Continuing to refer to FIG. 8, in some embodiments, the UE 101 may initiate 850 an authorization for the UE 101 to control the RIS 103. In other words, the UE 101 may request the core network element 109 to authorize the UE 101 to control and configure the RIS 103.

**[0192]** With reference to FIG. 8, the network entity 102-1 may transmit 851, to the UE 101, first information of the RIS 103 for the authorization. In some embodiments, the first information may be transmitted via Msg 2 or Msg 4 in a random access procedure. It is to be understood that any other suitable ways for transmitting the first information may also be feasible.

**[0193]** In some embodiments, the first information may comprise at least one of the following: identity information of the RIS 103 (e.g., RIS ID); location information of the RIS 103; identity information of a cell in which the RIS 103 is camping; or an indication of the core network element 109 supporting the RIS 103 (e.g., a selected RIS capable AMF). It is to be understood that the first information may comprise any other suitable information or combination of information.

**[0194]** With reference to FIG. 8, the UE 101 may transmit 852, to the core network element 109, third information of the RIS 103 for the authorization. In some embodiments, the third information may comprise at least one of the following: identity information of the RIS 103 (e.g., RIS ID); location information of the RIS 103; or identity information of a cell in which the RIS 103 is camping. It is to be understood that the third information may comprise any other suitable information or combination of information.

**[0195]** With reference to FIG. 8, the core network element 109 may check the registration information of the RIS 103 and respond 853 with authorization information of the RIS 103 to the UE 101. The authorization information may comprise an indication of whether the UE 101 is authorized for controlling the RIS 103.

[0196] Continuing to refer to FIG. 8, in some alternative embodiments, the network entity 102-1 may initiate 860 an authorization for the UE 101 to control the RIS 103 based on the capability information of the UE 101. In other words, the network entity 102-1 may request the core network element 109 to authorize the UE 101 to control and configure the RIS 103.

[0197] With reference to FIG. 8, the network entity 102-1 may transmit 861, to the core network element 109, second information of the RIS 103 for the authorization. In some embodiments, the second information may comprise at least one of the following: identity information of the RIS 103 (e.g., RIS ID); location information of the RIS 103; identity information of a cell in which the RIS 103 is camping; identity information of the UE 101 (e.g., UE ID); location information (e.g., approximate location) of the UE 101; or identity information of a cell in which the UE 101 is camping. It is to be understood that the second information may comprise any other suitable information or combination of information.

[0198] The core network element 109 may check the registration information of the RIS 103 and respond 862 with authorization information of the RIS 103 to the network entity 102-1. The authorization information may comprise an indication of whether the UE 101 is authorized for controlling the RIS 103. The network entity 102-1 may transmit 863 the authorization information to the UE 101.

[0199] So far, an authorization for a UE to control and configure a RIS may be achieved. It is to be understood that the processes 300 to 800 may be carried out separately or in any suitable combination.

[0200] FIG. 9 illustrates an example of a device 900 that supports a control of a RIS in accordance with aspects of the present disclosure. The device 900 may be an example of a base station, a UE, or a core network element as described herein. The device 900 may support wireless communication with one or more network entities 102, UEs, core network elements or any combination thereof. The device 900 may include components for bi-directional communications including components for transmitting and receiving communications, such as a processor 902, a memory 904, a transceiver 906, and, optionally, an I/O controller 908. These components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

**[0201]** The processor 902, the memory 904, the transceiver 906, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. For example, the processor 902, the memory 904, the transceiver 906, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

**[0202]** In some implementations, the processor 902, the memory 904, the transceiver 906, or various combinations or components thereof may be implemented in hardware (e.g., in communications management circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA) or other programmable logic device, a discrete gate or transistor logic, discrete hardware components, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure. In some implementations, the processor 902 and the memory 904 coupled with the processor 902 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 902, instructions stored in the memory 904).

**[0203]** For example, the processor 902 may support wireless communication at the device 900 in accordance with examples as disclosed herein. In some embodiments where the device 900 is a base station, the processor 902 may be configured to operable to support a means for: in accordance with a determination that a handover of a control node of a RIS from the base station is triggered, obtaining a set of measurements of a set of links between a first set of UEs and the RIS; determining a first UE from the first set of UEs at least based on the set of measurements; and performing a handover of the control node of the RIS from the base station to the first UE. In some embodiments where the device 900 is a UE, the processor 902 may be configured to operable to support a means for: in accordance with a determination that a handover of a control node of a RIS from a base station is triggered, performing a measurement of a link between the UE and the RIS; and transmitting the measurement to the base station via the transceiver.

**[0204]** In some embodiments where the device 900 is a base station, the processor 902 may be configured to operable to support a means for: in accordance with a determination that a handover of a control node of a RIS from the base station to a UE is to be performed, transmitting, to the UE via the transceiver, a request for capability information of the UE related to the RIS; receiving, from the UE via the transceiver, the capability information of the UE; and initiating an authorization for the UE to control the RIS based on the capability information of the UE. In some embodiments where the device 900 is a UE, the processor 902 may be configured to operable to support a means for: receiving, from a base station via the transceiver, a request for capability information of the UE related to a RIS; transmitting, to the base station via the transceiver, the capability information of the UE; and obtaining an authorization for the UE to control the RIS.

**[0205]** The processor 902 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, a microcontroller, an ASIC, an FPGA, a programmable logic device, a discrete gate or transistor logic component, a discrete hardware component, or any combination thereof). In some implementations, the processor 902 may be configured to operate a memory array using a memory controller. In some other implementations, a memory controller may be integrated into the processor 902. The processor 902 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 904) to cause the device 900 to perform various functions of the present disclosure.

**[0206]** The memory 904 may include random access memory (RAM) and read-only memory (ROM). The memory 904 may store computer-readable, computer-executable code including instructions that, when executed by the processor 902 cause the device 900 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. In some implementations, the code may not be directly executable by the processor 902 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 904 may include, among other things, a basic I/O system (BIOS) which may control basic hardware or software operation such as the interaction with peripheral components or devices.

**[0207]** The I/O controller 908 may manage input and output signals for the device 900. The I/O controller 908 may also manage peripherals not integrated into the device 900. In some implementations, the I/O controller 908 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 908 may utilize an operating system such as iOS®, ANDROID®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system. In some implementations, the I/O controller 908 may be implemented as part of a processor, such as the processor 906. In some implementations, a user may interact with the device 900 via the I/O controller 908 or via hardware components controlled by the I/O controller 908.

**[0208]** In some implementations, the device 900 may include a single antenna 910. However, in some other implementations, the device 900 may have more than one antenna 910 (i.e., multiple antennas), including multiple antenna panels or antenna arrays, which may be capable of concurrently transmitting or receiving multiple wireless transmissions. The transceiver 906 may communicate bi-directionally, via the one or more antennas 910, wired, or wireless links as described herein. For example, the transceiver 906 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 906 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 910 for transmission, and to demodulate packets received from the one or more antennas 910. The transceiver 906 may include one or more transmit chains, one or more receive chains, or a combination thereof.

**[0209]** A transmit chain may be configured to generate and transmit signals (e.g., control information, data, packets). The transmit chain may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmit chain may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmit chain may also include one or more antennas 910 for transmitting the amplified signal into the air or wireless medium.

**[0210]** A receive chain may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receive chain may include one or more antennas 910 for receive the signal over the air or wireless medium. The receive chain may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receive chain may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receive chain may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

**[0211]** FIG. 10 illustrates an example of a processor 1000 that supports a control of a RIS in accordance with aspects of the present disclosure. The processor 1000 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 1000 may include a controller 1002 configured to perform various operations in accordance with examples as described herein. The processor 1000 may optionally include at least one memory 1004, such as L1/L2/L3 cache. Additionally, or alternatively, the processor 1000 may optionally include one or more arithmetic-logic units (ALUs) 1006. One or more of these components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

**[0212]** The processor 1000 may be a processor chipset and include a protocol stack (e.g., a software stack) executed by the processor chipset to perform various operations (e.g., receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) in accordance with examples as described herein. The processor chipset may include one or more cores, one or more caches (e.g., memory local to or included in the processor chipset (e.g., the processor 1000) or other memory (e.g., random access memory (RAM), read-only memory (ROM), dynamic RAM (DRAM), synchronous dynamic RAM (SDRAM), static RAM (SRAM), ferroelectric RAM (FeRAM), magnetic RAM (MRAM), resistive RAM (RRAM), flash memory, phase change memory (PCM), and others).

**[0213]** The controller 1002 may be configured to manage and coordinate various operations (e.g., signaling, receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) of the processor 1000 to cause the processor 1000 to support various operations in accordance with examples as described herein. For example, the controller 1002 may operate as a control unit of the processor 1000, generating control signals that manage the operation of various components of the processor 1000. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

**[0214]** The controller 1002 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 1004 and determine subsequent instruction(s) to be executed to cause the processor 1000 to support various operations in accordance with examples as described herein. The controller 1002 may be configured to track memory address of instructions associated with the memory 1004. The controller 1002 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 1002 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 1000 to cause the processor 1000 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 1002 may be configured to manage flow of data within the processor 1000. The controller 1002 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 1000.

**[0215]** The memory 1004 may include one or more caches (e.g., memory local to or included in the processor 1000 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementation, the memory 1004 may reside within or on a processor chipset (e.g., local to the processor 1000). In some other implementations, the memory 1004 may reside external to the processor chipset (e.g., remote to the processor 1000).

**[0216]** The memory 1004 may store computer-readable, computer-executable code including instructions that, when executed by the processor 1000, cause the processor 1000 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. The controller 1002 and/or the processor 1000 may be configured to execute computer-readable instructions stored in the memory 1004 to cause the processor 1000 to perform various functions. For example, the processor 1000 and/or the controller 1002 may be coupled with or to the memory 1004, and the processor 1000, the controller 1002, and the memory 1004 may be configured to perform various functions described herein. In some examples, the processor 1000 may include multiple processors and the memory 1004 may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions herein.

**[0217]** The one or more ALUs 1006 may be configured to support various operations in accordance with examples as described herein. In some implementation, the one or more ALUs 1006 may reside within or on a processor chipset (e.g., the processor 1000). In some other implementations, the one or more ALUs 1006 may reside external to the processor chipset (e.g., the processor 1000). One or more ALUs 1006 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 1006 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 1006 be configured with a variety of logical and arithmetic circuits, including adders, subtractors, shifters, and logic gates, to process and manipulate the data according to the operation. Additionally, or alternatively, the one or more ALUs 1006 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 1006 to handle conditional operations, comparisons, and bitwise operations.

**[0218]** The processor 1000 may support wireless communication in accordance with examples as disclosed herein. In some embodiments, the processor 1000 may be configured to or operable to support a means for: in accordance with a determination that a handover of a control node of a RIS from a base station is triggered, obtaining, at the base station, a set of measurements of a set of links between a first set of UEs and the RIS; determining a first UE from the first set of UEs at least based on the set of measurements; and performing a handover of the control node of the RIS from the base station to the first UE. In some embodiments, the processor 1000 may be configured to or operable to support a means for: in accordance with a determination that a handover of a control node of a RIS from a base station is triggered, performing, at a UE, a measurement of a link between the UE and the RIS; and transmitting the measurement to the base station via the transceiver.

**[0219]** In some embodiments, the processor 1000 may be configured to or operable to support a means for: in accordance with a determination that a handover of a control node of a RIS from a base station to a UE is to be performed, transmitting, at the base station to the UE via the transceiver, a request for capability information of the UE related to the RIS; receiving, from the UE via the transceiver, the capability information of the UE; and initiating an authorization for the UE to control the RIS based on the capability information of the UE. In some embodiments, the processor 1000 may be configured to or operable to support a means for: receiving, at a UE from a base station via the transceiver, a request for capability information of the UE related to a RIS; transmitting, to the base station via the transceiver, the capability information of the UE; and obtaining an authorization for the UE to control the RIS.

**[0220]** FIG. 11 illustrates a flowchart of a method 1100 that supports a control of a RIS in accordance with aspects of the present disclosure. The operations of the method 1100 may be implemented by a device or its components as described herein. For example, the operations of the method 1100 may be performed by a base station (e.g., the network entity 102-1) as described herein. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

**[0221]** At block 1110, the method 1100 may comprise determining, at a base station, a handover of a control node of a RIS from the base station is triggered. The operations of 1110 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1110 may be performed by a device as described with reference to FIG. 1.

**[0222]** In some embodiments, the method 1100 may further comprise determining that the handover of the control node of the RIS is triggered by at least one of the following: receiving an indication of the handover of the control node of the RIS from a second set of UEs served by the RIS, QoS requirements of the second set of UEs being unsatisfied; or transmitting a request for the handover of the control node of the RIS to a third set of UEs served by the RIS based on at least one of the following: no resources are available to transmit control information to the RIS, capability of transmitting the control information to the RIS is limited, the RIS moves out of coverage of the base station, or signal quality of a link between the base station and the RIS is lower than or equal to a quality threshold.

**[0223]** At block 1120, the method 1100 may comprise obtaining a set of measurements of a set of links between a first set of UEs and the RIS. The operations of 1120 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1120 may be performed by a device as described with reference to FIG. 1.

**[0224]** In some embodiments, obtaining the set of measurements may comprise: determining control information of the RIS; transmitting, to the RIS, the control information for forwarding of a reference signal, the reference signal being transmitted from a UE in the first set of UEs to the RIS; and receiving, from the UE or a further base station serving the UE, a measurement on the reference signal forwarded to the UE.

**[0225]** In some embodiments, determining the control information may comprise: determining information of a direction of the reference signal from the UE to the RIS; and deriving the control information from the information of the direction of the reference signal.

**[0226]** In some embodiments, determining the information of the direction of the reference signal may comprise: transmitting, to the UE or the further base station, a request for location information of the UE, the request comprising location information of the RIS; and receiving, from the UE or the further base station, the information of the direction of the reference signal.

**[0227]** In some embodiments, determining the information of the direction of the reference signal may comprise: transmitting, to the UE or the further base station, a request for location information of the UE, the request comprising location information of the RIS; receiving, from the UE or the further base station, the location information of the UE; and deriving the information of the direction of the reference signal based on the location information of the UE and the location information of the RIS. In some embodiments, the method 1100 may further include transmitting the information of the direction of the reference signal to the UE or the further base station.

**[0228]** In some embodiments, the location information of the RIS may comprise at least one of the following: a location of the RIS; refresh time of the location of the RIS;

validity time of the location of the RIS; a fluctuation of the location of the RIS within an area; or a moving state of the RIS.

**[0229]** In some embodiments where the location information of the UE is received from the further base station, the location information of the UE may comprise at least one of the following: a set of UE lists, a set of identities of UEs in a UE list in the set of UE lists, or location information of a UE in the UE list.

**[0230]** In some embodiments where the information of the direction of the reference signal is received from the further base station, the information of the direction of the reference signal may comprise at least one of the following: a set of UE lists, a set of identities of UEs in a UE list in the set of UE lists, or the information of the direction of the reference signal for a UE in the UE list.

**[0231]** In some embodiments, the information of the direction of the reference signal may comprise at least one of the following: a horizontal angle of the reference signal; or a vertical angle of the reference signal.

**[0232]** In some embodiments, determining the control information may comprise transmitting, to the UE, a further reference signal comprising location information of the RIS; receiving, from the UE, a further measurement on the further reference signal; and deriving the control information based on the further measurement on the further reference signal.

**[0233]** At block 1130, the method 1100 may comprise determining a first UE from the first set of UEs at least based on the set of measurements. The operations of 1130 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1130 may be performed by a device as described with reference to FIG. 1.

**[0234]** In some embodiments, the method 1100 may further comprise receiving moving information of the first set of UEs. In some embodiments, determining the first UE may comprise: selecting the first UE from the first set of UEs based on the set of measurements and the moving information of the first set of UEs. In some embodiments, the moving information of the first set of UEs may comprise at least one of the following: a moving speed of a UE in the first set of UEs; or a moving direction of the UE in the first set of UEs.

**[0235]** At block 1140, the method 1100 may comprise performing the handover of the control node of the RIS from the base station to the first UE. The operations of 1140 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1140 may be performed by a device as described with reference to FIG. 1.

**[0236]** In some embodiments, the method 1100 may further comprise transmitting a first configuration of the reference signal to the UE or the further base station. In some embodiments, the method 1100 may further comprise: transmitting a set of resources available for the reference signal to the UE or the further base station, and receiving a second configuration of the reference signal from the UE or the further base station.

**[0237]** In some embodiments, performing the handover of the control node of the RIS may comprise at least one of the following: transmitting, to the first UE or a further base station serving the first UE, a request for the handover; receiving, from the first UE or the further base station, a response to the request for the handover, the response comprising a request for information associated with the RIS; or transmitting the information associated with the RIS to the first UE or the further base station.

**[0238]** In some embodiments, the information associated with the RIS may comprise at least one of the following: information of the RIS; information of capability of the RIS; or information of capability of a controller of the RIS.

**[0239]** In some embodiments, the information of the RIS may comprise at least one of the following: moving information of the RIS; number of elements of the RIS; or an operation mode of the RIS.

**[0240]** In some embodiments, the information of capability of the RIS may comprise an indication of whether a coefficient and a property of the RIS is capable to be tuned according to control information.

**[0241]** In some embodiments, the information of capability of the controller may comprise at least one of the following: an indication of whether the controller is capable to receive control information; or an indication of whether the controller is capable to transmit a positive or negative acknowledgement for the reception of the control information.

**[0242]** FIG. 12 illustrates a flowchart of another method 1200 that supports a control of a RIS in accordance with aspects of the present disclosure. The operations of the method 1200 may be implemented by a device or its components as described herein. For example, the operations of the method 1200 may be performed by a UE (e.g., the UE 101 or 105) as described herein. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

**[0243]** At block 1210, the method 1200 may comprise determining at a UE that a handover of a control node of a RIS from a base station is triggered. The operations of 1210 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1210 may be performed by a device as described with reference to FIG. 1.

**[0244]** In some embodiments, determining that the handover of the control node of the RIS is triggered may comprise at least one of the following: in accordance with a determination that QoS requirements of the UE are unsatisfied, transmitting, to the base station, an indication of the handover of the control node of the RIS; or receiving, from the base station, a request for the handover of the control node of the RIS.

**[0245]** At block 1220, the method 1200 may comprise performing a measurement of a link between the UE and the RIS. The operations of 1220 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1220 may be performed by a device as described with reference to FIG. 1.

**[0246]** In some embodiments, performing the measurement may comprise: determining information of a direction of a reference signal from the UE to the RIS; transmitting the reference signal to the RIS based on the information of the direction of the reference signal; and performing the measurement on the reference signal forwarded from the RIS.

**[0247]** In some embodiments, determining the information of the direction of the reference signal may comprise: receiving, from the base station or a further base station serving the UE, a request for location information of the UE, the request comprising location information of the RIS; and determining the information of the direction of the reference signal based on the location information of the UE and the location information of the RIS. In some embodiments, the method 1200 may further comprise transmitting, to the base station or the further base station, the information of the direction of the reference signal.

**[0248]** In some embodiments, determining the information of the direction of the reference signal may comprise: receiving, from the base station or a further base station serving the UE, a request for location information of the UE, the request comprising location information of the RIS; transmitting, to the base station or the further base station, the location information of the UE; and receiving, from the base station or the further base station, the information of the direction of the reference signal.

**[0249]** In some embodiments, the location information of the RIS may comprise at least one of the following: a location of the RIS; refresh time of the location of the RIS; validity time of the location of the RIS; a fluctuation of the location of the RIS within an area; or a moving state of the RIS.

**[0250]** In some embodiments, the information of the direction of the reference signal may comprise at least one of the following: a horizontal angle of the reference signal; or a vertical angle of the reference signal.

**[0251]** In some embodiments, determining the information of the direction of the reference signal may comprise: receiving, from the base station, a further reference signal comprising location information of the RIS; and determining the information of the direction of the reference signal based on location information of the UE and the location information of the RIS.

**[0252]** At block 1230, the method 1200 may include transmitting the measurement to the base station. The operations of 1230 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1230 may be performed by a device as described with reference to FIG. 1.

**[0253]** In some embodiments, the method 1200 may further comprise receiving a first configuration of the reference signal from the base station. In some embodiments, the method 1200 may further comprise: receiving a set of resources available for the reference signal from the base station, determining a second configuration of the reference signal based on the set of resources, and transmitting the second configuration of the reference signal to the base station.

**[0254]** In some embodiments, the method 1200 may further comprise transmitting moving information of the UE to the base station. In some embodiments, the moving information of the UE may comprise at least one of the following: a moving speed of the UE; or a moving direction of the UE.

**[0255]** In some embodiments, the method 1200 may further comprise at least one of the following: receiving a request for the handover from the base station or a further base station serving the UE; transmitting, to the base station or the further base station, a response to the request for the handover, the response comprising a request for information associated with the RIS; receiving the information associated with the RIS from the base station or the further base station; determining a configuration for control information of the RIS based on the information associated with the RIS; or transmitting, to the RIS, the configuration for the control information of the RIS and information of the UE.

**[0256]** In some embodiments, the information associated with the RIS may comprise at least one of the following: information of the RIS; information of capability of the RIS; or information of capability of a controller of the RIS.

**[0257]** In some embodiments, the information of the RIS may comprise at least one of the following: moving information of the RIS; number of elements of the RIS; or an operation mode of the RIS.

**[0258]** In some embodiments, the information of capability of the RIS may comprise an indication of whether a coefficient and a property of the RIS is capable to be tuned according to control information.

**[0259]** In some embodiments, the information of capability of the controller may comprise at least one of the following: an indication of whether the controller is capable to receive control information; or an indication of whether the controller is capable to transmit a positive or negative acknowledgement for the reception of the control information.

**[0260]** In some embodiments, determining the configuration of the control information of the RIS may comprise: receiving the configuration of the control information from the further base station.

[0261] In some embodiments, the configuration of the control information may comprise at least one of the following: phase, amplitude, directivity, or beamforming information; uplink or downlink TDD configuration information for resource allocation and interference management; timing configuration for transmission alignment; on or off information for energy and interference management; operation mode indication; or feedback information.

[0262] In some embodiments, the information of the UE may comprise at least one of the following: an identity of the UE; or location information of the UE.

[0263] FIG. 13 illustrates a flowchart of another method 1300 that supports a control of a RIS in accordance with aspects of the present disclosure. The operations of the method 1300 may be implemented by a device or its components as described herein. For example, the operations of the method 1300 may be performed by a base station (e.g., the network entity 102-1) as described herein. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[0264] At block 1310, the method 1300 may comprise determining, at a base station, that a handover of a control node of a RIS from the base station to a UE is to be performed. The operations of 1310 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1310 may be performed by a device as described with reference to FIG. 1.

[0265] At block 1320, the method 1300 may comprise transmitting, to the UE, a request for capability information of the UE related to the RIS. The operations of 1320 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1320 may be performed by a device as described with reference to FIG. 1.

[0266] In some embodiments, the capability information may comprise at least one of the following: capability of the RIS supported by the UE; or capability of configuring control information of the RIS.

[0267] At block 1330, the method 1300 may comprise receiving, from the UE, the capability information of the UE. The operations of 1330 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1330 may be performed by a device as described with reference to FIG. 1.

**[0268]** At block 1340, the method 1300 may comprise initiating an authorization for the UE to control the RIS based on the capability information of the UE. The operations of 1340 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1340 may be performed by a device as described with reference to FIG. 1.

**[0269]** In some embodiments, initiating the authorization may comprise at least one of the following: transmitting, to the UE, first information of the RIS for the authorization; transmitting, to a core network element, second information of the RIS for the authorization; receiving, from the core network element, an indication of whether the UE is authorized for controlling the RIS; or transmitting the indication to the UE.

**[0270]** In some embodiments, the first information may comprise at least one of the following: identity information of the RIS; location information of the RIS; identity information of a cell in which the RIS is camping; or an indication of the core network element supporting the RIS.

**[0271]** In some embodiments, the second information may comprise at least one of the following: identity information of the RIS; location information of the RIS; identity information of a cell in which the RIS is camping; identity information of the UE; location information of the UE; or identity information of a cell in which the UE is camping.

**[0272]** In some embodiments, the method 1300 may further comprise receiving, from the RIS, a request of a registration with a core network element. Registration information for the authorization is generated based on the request. The registration information may comprise at least one of the following: a list of base stations that have capability to control the RIS; a list of UEs that have capability to control the RIS; a list of RISs that are only controlled by the UE; a list of RISs that are only controlled by the base station; or a list of RISs that are controlled by the UE and the base station.

**[0273]** FIG. 14 illustrates a flowchart of another method 1400 that supports a control of a RIS in accordance with aspects of the present disclosure. The operations of the method 1200 may be implemented by a device or its components as described herein. For example, the operations of the method 1400 may be performed by a UE (e.g., the UE 101 or 105) as described herein. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

**[0274]** At block 1410, the method 1400 may comprise receiving, at a UE from a base station, a request for capability information of the UE related to a RIS. The operations of 1410 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1410 may be performed by a device as described with reference to FIG. 1.

**[0275]** At block 1420, the method 1400 may comprise transmitting, to the base station, the capability information of the UE. The operations of 1420 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1420 may be performed by a device as described with reference to FIG. 1.

**[0276]** In some embodiments, the capability information may comprise at least one of the following: capability of the RIS supported by the UE; or capability of configuring control information of the RIS.

**[0277]** At block 1430, the method 1400 may comprise obtaining an authorization for the UE to control the RIS. The operations of 1430 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 1430 may be performed by a device as described with reference to FIG. 1.

**[0278]** In some embodiments, obtaining the authorization may comprise at least one of the following: receiving, from the base station, first information of the RIS for the authorization; transmitting, to a core network element, third information of the RIS for the authorization; receiving, from the core network element, an indication of whether the UE is authorized for controlling the RIS; or receiving, from the base station, an indication of whether the UE is authorized for controlling the RIS.

**[0279]** In some embodiments, the first information may comprise at least one of the following: identity information of the RIS; location information of the RIS; identity information of a cell in which the RIS is camping; or an indication of the core network element supporting the RIS.

**[0280]** In some embodiments, the third information may comprise at least one of the following: identity information of the RIS; location information of the RIS; or identity information of a cell in which the RIS is camping.

**[0281]** It is to be understood that the operations of the methods 1100 to 1400 correspond to that described in connection with FIGs. 3 to 8, and thus other details are not repeated here for conciseness.

**[0282]** It should be noted that the methods described herein describes possible implementations, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible. Further, aspects from two or more of the methods may be combined.

**[0283]** The various illustrative blocks and components described in connection with the disclosure herein may be implemented or performed with a general-purpose processor, a DSP, an ASIC, a CPU, an FPGA or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices (e.g., a combination of a DSP and a microprocessor, multiple microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

**[0284]** The functions described herein may be implemented in hardware, software executed by a processor, firmware, or any combination thereof. If implemented in software executed by a processor, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Other examples and implementations are within the scope of the disclosure and appended claims. For example, due to the nature of software, functions described herein may be implemented using software executed by a processor, hardware, firmware, hardwiring, or combinations of any of these. Features implementing functions may also be physically located at various positions, including being distributed such that portions of functions are implemented at different physical locations.

**[0285]** Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer. By way of example, non-transitory computer-readable media may include RAM, ROM, electrically erasable programmable ROM (EEPROM), flash memory, compact disk (CD) ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other non-transitory medium that may be used to carry or store desired program code means in the form of instructions or data structures and that may be accessed by a general-purpose or special-purpose computer, or a general-purpose or special-purpose processor.

**[0286]** As used herein, including in the claims, an article "a" before an element is unrestricted and understood to refer to "at least one" of those elements or "one or more" of those elements. The terms "a," "at least one," "one or more," and "at least one of one or more" may be interchangeable. As used herein, including in the claims, "or" as used in a list of items (e.g., a list of items prefaced by a phrase such as "at least one of" or "one or more of" or "one or both of") indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C). Also, as used herein, the phrase "based on" shall not be construed as a reference to a closed set of conditions. For example, an example step that is described as "based on condition A" may be based on both a condition A and a condition B without departing from the scope of the present disclosure. In other words, as used herein, the phrase "based on" shall be construed in the same manner as the phrase "based at least in part on. Further, as used herein, including in the claims, a "set" may include one or more elements.

**[0287]** The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

# CLAIMS

What is claimed is:

1. A base station, comprising:

a processor; and

a transceiver coupled to the processor,

wherein the processor is configured to:

in accordance with a determination that a handover of a control node of a reconfigurable intelligent surface (RIS) from the base station is triggered, obtain a set of measurements of a set of links between a first set of user equipments (UEs) and the RIS;

determine a first UE from the first set of UEs at least based on the set of measurements; and

perform the handover of the control node of the RIS from the base station to the first UE.

2. The base station of claim 1, wherein the processor is further configured to:

determine that the handover of the control node of the RIS is triggered by at least one of the following:

receiving, via the transceiver, an indication of the handover of the control node of the RIS from a second set of UEs served by the RIS, quality of service (QoS) requirements of the second set of UEs being unsatisfied; or

transmitting, via the transceiver, a request for the handover of the control node of the RIS to a third set of UEs served by the RIS based on at least one of the following:

no resources are available to transmit control information to the RIS,

capability of transmitting the control information to the RIS is limited,

the RIS moves out of coverage of the base station, or

signal quality of a link between the base station and the RIS is lower than or equal to a quality threshold.

3. The base station of claim 1, wherein the processor is configured to obtain the set of measurements by:

determining control information of the RIS;

transmitting, to the RIS via the transceiver, the control information for forwarding of a reference signal, the reference signal being transmitted from a UE in the first set of UEs to the RIS; and

receiving, from the UE or a further base station serving the UE via the transceiver, a measurement on the reference signal forwarded to the UE,

wherein the processor is configured to determine the control information by:

determining information of a direction of the reference signal from the UE to the RIS; and

deriving the control information from the information of the direction of the reference signal, and

wherein the information of the direction of the reference signal comprises at least one of the following:

a horizontal angle of the reference signal; or

a vertical angle of the reference signal.

4. The base station of claim 3, wherein the processor is configured to determine the information of the direction of the reference signal by:

transmitting, to the UE or the further base station via the transceiver, a request for location information of the UE, the request comprising location information of the RIS; and

receiving, from the UE or the further base station via the transceiver, the information of the direction of the reference signal.

5. The base station of claim 3, wherein the processor is configured to determine the information of the direction of the reference signal by:

transmitting, to the UE or the further base station via the transceiver, a request for location information of the UE, the request comprising location information of the RIS;

receiving, from the UE or the further base station via the transceiver, the location information of the UE;

deriving the information of the direction of the reference signal based on the location information of the UE and the location information of the RIS; and

transmitting the information of the direction of the reference signal to the UE or the further base station via the transceiver.

6. The base station of claim 4 or 5, wherein the location information of the RIS comprises at least one of the following: a location of the RIS, refresh time of the location of the RIS, validity time of the location of the RIS, a fluctuation of the location of the RIS within an area, or a moving state of the RIS,

wherein the location information of the UE is received from the further base station, and comprises at least one of the following: a set of UE lists, a set of identities of UEs in a UE list in the set of UE lists, or location information of a UE in the UE list, or

wherein the information of the direction of the reference signal is received from the further base station, and comprises at least one of the following: a set of UE lists, a set of identities of UEs in a UE list in the set of UE lists, or the information of the direction of the reference signal for a UE in the UE list.

7. The base station of claim 3, wherein the processor is further configured to transmit a first configuration of the reference signal to the UE or the further base station via the transceiver; or

wherein the processor is further configured to: transmit a set of resources available for the reference signal to the UE or the further base station via the transceiver, and receive a second configuration of the reference signal from the UE or the further base station via the transceiver.

8. The base station of claim 1, wherein the processor is further configured to receive moving information of the first set of UEs,

wherein the processor is configured to determine the first UE by selecting the first UE from the first set of UEs based on the set of measurements and the moving information of the first set of UEs, and wherein the moving information of the first set of UEs comprises at least one of the following: a moving speed of a UE in the first set of UEs, or a moving direction of the UE in the first set of UEs.

9. A user equipment (UE), comprising:

a processor; and

a transceiver coupled to the processor,

wherein the processor is configured to:

in accordance with a determination that a handover of a control node of a reconfigurable intelligent surface (RIS) from a base station is triggered, perform a measurement of a link between the UE and the RIS; and

transmit the measurement to the base station via the transceiver,

wherein the processor is configured to perform the measurement by:

determining information of a direction of a reference signal from the UE to the RIS;

transmitting the reference signal to the RIS based on the information of the direction of the reference signal; and

performing the measurement on the reference signal forwarded from the RIS.

10. The UE of claim 9, wherein the processor is configured to determine the information of the direction of the reference signal by:

receiving, from the base station or a further base station serving the UE via the transceiver, a request for location information of the UE, the request comprising location information of the RIS;

determining the information of the direction of the reference signal based on the location information of the UE and the location information of the RIS; and

transmitting, to the base station or the further base station via the transceiver, the information of the direction of the reference signal.

11. The UE of claim 9, wherein the processor is configured to determine the information of the direction of the reference signal by:

receiving, from the base station or a further base station serving the UE via the transceiver, a request for location information of the UE, the request comprising location information of the RIS;

transmitting, to the base station or the further base station via the transceiver, the location information of the UE; and

receiving, from the base station or the further base station via the transceiver, the information of the direction of the reference signal.

12. The UE of claim 9, wherein the processor is further configured to at least one of the following:

receive a request for the handover from the base station or a further base station serving the UE via the transceiver;

transmit, to the base station or the further base station via the transceiver, a response to the request for the handover, the response comprising a request for information associated with the RIS;

receive the information associated with the RIS from the base station or the further base station via the transceiver;

determine a configuration for control information of the RIS based on the information associated with the RIS by receiving the configuration of the control information from the further base station; or

transmit, to the RIS via the transceiver, the configuration for the control information of the RIS and information of the UE.

13. The UE of claim 12, wherein the information associated with the RIS comprises at least one of the following: information of the RIS, information of capability of the RIS, or information of capability of a controller of the RIS,

wherein the information of the RIS comprises at least one of the following: moving information of the RIS, number of elements of the RIS, or an operation mode of the RIS,

wherein the information of capability of the RIS comprises an indication of whether a coefficient and a property of the RIS is capable to be tuned according to control information, and wherein the information of capability of the controller comprises at least one of the following: an indication of whether the controller is capable to receive control information, or an indication of whether the controller is capable to transmit a positive or negative acknowledgement for the reception of the control information.

14. The UE of claim 12, wherein the configuration of the control information comprises at least one of the following:

phase, amplitude, directivity, or beamforming information;

uplink or downlink time division duplexing (TDD) configuration information for resource allocation and interference management;

timing configuration for transmission alignment;

on or off information for energy and interference management;

operation mode indication; or

feedback information.

15. A base station, comprising:

a processor; and

a transceiver coupled to the processor,

wherein the processor is configured to:

in accordance with a determination that a handover of a control node of a reconfigurable intelligent surface (RIS) from the base station to a user equipment (UE) is to be performed, transmit, to the UE via the transceiver, a request for capability information of the UE related to the RIS;

receive, from the UE via the transceiver, the capability information of the UE; and

initiate an authorization for the UE to control the RIS based on the capability information of the UE, wherein the capability information comprises at least one of the following: capability of the RIS supported by the UE, or capability of configuring control information of the RIS.

16. The base station of claim 15, wherein the processor is configured to initiate the authorization by at least one of the following:

transmitting, to the UE via the transceiver, first information of the RIS for the authorization;

transmitting, to a core network element via the transceiver, second information of the RIS for the authorization;

receiving, from the core network element via the transceiver, an indication of whether the UE is authorized for controlling the RIS; or

transmitting the indication to the UE via the transceiver.

17. The base station of claim 16, wherein the first information comprises at least one of the following: identity information of the RIS; location information of the RIS; identity information of a cell in which the RIS is camping; or an indication of the core network element supporting the RIS, or

wherein the second information comprises at least one of the following: identity information of the RIS; location information of the RIS; identity information of a cell in which the RIS is camping; identity information of the UE; location information of the UE; or identity information of a cell in which the UE is camping.

18. The base station of claim 15, wherein the processor is further configured to:

receive, from the RIS via the transceiver, a request of a registration with a core network element, registration information for the authorization being generated based on the request, the registration information comprising at least one of the following:

a list of base stations that have capability to control the RIS;

a list of UEs that have capability to control the RIS;

a list of RISs that are only controlled by the UE;

a list of RISs that are only controlled by the base station; or

a list of RISs that are controlled by the UE and the base station.

19. A user equipment (UE), comprising:

a processor; and

a transceiver coupled to the processor,

wherein the processor is configured to:

receive, from a base station via the transceiver, a request for capability information of the UE related to a reconfigurable intelligent surface (RIS);

transmit, to the base station via the transceiver, the capability information of the UE; and

obtain an authorization for the UE to control the RIS.

20. The UE of claim 19, wherein the processor is configured to obtain the authorization by at least one of the following:

receiving, from the base station via the transceiver, first information of the RIS for the authorization;

transmitting, to a core network element via the transceiver, third information of the RIS for the authorization;

receiving, from the core network element via the transceiver, an indication of whether the UE is authorized for controlling the RIS; or

receiving, from the base station via the transceiver, an indication of whether the UE is authorized for controlling the RIS.

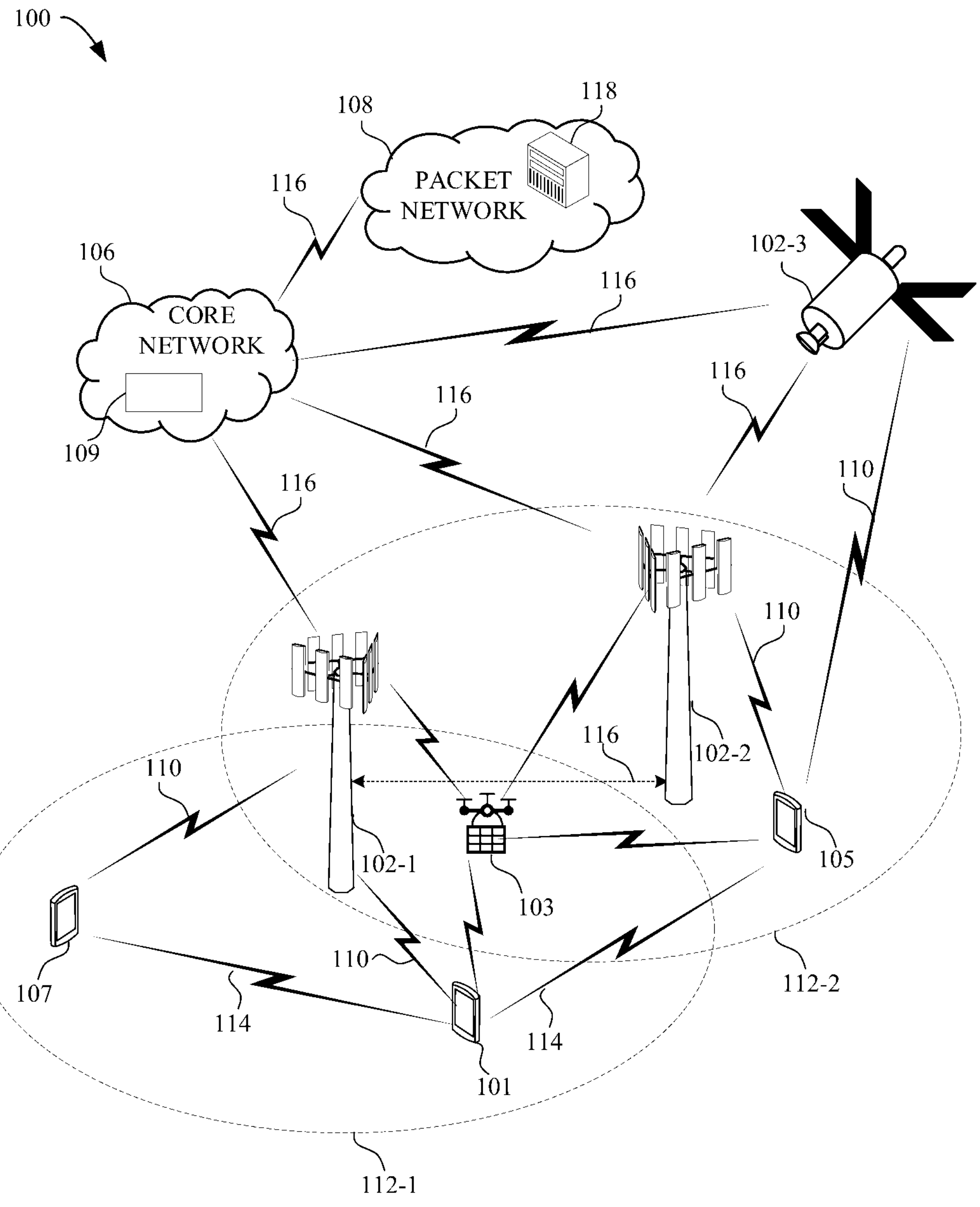

100
108
118
PACKET
NETWORK
116
106
CORE
NETWORK
109
102-3
116
116
116
110
116
110
110
116
102-2
102-1
103
105
107
110
114
114
101
112-2
112-1

FIG. 1

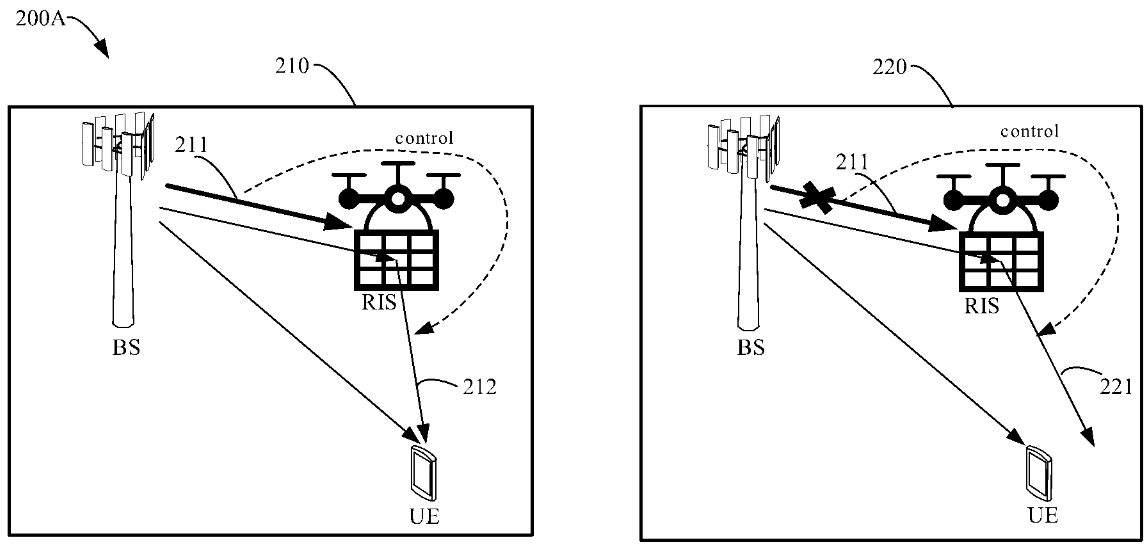

200A
210
220
211
control
RIS
BS
212
UE
211
control
RIS
BS
221
UE

FIG. 2A

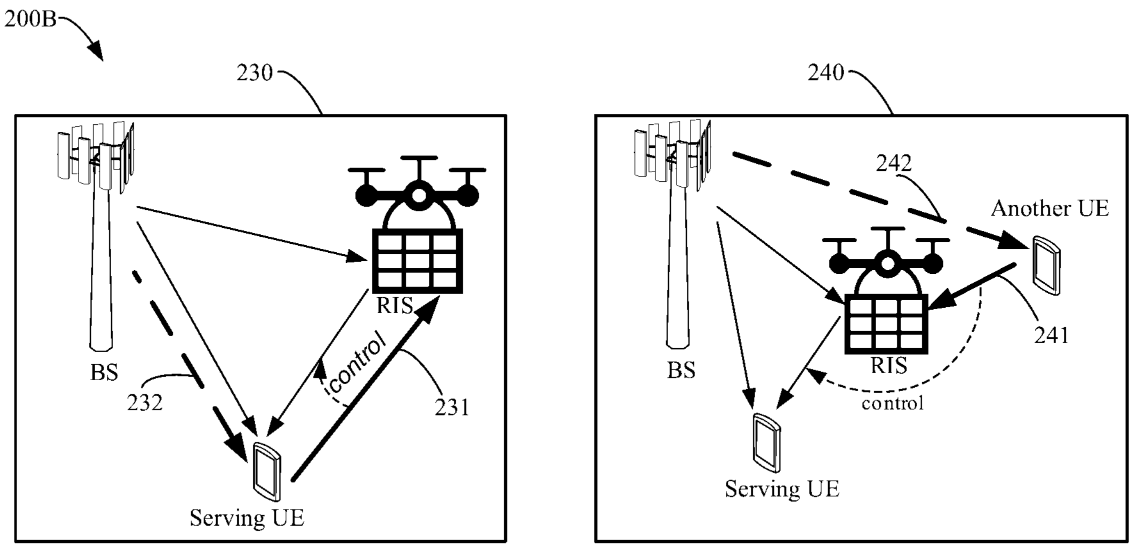

200B
230
240
RIS
BS
232
control
231
Serving UE
242
Another UE
241
RIS
BS
control
Serving UE

FIG. 2B

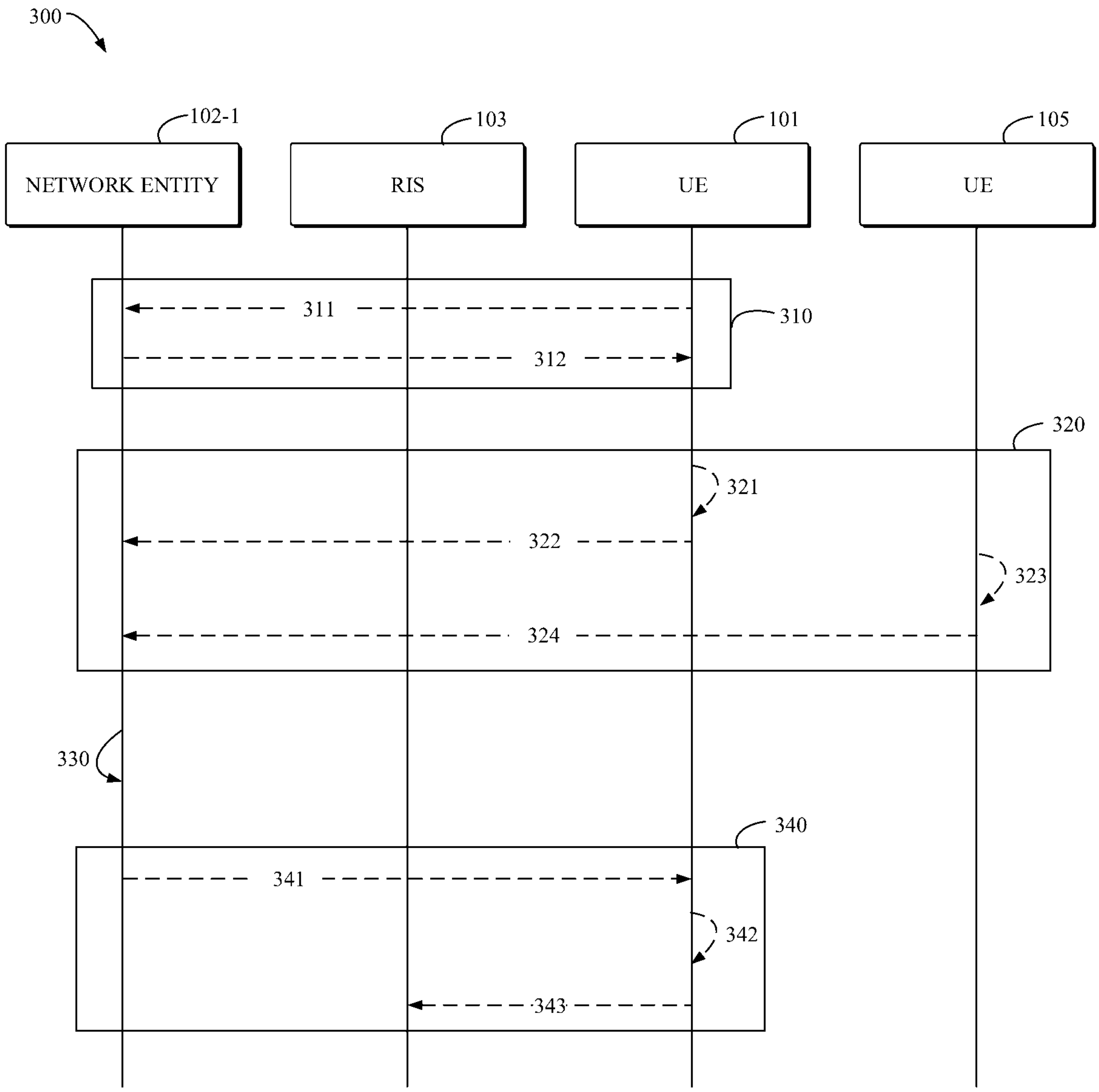

300
102-1
103
101
105
NETWORK ENTITY
RIS
UE
UE
311
310
312
320
321
322
323
324
330
340
341
342
343

FIG. 3

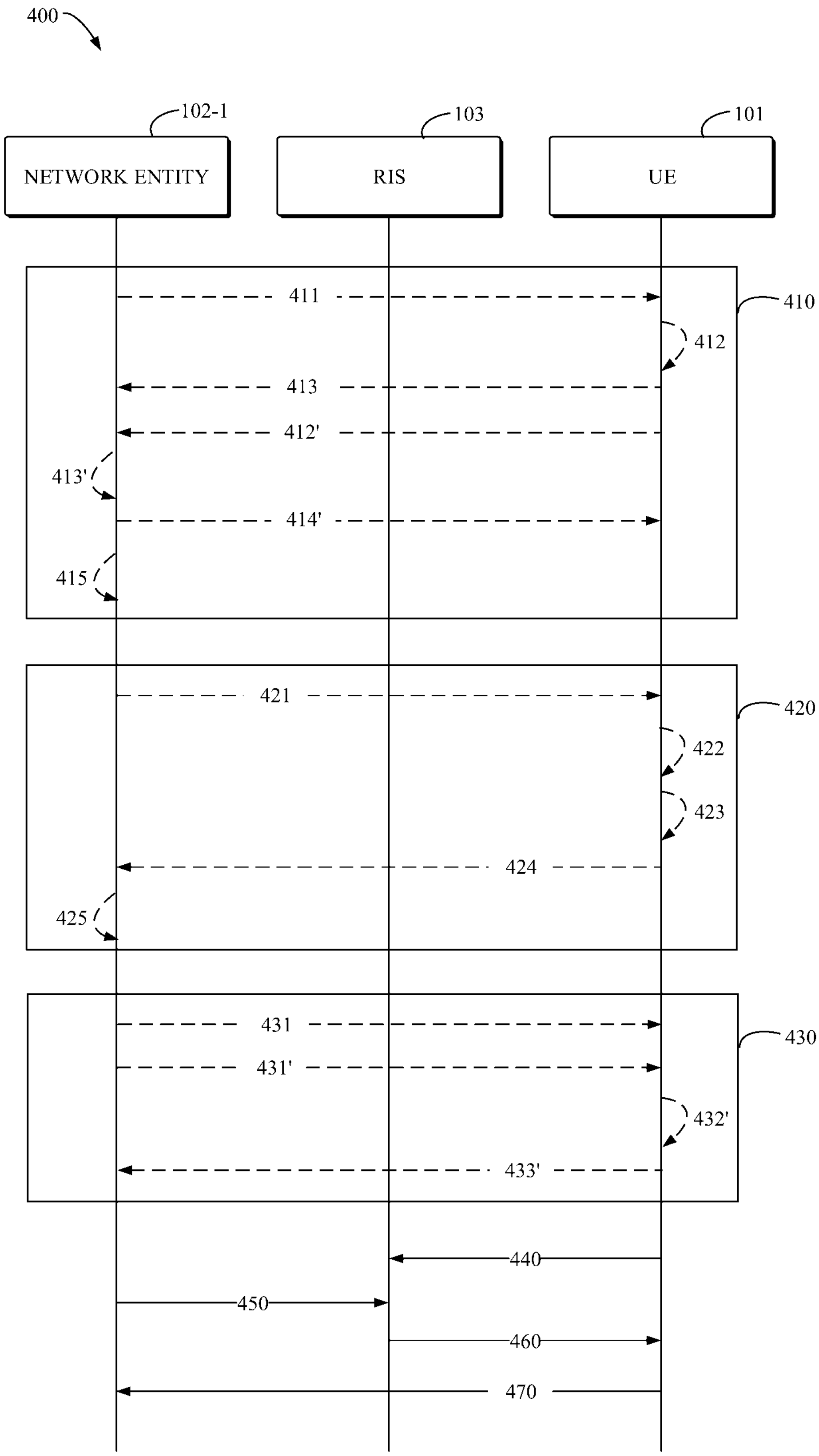
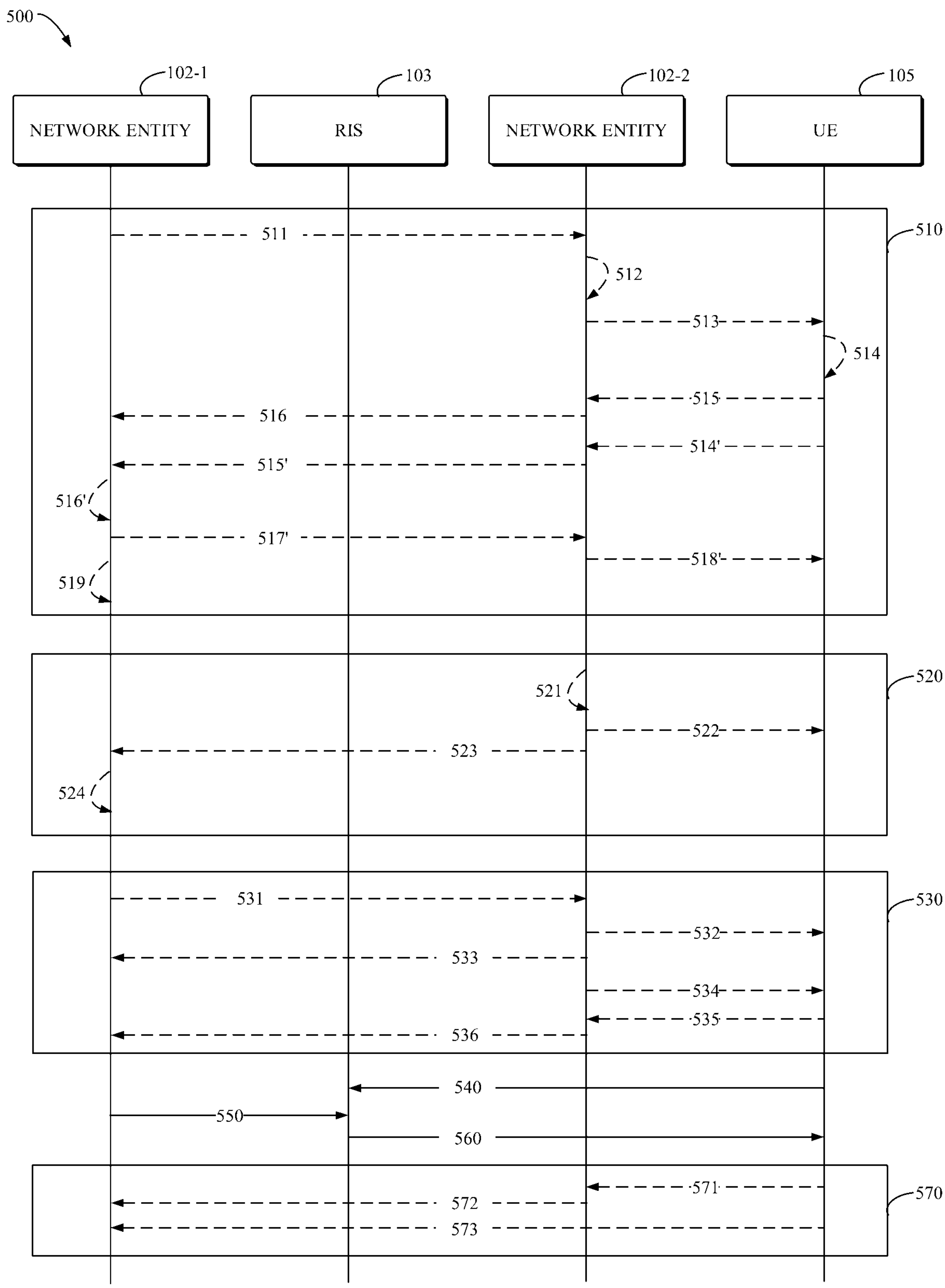

400
102-1
103
101
NETWORK ENTITY
RIS
UE
410
411
412
413
412'
413'
414'
415
420
421
422
423
424
425
430
431
431'
432'
433'
440
450
460
470

FIG. 4



500
102-1
103
102-2
105
NETWORK ENTITY
RIS
NETWORK ENTITY
UE
510
511
512
513
514
515
516
514'
515'
516'
517'
518'
519
520
521
522
523
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530
531
532
533
534
535
536
540
550
560
570
571
572
573


FIG. 5

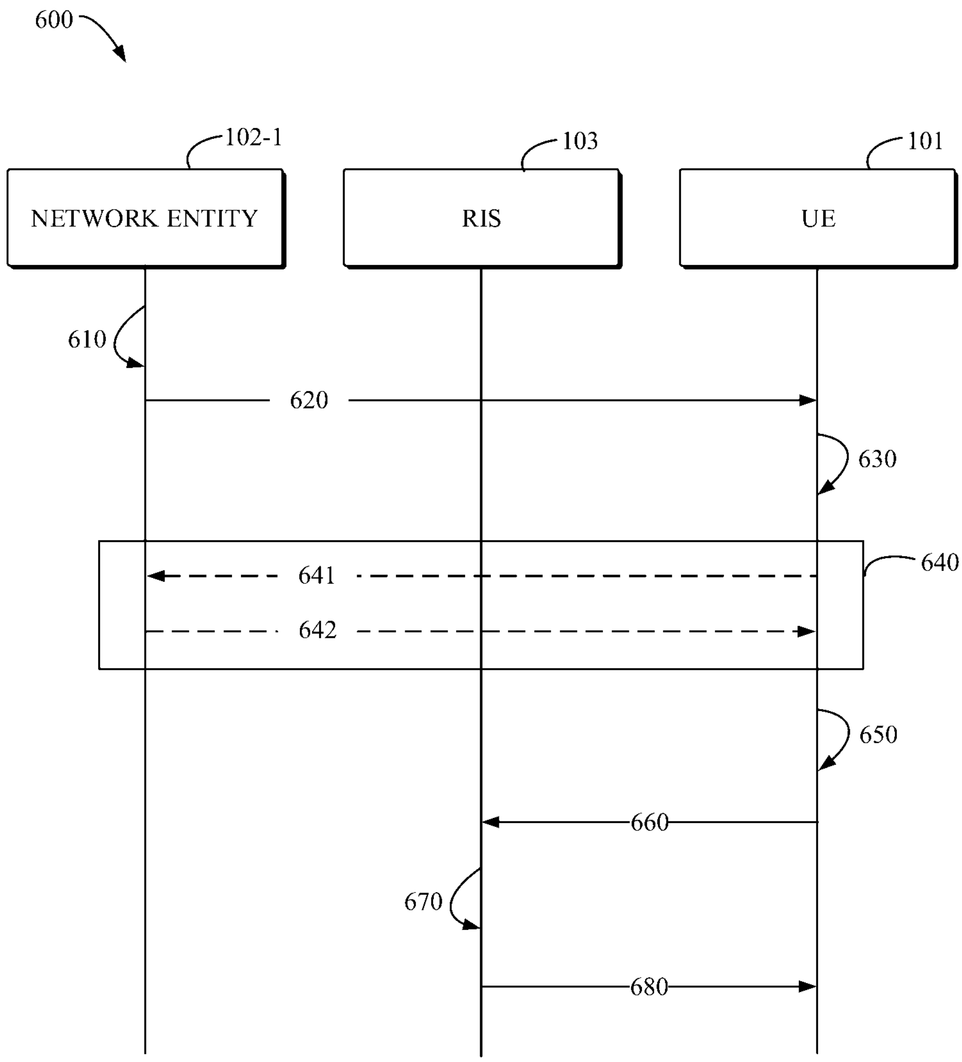
600
102-1
103
101
NETWORK ENTITY
RIS
UE
610
620
630
640
641
642
650
660
670
680

FIG. 6

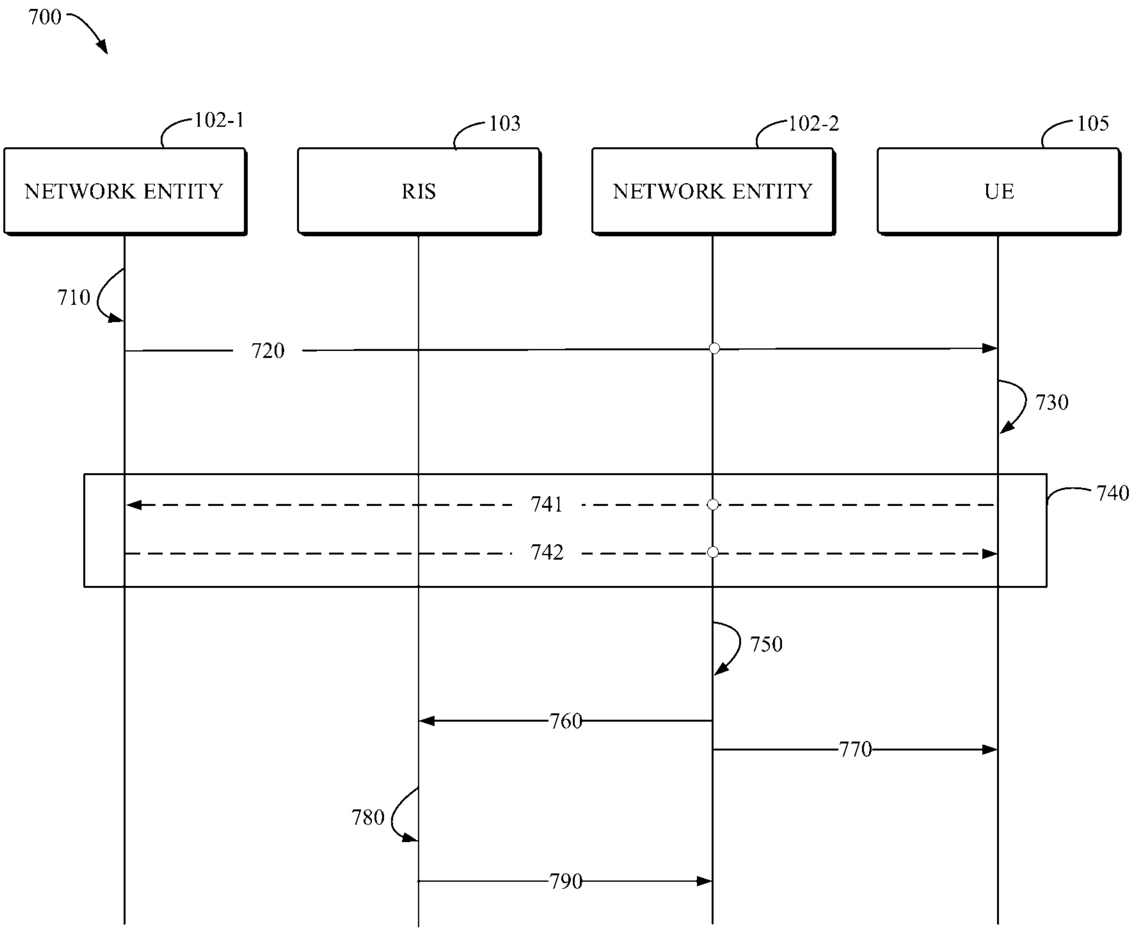
700
102-1
NETWORK ENTITY
103
RIS
102-2
NETWORK ENTITY
105
UE
710
720
730
740
741
742
750
760
770
780
790

FIG. 7

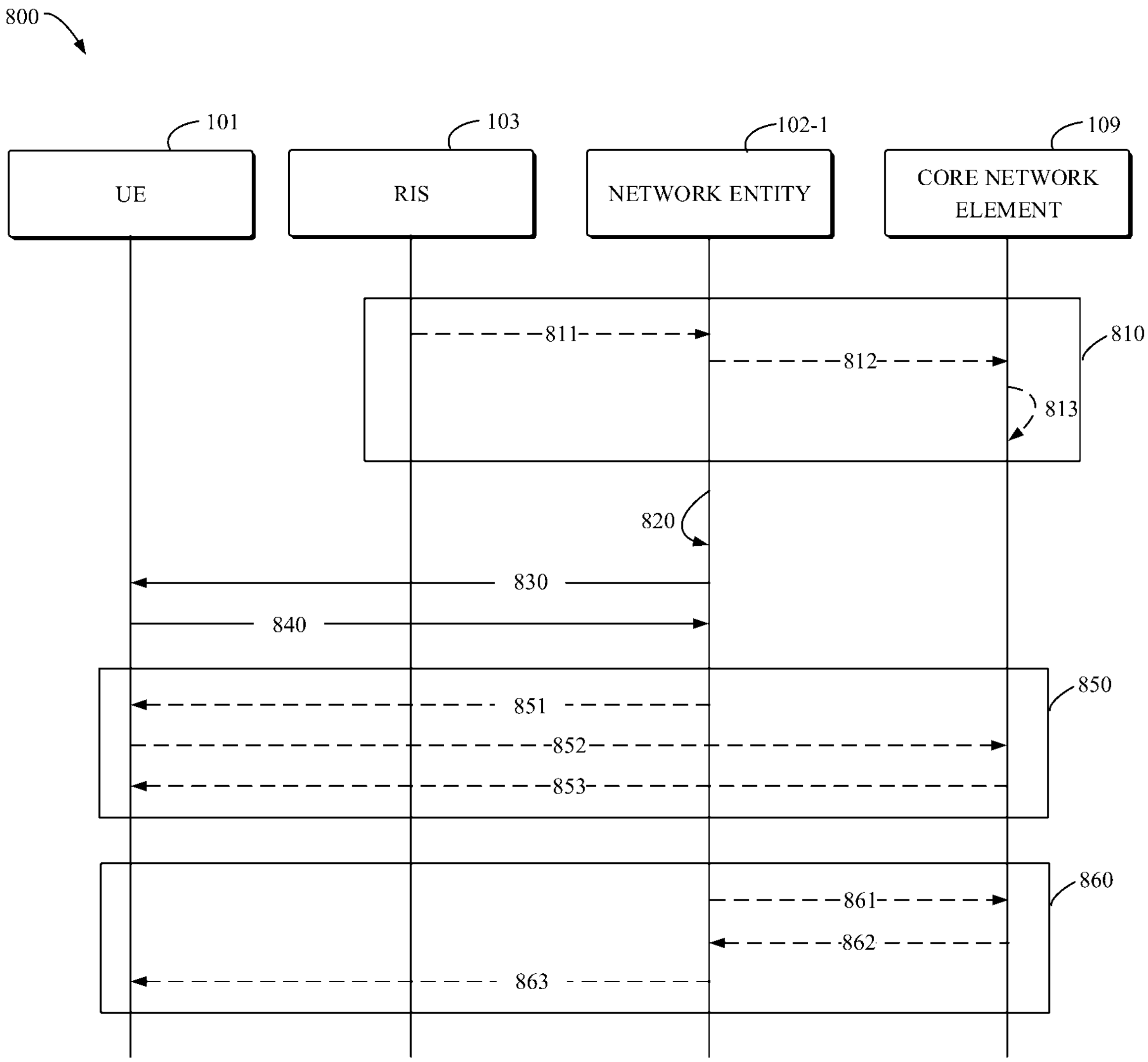
800
101
UE
103
RIS
102-1
NETWORK ENTITY
109
CORE NETWORK ELEMENT
810
811
812
813
820
830
840
850
851
852
853
860
861
862
863

FIG. 8

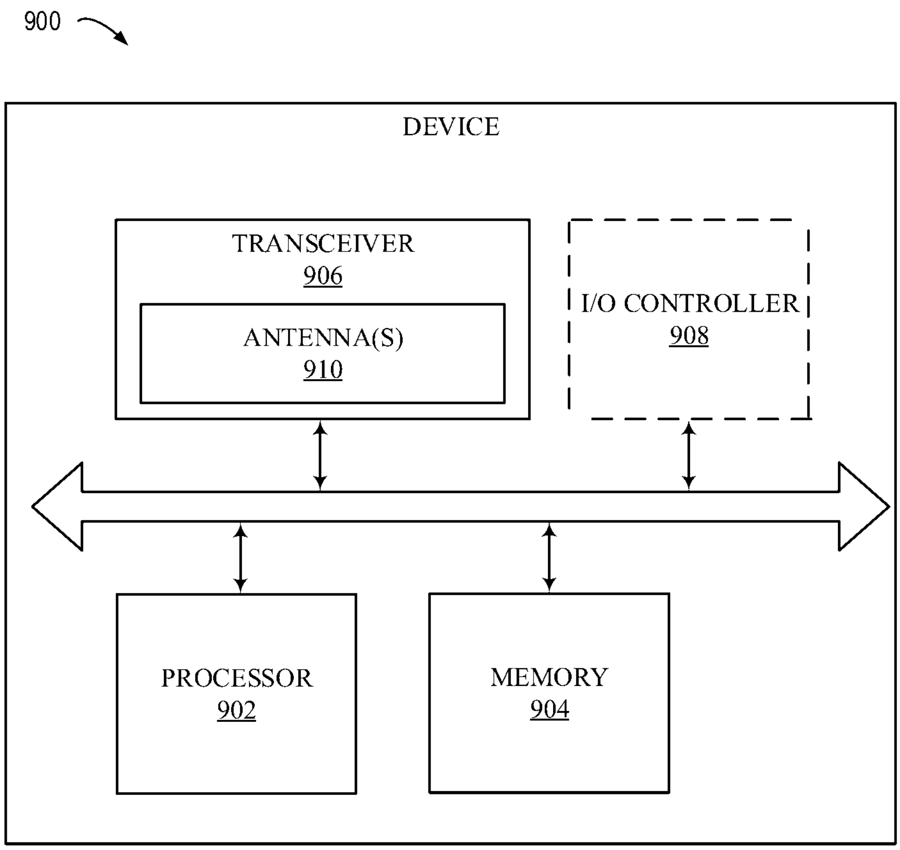
900
DEVICE
TRANSCEIVER
906
ANTENNA(S)
910
I/O CONTROLLER
908
PROCESSOR
902
MEMORY
904

FIG. 9

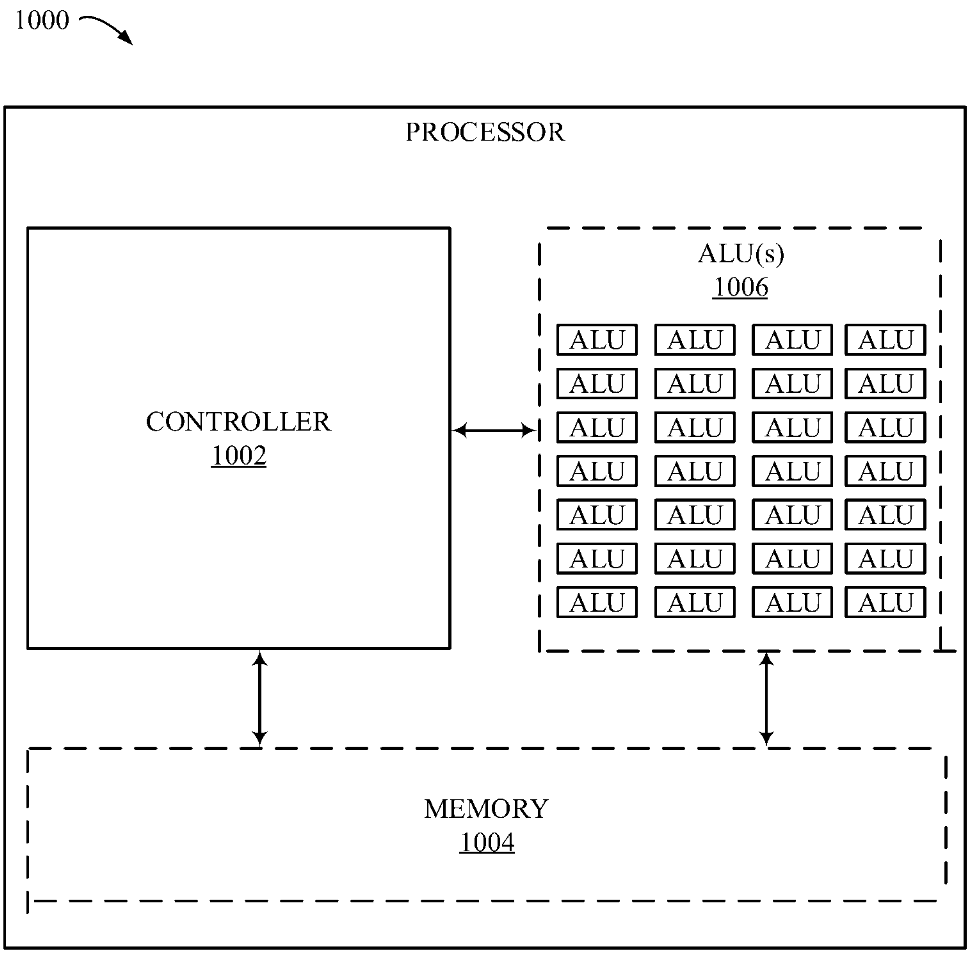
1000
PROCESSOR
CONTROLLER
1002
ALU(s)
1006
ALU ALU ALU ALU
ALU ALU ALU ALU
ALU ALU ALU ALU
ALU ALU ALU ALU
ALU ALU ALU ALU
ALU ALU ALU ALU
ALU ALU ALU ALU
MEMORY
1004

FIG. 10

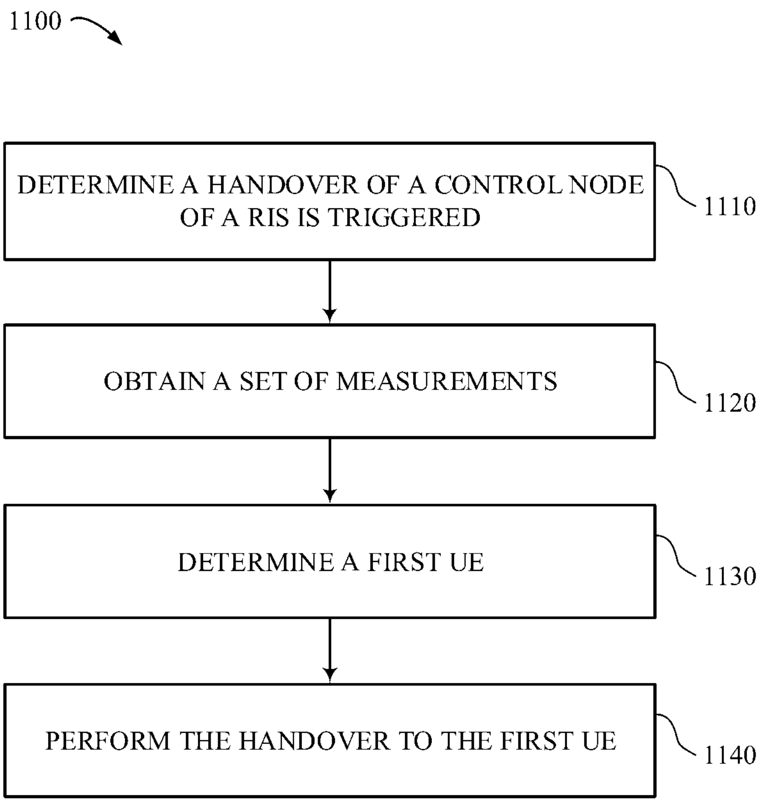
1100
DETERMINE A HANDOVER OF A CONTROL NODE OF A RIS IS TRIGGERED
1110
OBTAIN A SET OF MEASUREMENTS
1120
DETERMINE A FIRST UE
1130
PERFORM THE HANDOVER TO THE FIRST UE
1140

FIG. 11

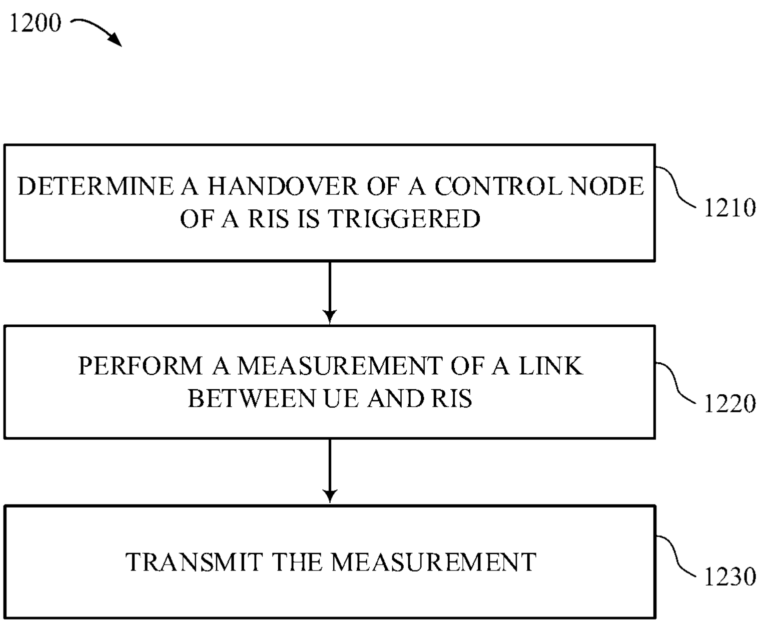
1200
DETERMINE A HANDOVER OF A CONTROL NODE OF A RIS IS TRIGGERED
1210
PERFORM A MEASUREMENT OF A LINK BETWEEN UE AND RIS
1220
TRANSMIT THE MEASUREMENT
1230

FIG. 12

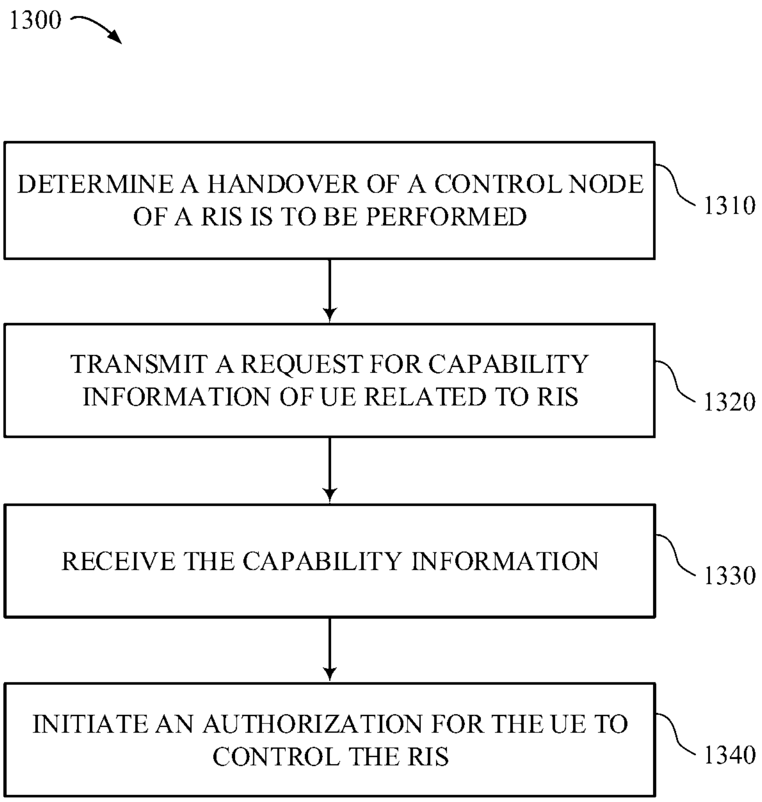
1300
DETERMINE A HANDOVER OF A CONTROL NODE OF A RIS IS TO BE PERFORMED
1310
TRANSMIT A REQUEST FOR CAPABILITY INFORMATION OF UE RELATED TO RIS
1320
RECEIVE THE CAPABILITY INFORMATION
1330
INITIATE AN AUTHORIZATION FOR THE UE TO CONTROL THE RIS
1340

FIG. 13

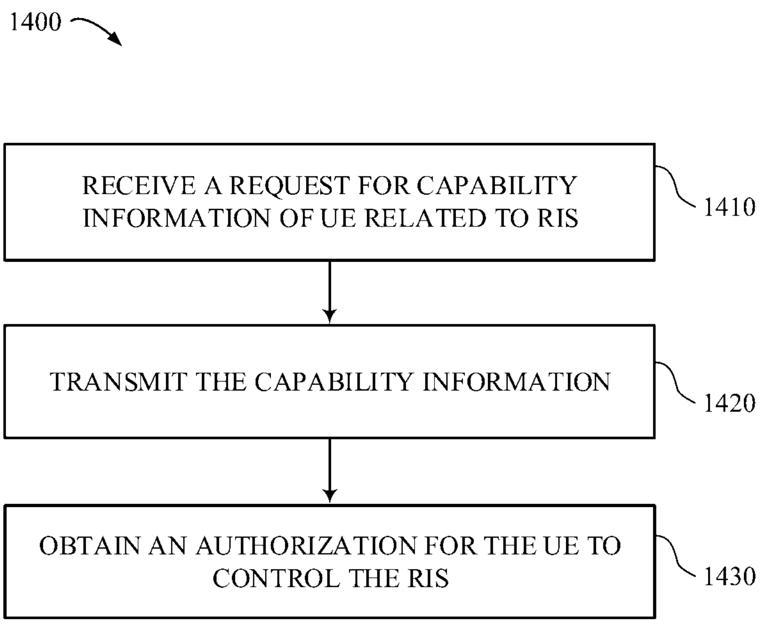
1400
RECEIVE A REQUEST FOR CAPABILITY INFORMATION OF UE RELATED TO RIS
1410
TRANSMIT THE CAPABILITY INFORMATION
1420
OBTAIN AN AUTHORIZATION FOR THE UE TO CONTROL THE RIS
1430

FIG. 14

## INTERNATIONAL SEARCH REPORT

International application No.
**PCT/CN2023/138945**

**A. CLASSIFICATION OF SUBJECT MATTER**

H04L5/00(2006.01)i; H04W36/30(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)

IPC: H04L H04W

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

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

CNTXT, ENTXT, CNKI, WPABS, DWPI, 3GPP, ETSI, BING: Reconfigurable, Intelligence, reflect, Surface, RIS, IRS, control, BS, GNB, handover, switch, UE, reference signal, RS, direction, capability, authorize

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | ETSI. "Reconfigurable Intelligent Surfaces (RIS); Use Cases, Deployment Scenarios and Requirements" *ETSI GR RIS 001 V1.1.1,* 30 April 2023 (2023-04-30), clause 6.3 | 1-2、8 |
| Y | ETSI. "Reconfigurable Intelligent Surfaces (RIS); Use Cases, Deployment Scenarios and Requirements" *ETSI GR RIS 001 V1.1.1,* 30 April 2023 (2023-04-30), clause 6.3 | 15-18 |
| Y | ETSI. "Reconfigurable Intelligent Surfaces (RIS); Technological challenges, architecture and impact on standardization" *ETSI GR RIS 002 V1.1.1,* 31 August 2023 (2023-08-31), clauses 4.2.4, 6.3.1.4, 7.2.1 | 15-20 |
| Y | WO 2023088566 A1 (HUAWEI TECHNOLOGIES CO., LTD.) 25 May 2023 (2023-05-25) description, page 20 lines 5-26 | 15-20 |
| A | US 2022232422 A1 (QUALCOMM INCORPORATED) 21 July 2022 (2022-07-21) the whole document | 1-20 |

☑ 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
- "D" document cited by the applicant in the international application
- "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
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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| **09 August 2024** | **21 August 2024** |

| Name and mailing address of the ISA/CN | Authorized officer |
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**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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**Information on patent family members**

International application No.
**PCT/CN2023/138945**

| Patent document cited in search report | Publication date (day/month/year) | Patent family member(s) | Publication date (day/month/year) |
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