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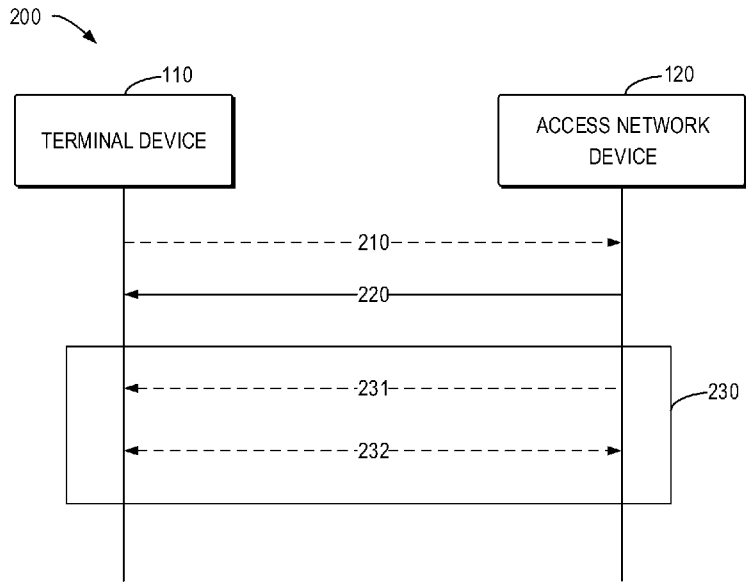


FIG. 2

(57) Abstract: Embodiments of the present disclosure relate to devices and methods of communication. An access network device transmits, to a terminal device, a configuration for transmission or reception of a sensing signal in an inactive state. The configuration comprises at least one of the following: first information of the transmission or reception of the sensing signal in a normal uplink carrier, second information of the transmission or reception of the sensing signal in a supplementary uplink carrier, or third information of time alignment for the transmission of the sensing signal. The terminal device performs, based on the configuration, the transmission or reception of the sensing signal in the inactive state. In this way, a sensing operation in an inactive state may be carried out.

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DEVICES AND METHODS OF COMMUNICATION

TECHNICAL FIELD

[0001] Embodiments of the present disclosure generally relate to the field of telecommunication, and in particular, to methods, devices and computer storage media of communication for a sensing operation in integrated sensing and communication (ISAC).

BACKGROUND

[0002] Many new emerging businesses require sensing capability to provide accurate and timely services. However, traditional radar technology is high cost to deploy and not flexible enough to extent to current diverse services. ISAC has been proposed to provide high quality services. With the ISAC, a network or user equipment (UE) may have capability to sense their surroundings and exchange their observations through communication. Sensing in an inactive state may reduce latency and signaling overhead. However, implementation on a sensing operation in an inactive state is still unclear.

SUMMARY

[0003] In general, embodiments of the present disclosure provide methods, devices and computer storage media of communication for a sensing operation in an inactive state.

[0004] In a first aspect, there is provided a terminal device. The terminal device comprises a processor. The processor is configured to cause the terminal device to: receive, from an access network device, a configuration for transmission or reception of a sensing signal in an inactive state, the configuration comprising at least one of the following: first information of the transmission or reception of the sensing signal in a normal uplink carrier, second information of the transmission or reception of the sensing signal in a supplementary uplink carrier, or third information of time alignment for the transmission of the sensing signal; and perform, based on the configuration, the transmission or reception of the sensing signal in the inactive state.

[0005] In a second aspect, there is provided an access network device. The access network device comprises a processor. The processor is configured to cause the access network device to: transmit, to a terminal device, a configuration for transmission or reception of a sensing signal in an inactive state, the configuration comprising at least one

of the following: first information of the transmission or reception of the sensing signal in a normal uplink carrier, second information of the transmission or reception of the sensing signal in a supplementary uplink carrier, or third information of time alignment for the transmission of the sensing signal.

5 [0006] In a third aspect, there is provided a method of communication. The method comprises: receiving, at a terminal device and from an access network device, a configuration for transmission or reception of a sensing signal in an inactive state, the configuration comprising at least one of the following: first information of the transmission or reception of the sensing signal in a normal uplink carrier, second information of the
10 transmission or reception of the sensing signal in a supplementary uplink carrier, or third information of time alignment for the transmission of the sensing signal; and performing, based on the configuration, the transmission or reception of the sensing signal in the inactive state.

[0007] In a fourth aspect, there is provided a method of communication. The method
15 comprises: transmitting, at an access network device and to a terminal device, a configuration for transmission or reception of a sensing signal in an inactive state, the configuration comprising at least one of the following: first information of the transmission or reception of the sensing signal in a normal uplink carrier, second information of the transmission or reception of the sensing signal in a supplementary uplink carrier, or third
20 information of time alignment for the transmission of the sensing signal.

[0008] In a fifth aspect, there is provided a computer readable medium having instructions stored thereon. The instructions, when executed on at least one processor, cause the at least one processor to perform the method according to the third or fourth aspect of the present disclosure.

25 [0009] Other features of the present disclosure will become easily comprehensible through the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Through the more detailed description of some embodiments of the present
30 disclosure in the accompanying drawings, the above and other objects, features and advantages of the present disclosure will become more apparent, wherein:

[0011] FIG. 1 illustrates an example communication network in which some embodiments

of the present disclosure can be implemented;

[0012] FIG. 2 illustrates a schematic diagram illustrating a process of communication according to embodiments of the present disclosure;

5 [0013] FIG. 3 illustrates an example method of communication implemented at a terminal device in accordance with some embodiments of the present disclosure;

[0014] FIG. 4 illustrates an example method of communication implemented at an access network device in accordance with some embodiments of the present disclosure; and

[0015] FIG. 5 illustrates a simplified block diagram of a device that is suitable for implementing embodiments of the present disclosure.

10 [0016] Throughout the drawings, the same or similar reference numerals represent the same or similar element.

DETAILED DESCRIPTION

15 [0017] Principle 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 limitations as to the scope of the disclosure. The disclosure described herein can be implemented in various manners other than the ones described below.

20 [0018] 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.

[0019] As used herein, the term ‘terminal device’ refers to any device having wireless or wired communication capabilities. Examples of the terminal device include, but not
25 limited to, user equipment (UE), personal computers, desktops, mobile phones, cellular phones, smart phones, personal digital assistants (PDAs), portable computers, tablets, wearable devices, internet of things (IoT) devices, Ultra-reliable and Low Latency Communications (URLLC) devices, Internet of Everything (IoE) devices, machine type communication (MTC) devices, device on vehicle for V2X communication where X means
30 pedestrian, vehicle, or infrastructure/network, devices for Integrated Access and Backhaul (IAB), Space borne vehicles or Air borne vehicles in Non-terrestrial networks (NTN)

including Satellites and High Altitude Platforms (HAPs) encompassing Unmanned Aircraft Systems (UAS), eXtended Reality (XR) devices including different types of realities such as Augmented Reality (AR), Mixed Reality (MR) and Virtual Reality (VR), the unmanned aerial vehicle (UAV) commonly known as a drone which is an aircraft without any human
5 pilot, devices on high speed train (HST), or image capture devices such as digital cameras, sensors, gaming devices, music storage and playback appliances, or Internet appliances enabling wireless or wired Internet access and browsing and the like. The ‘terminal device’ can further has ‘multicast/broadcast’ feature, to support public safety and mission critical, V2X applications, transparent IPv4/IPv6 multicast delivery, IPTV, smart TV, radio services,
10 software delivery over wireless, group communications and IoT applications. It may also incorporated one or multiple Subscriber Identity Module (SIM) as known as Multi-SIM. The term “terminal device” can be used interchangeably with a UE, a mobile station, a subscriber station, a mobile terminal, a user terminal or a wireless device.

[0020] The term “network device” may refer to a core network device or an access
15 network device. The term “core network device” refers to any device or entity that provides access and mobility management function (AMF), network exposure function (NEF), authentication server function (AUSF), unified data management (UDM), session management function (SMF), user plane function (UPF), a location management function (LMF), etc.. In other embodiments, the core network device may be any other suitable
20 device or entity providing any other suitable functionality.

[0021] As used herein, the term “access network device” refers to a device which is capable of providing or hosting a cell or coverage where terminal devices can communicate. Examples of an access network device include, but not limited to, a satellite, a unmanned
25 aerial systems (UAS) platform, a Node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a next generation NodeB (gNB), a transmission reception point (TRP), a remote radio unit (RRU), a radio head (RH), a remote radio head (RRH), an IAB node, a low power node such as a femto node, a pico node, a reconfigurable intelligent surface (RIS), and the like.

[0022] The terminal device or the network device may have Artificial intelligence (AI) or
30 Machine learning capability. It generally includes a model which has been trained from numerous collected data for a specific function, and can be used to predict some information.

[0023] The terminal or the network device may work on several frequency ranges, e.g. FR1 (410 MHz to 7125 MHz), FR2 (24.25GHz to 71GHz), frequency band larger than 100GHz as well as Tera Hertz (THz). It can further work on licensed/unlicensed/shared spectrum. The terminal device may have more than one connections with the network devices under Multi-Radio Dual Connectivity (MR-DC) application scenario. The terminal device or the network device can work on full duplex, flexible duplex and cross division duplex modes.

[0024] The embodiments of the present disclosure may be performed in test equipment, e.g. signal generator, signal analyzer, spectrum analyzer, network analyzer, test terminal device, test network device, channel emulator.

[0025] In one embodiment, the terminal device may be connected with a first network device and a second network device. One of the first network device and the second network device may be a master node and the other one may be a secondary node. The first network device and the second network device may use different radio access technologies (RATs). In one embodiment, the first network device may be a first RAT device and the second network device may be a second RAT device. In one embodiment, the first RAT device is eNB and the second RAT device is gNB. Information related with different RATs may be transmitted to the terminal device from at least one of the first network device or the second network device. In one embodiment, first information may be transmitted to the terminal device from the first network device and second information may be transmitted to the terminal device from the second network device directly or via the first network device. In one embodiment, information related with configuration for the terminal device configured by the second network device may be transmitted from the second network device via the first network device. Information related with reconfiguration for the terminal device configured by the second network device may be transmitted to the terminal device from the second network device directly or via the first network device.

[0026] 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. The term 'includes' and its variants are to be read as open terms that mean 'includes, but is not limited to.' The term 'based on' is to be read as 'at least in part based on.' The term 'one embodiment' and 'an embodiment' are to be read as 'at least one embodiment.' The term 'another embodiment' is to be read as 'at least one other embodiment.' The terms 'first,' 'second,'

and the like may refer to different or same objects. Other definitions, explicit and implicit, may be included below.

[0027] In some examples, values, procedures, or apparatus are referred to as ‘best,’ ‘lowest,’ ‘highest,’ ‘minimum,’ ‘maximum,’ or the like. It will be appreciated that such descriptions are intended to indicate that a selection among many used functional alternatives can be made, and such selections need not be better, smaller, higher, or otherwise preferable to other selections.

[0028] In the context of the present disclosure, the term “sensing operation” may refer to a functionality to get information about characteristics of an environment and/or objects within the environment (e.g. shape, size, orientation, speed, location, distance or relative motion between objects, etc.) using new radio (NR) radio frequency (RF) signal and, in some cases, previously defined information available in evolved packet core (EPC) and/or evolved universal terrestrial radio access (E-UTRA). The term “sensing transmitter” may be an entity that sends out a sensing signal which a sensing service will use in its operation. The term “sensing receiver” may be an entity that receives a sensing signal which a sensing service will use in its operation. The sensing transmitter may be located in the same or different entity as the sensing receiver.

[0029] For a sensing transmitter, a sensing signal may be a wireless signal sent by the sensing transmitter, such as a synchronization signal block (SSB), a positioning reference signal (PRS), a sounding reference signal (SRS), a channel state information-reference signal (CSI-RS), a demodulation reference signal (DMRS) or any other suitable signals. For a sensing receiver, a sensing signal may be a directly received or impacted (e.g., reflected, refracted or diffracted) wireless signal received by the sensing receiver. For convenience, in the following description, the term “sensing signal” refers to an RF signal used for a sensing service, and the term “wireless signal” refers to an RF signal used for a communication service.

[0030] Embodiments of the present disclosure provide a solution for a sensing operation in an inactive state. In the solution, an access network device transmits, to a terminal device, a configuration for transmission or reception of a sensing signal in an inactive state. The configuration comprises at least one of the following: first information of the transmission or reception of the sensing signal in a normal uplink carrier, second information of the transmission or reception of the sensing signal in a supplementary uplink

carrier, or third information of time alignment for the transmission of the sensing signal. The terminal device performs, based on the configuration, the transmission or reception of the sensing signal in the inactive state. In this way, a sensing operation in an inactive state may be carried out.

- 5 [0031] Principles and implementations of the present disclosure will be described in detail below with reference to the figures.

EXAMPLE OF COMMUNICATION NETWORK

[0032] FIG. 1 illustrates a schematic diagram of an example communication network 100 in which some embodiments of the present disclosure can be implemented. As shown in
10 FIG. 1, the communication network 100 may include a terminal device 110, an access network device 120, a core network device 130 and an object 140.

[0033] In some embodiments, the access network device 120 may provide one or more serving cells (not shown) to serve the terminal device 110. In the example of FIG. 1, the terminal device 110 may have sensing and communication functionalities (i.e., support
15 ISAC), and the network device 120 may have sensing and communication functionalities (i.e., support ISAC). In some embodiments, the terminal device 110 may transmit a wireless signal to the access network device 120, and/or receive a wireless signal from the access network device 120.

[0034] In the example of FIG. 1, the terminal device 110 may be a sensing transmitter or a
20 sensing receiver or both. The network device 120 may also be a sensing transmitter or a sensing receiver or both. A sensing transmitter may transmit a sensing signal towards the object 140, and the object 140 may reflect or refract or diffract the sensing signal to a sensing receiver.

[0035] There may be various sensing modes. In some embodiments, the sensing
25 transmitter may be the network device 120, and the sensing receiver may be the terminal device 110. In some embodiments, the sensing transmitter may be the terminal device 110, and the sensing receiver may be the network device 120. In some embodiments, the sensing transmitter may be the network device 120, and the sensing receiver may be another network device not shown. In some embodiments, the sensing receiver may be
30 the network device 120, and the sensing transmitter may be another network device not shown. In some embodiments, the sensing transmitter may be the terminal device 110, and the sensing receiver may be another terminal device not shown. In some

embodiments, the sensing receiver may be the terminal device 110, and the sensing transmitter may be another terminal device not shown.

[0036] The core network device 130 may have a sensing function. In some embodiments, the terminal device 110 may communicate with the core network device 130 via the access network device 120.

[0037] The terminal device 110 may communicate with the access network device 120 via a Uu interface. The access network device 120 may communicate with the core network device 130 via an Ng interface. The communications in the communication network 100 may conform to any suitable standards including, but not limited to, global system for mobile communications (GSM), long term evolution (LTE), LTE-evolution, LTE-advanced (LTE-A), NR, wideband code division multiple access (WCDMA), code division multiple access (CDMA), GSM EDGE radio access network (GERAN), machine type communication (MTC) and the like. The embodiments of the present disclosure may be performed according to any generation communication protocols either currently known or to be developed in the future. Examples of the communication protocols include, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G) communication protocols, 5.5G, 5G-Advanced networks, or the sixth generation (6G) networks.

[0038] It is to be understood that the number of devices and/or objects in FIG. 1 is given for the purpose of illustration without suggesting any limitations to the present disclosure. The communication network 100 may include any suitable number of access network devices and/or terminal devices and/or core network devices and/or objects adapted for implementing implementations of the present disclosure.

[0039] In some use cases of ISAC, a sensing signal may be used for intruder detection in smart home. In some use cases of ISAC, a sensing signal may be used for transparent sensing for stationary and moving objects. In some use cases of ISAC, a sensing signal may be used for UAV flight trajectory tracing. In some use cases of ISAC, a sensing signal may be used for pedestrian or animal intrusion detection on a highway.

[0040] In new radio (NR), three radio resource control (RRC) states are defined: an idle state (i.e., RRC_IDLE), a connected state (i.e., RRC_CONNECTED) and an inactive state (i.e., RRC_INACTIVE). Sensing in an inactive state may reduce power consumption, latency and signaling overhead. However, it is still unclear how to configure and perform

the sensing in the inactive state. It is unclear how to maintain timing advance (TA) for uplink sensing signal transmission in the inactive state. UE capabilities for the sensing in the inactive state are also unclear.

[0041] In view of the above, embodiments of the present disclosure provide a solution of communication for a sensing operation in an inactive state so as to overcome the above and other potential issues. The detailed description will be made with reference to FIGs. 2 and 3 below.

EXAMPLE IMPLEMENTATION OF SENSING OPERATION IN INACTIVE STATE

[0042] FIG. 2 illustrates a schematic diagram illustrating a process 200 of communication according to embodiments of the present disclosure. For the purpose of discussion, the process 200 will be described with reference to FIG. 1. The process 200 may involve the terminal device 110 and the access network device 120 as illustrated in FIG. 1.

[0043] As shown in FIG. 2, the terminal device 110 may transmit 210, to the access network device 120, capability of the terminal device 110. In some embodiments, the terminal device 110 may transmit the capability of the terminal device 110 via an RRC signaling, e.g., UECapabilityInformation message or any other suitable messages.

[0044] In some embodiments, the capability of the terminal device 110 may comprise first capability of whether the terminal device 110 supports the transmission or reception of the sensing signal in the inactive state for an initial uplink bandwidth part (BWP). In some embodiments, the capability of the terminal device 110 may comprise second capability of whether the terminal device 110 supports the transmission or reception of the sensing signal in the inactive state outside the initial uplink BWP.

[0045] In some embodiments, the first capability or the second capability may comprise a maximum bandwidth for sensing supported for a subcarrier spacing (SCS) (e.g., each SCS) that the terminal device 110 supports within a single component carrier (CC) for frequency range 1 (FR1). In some embodiments, the first capability or the second capability may comprise a maximum bandwidth for sensing supported for an SCS (e.g., each SCS) that the terminal device 110 supports within a single CC for frequency range 2 (FR2). In some embodiments, the first capability or the second capability may comprise a maximum number of resource sets for sensing supported by the terminal device 110. In some embodiments, the first capability or the second capability may comprise a maximum number of periodic resources for sensing supported by the terminal device 110. In some

embodiments, the first capability or the second capability may comprise a maximum number of periodic resources for sensing per slot supported by the terminal device 110. In some embodiments, the first capability or the second capability may comprise a maximum number of semi-persistent (SP) resources for sensing supported by the terminal device 110.

5 In some embodiments, the first capability or the second capability may comprise a maximum number of SP resources for sensing per slot supported by the terminal device 110. In some embodiments, the first capability or the second capability may comprise a maximum number of periodic and SP resources for sensing supported by the terminal device 110. In some embodiments, the first capability or the second capability may
10 comprise a maximum number of periodic and SP resources for sensing per slot supported by the terminal device 110.

[0046] In some embodiments, the capability of the terminal device 110 may comprise third capability of whether the terminal device 110 supports the transmission of the sensing signal in the inactive state with SP sensing for the initial uplink BWP. In some
15 embodiments, the capability of the terminal device 110 may comprise fourth capability of whether the terminal device 110 supports the transmission of the sensing signal in the inactive state with SP sensing outside the initial uplink BWP. In some embodiments, the capability of the terminal device 110 may comprise fifth capability of whether the terminal device 110 supports a spatial relation for the sensing signal with respect to a reference
20 signal (RS) in the inactive state. For example, the RS may be a synchronization signal and physical broadcast channel block (SSB), a channel status information-reference signal (CSI-RS), a positioning reference signal (PRS), a sounding reference signal (SRS) or any other suitable signals. It is to be understood that the capability of the terminal device 110 may also comprise any other suitable information.

25 [0047] With the capabilities reported by the terminal device 110, the access network device 120 may properly configure sensing in an inactive state for the terminal device 110.

[0048] Continuing to refer to FIG. 2, the access network device 120 may transmit 220, to the terminal device 110, a configuration (also referred to as a sensing configuration herein) for transmission or reception of a sensing signal in an inactive state. In some
30 embodiments, the access network device 120 may transmit the configuration via an RRC signaling when the RRC state of the terminal device 110 is changed from a connected state to an inactive state. In some embodiments, the RRC signaling may comprise an RRC release message. It is to be understood that the configuration may be transmitted in any

suitable ways, and the present disclosure does not limit this aspect.

[0049] In some embodiments, the configuration may comprise first information of the transmission or reception of the sensing signal in a normal uplink (NUL) carrier. In some embodiments, the first information may comprise information of one or more resources (also referred to as sensing resources herein) for the transmission or reception of the sensing signal in the NUL carrier. In some embodiments, the first information may comprise information of one or more resource sets (also referred to as sensing resource sets herein) for the transmission or reception of the sensing signal in the NUL carrier. In some embodiments, the first information may comprise information of a BWP for the transmission or reception of the sensing signal in the NUL carrier. It is to be understood that the first information may comprise any other suitable information and any combination of the above information may also be feasible.

[0050] In some embodiments, the configuration may comprise second information of the transmission or reception of the sensing signal in a supplementary uplink (SUL) carrier. In some embodiments, the second information may comprise information of one or more resources for the transmission or reception of the sensing signal in the SUL carrier. In some embodiments, the second information may comprise information of one or more resource sets for the transmission or reception of the sensing signal in the SUL carrier. In some embodiments, the second information may comprise information of a BWP for the transmission or reception of the sensing signal in the SUL carrier. It is to be understood that the second information may comprise any other suitable information and any combination of the above information may also be feasible.

[0051] In some embodiments, the configuration may comprise third information of time alignment for the transmission of the sensing signal. In some embodiments, the third information may indicate a value of a timer configured for the time alignment. In some embodiments, the third information may indicate a threshold of signal strength variation configured for validation of the time alignment. It is to be understood that the third information may comprise any other suitable information and any combination of the above information may also be feasible.

[0052] For illustration, an example configuration for sensing in an inactive state may be configured as below.

RRCRelease ::= SEQUENCE {

```

...
suspendConfig          SuspendConfig
...
}
5
SuspendConfig ::=          SEQUENCE {
    sensingRRC-Inactive    SetupRelease { SensingRRC-Inactive }
    ...
}
10
SensingRRC-Inactive ::=    SEQUENCE {
    sensingConfigNUL        SensingConfig
    SensingConfigSUL        SensingConfig
    bwp-NUL                 BWP
15    bwp-SUL                 BWP
    inactiveSensing-TimeAlignmentTimer    TimeAlignmentTimer
    inactiveSensingSignal-RSRP-ChangeThreshold    RSRP-ChangeThreshold
}
20
SensingConfig ::=          SEQUENCE {
    sensingResourceSetToReleaseList    SEQUENCE
    (SIZE(1..maxNrofSensingResourceSets)) OF SensingResourceSetId
    sensingResourceSetToAddModList    SEQUENCE
    (SIZE(1..maxNrofSensingResourceSets)) OF SensingResourceSet
25    sensingResourceToReleaseList    SEQUENCE
    (SIZE(1..maxNrofSensingResources)) OF SensingResourceId
    sensingResourceToAddModList        SEQUENCE

```

(SIZE(1..maxNrofSensingResources)) OF SensingResource

}

- [0053] In this example, the field “suspendConfig” indicates a configuration for an inactive state, and the field “sensingRRC-Inactive” indicates a configuration for sensing in the inactive state. Contents in the field “sensingRRC-Inactive” are described in Table 1 below.

Table 1

SensingRRC-Inactive field descriptions
bwp-NUL BWP configuration for sensing during the RRC_INACTIVE state in NUL carrier. If the field is absent, UE is configured with a sensing resource or sensing resource set associated with the initial UL BWP and transmitted, during the RRC_INACTIVE state, inside the initial UL BWP with the same cyclic prefix (CP) and subcarrier spacing (SCS) as configured for initial UL BWP.
bwp-SUL BWP configuration for Sensing during the RRC_INACTIVE state in SUL carrier. If the field is absent, UE is configured with a sensing resource or sensing resource set associated with the initial UL BWP and transmitted, during the RRC_INACTIVE state, inside the initial UL BWP with the same CP and SCS as configured for initial UL BWP.
inactiveSensingSignal-RSRP-ChangeThreshold RSRP threshold for the increase/decrease of RSRP for time alignment validation.
inactiveSensing-TimeAlignmentTimer TAT(Time Alignment Timer) value for sensing signal transmission during RRC_INACTIVE state.
sensingConfigNUL Sensing configuration in RRC_INACTIVE state in NUL carrier.
sensingConfigSUL Sensing configuration in RRC_INACTIVE state in SUL carrier.

sensingResourceSetToAddModList a list of sensing resource sets to be added for sensing signal transmission or reception in RRC_INACTIVE state.
sensingResourceSetToReleaseModList a list of sensing resource sets to be released for sensing signal transmission or reception in RRC_INACTIVE state.
sensingResourceToAddModList a list of sensing resources to be added for sensing signal transmission or reception in RRC_INACTIVE state.
sensingResourceToReleaseModList a list of sensing resources to be released for sensing signal transmission or reception in RRC_INACTIVE state.

[0054] It can be seen that in this example, the first information includes information indicated by the fields sensingConfigNUL and bwp-NUL, the second information includes information indicated by the fields sensingConfigSUL (including sensingResourceSetToReleaseList, sensingResourceSetToAddModList, sensingResourceToReleaseList and sensingResourceToAddModList) and bwp-SUL, and the third information includes information indicated by the fields inactiveSensing-TimeAlignmentTimer and inactiveSensingSignal-RSRP-ChangeThreshold. It is to be understood that this example is merely for illustration, and is not intended for limitation.

10 [0055] In some embodiments, the information of the one or more resource sets in the first or second information may comprise a list of resource sets to be released (e.g., as shown by the field sensingResourceSetToReleaseList in the above example). In some embodiments, the information of the one or more resource sets in the first or second information may comprise a list of resource sets to be added (e.g., as shown by the field

15 sensingResourceSetToAddModList in the above example). It is to be understood that any combination of the above information may also be feasible.

[0056] In some embodiments, the information of the one or more resources in the first or second information may comprise a list of resources to be released (e.g., as shown by the

field sensingResourceToReleaseList in the above example). In some embodiments, the information of the one or more resources in the first or second information may comprise a list of resources to be added (e.g., as shown by the field sensingResourceToAddModList in the above example). It is to be understood that any combination of the above information
 5 may also be feasible.

[0057] In some embodiments, a resource set (e.g., each resource set) in the one or more resource sets in the first or second information may comprise at least one of the following: an identity of the resource set, a list of identities of resources in the resource set, a configuration type of the resources in the resource set, or a path loss reference signal to be
 10 used for a path loss estimation for the transmission or reception of the sensing signal.

[0058] For illustration, an example configuration for a list of resource sets (e.g., sensingResourceSetToAddModList) may be configured as below.

```
SensingResourceSet ::=
    SEQUENCE {
        sensingResourceSetId          SensingResourceSetId, // The ID of this
15  sensing resource set.
        sensingResourceIdList          SEQUENCE
        (SIZE(1..maxNrofSensingResourcesPerSet)) OF SensingResourceId
        resourceType                   CHOICE { // This field indicates
time domain behavior of Sensing resource configuration. The network configures Sensing
20  resources in the same resource set with the same time domain behavior on periodic,
aperiodic, and semi-persistent Sensing. The aperiodic Sensing may not be applicable for the
UE in RRC_INACTIVE.
```

```
        aperiodic                     SEQUENCE {
```

```
        ...
```

```
    },
```

```
        semi-persistent                SEQUENCE {
```

```
        ...
```

```
    },
```

```
        periodic                       SEQUENCE {
```

```
        ...
```

```

    }
  },
  pathlossReferenceRS-Sensing CHOICE { // A reference
    signal (e.g. a SS block, a DL-PRS or CSI-RS config) to be used for Sensing path loss
5  estimation.
    ...
  }
}

```

[0059] In this example, the field “sensingResourceSetId” indicates an identity of a
 10 resource set, the field “sensingResourceIdList” indicates a list of identities of resources in
 the resource set, and the field “resourceType” indicates a configuration type of the
 resources in the resource set. The resource set may be aperiodic, periodic or
 semi-persistent. The field “pathlossReferenceRS-Sensing” indicates a path loss reference
 15 signal. It is to be understood that this example is merely for illustration, and is not
 intended for limitation.

[0060] In some embodiments, a resource (e.g., each resource) in the one or more resources
 in the first or second information may comprise at least one of the following: an identity of
 the resource, time-domain information of the resource, frequency-domain information of
 20 the resource, spatial-domain information of the resource, a periodicity of the resource, or a
 time offset of the resource. In some embodiments, the spatial-domain information may
 comprise an identity of a reference signal (RS). In some embodiments, the spatial-domain
 information may comprise an identity of an uplink BWP. In some embodiments, the
 spatial-domain information may comprise both an identity of an RS and an identity of an
 25 uplink BWP.

[0061] For illustration, an example configuration for a list of resources (e.g.,
 sensingResourceToAddModList) may be configured as below.

```

SensingResource ::= SEQUENCE {
  sensingResourceId SensingResourceId, // The ID of this
30 sensing resource.
  resourceMapping SEQUENCE { // OFDM symbol

```

location of the Sensing resource within a slot including nrofSymbols (number of OFDM symbols), startPosition (e.g., value 0 refers to the last symbol, value 1 refers to the second last symbol, and so on)

```

        startPosition                INTEGER (0..13),
5      nrofSymbols                    ENUMERATED {n1, n2, n4,
n8, n12}
    },
    freqDomainPosition                INTEGER (0..M),      // frequency
domain position of sensing resource
10   resourceType                     CHOICE {              //
Periodicity and offset for semi-persistent and periodic Sensing resource, or slot offset for
aperiodic Sensing resource
        aperiodic                    SEQUENCE {
            slotOffset                INTEGER (1..N)
15      },
        semi-persistent              SEQUENCE {
            periodicityAndOffset-sp
Sensing-PeriodicityAndOffset, // Periodicity and slot offset for this Sensing resource. The
values may be in "number of subframes, slots or symbols, etc.".
20      },
        periodic                     SEQUENCE {
            periodicityAndOffset-p
Sensing-PeriodicityAndOffset, // Periodicity and slot offset for this Sensing resource. The
values may be in "number of subframes, slots or symbols, etc.".
25      }
    },
    spatialRelationInfoSensing
SensingSpatialRelationInfoSensing //Configuration of the spatial relation between a
reference RS (e.g., SSB, CSI-RS, SRS, PRS, or other signals) and the target Sensing signal.

```

}

[0062] In this example, the field “sensingResourceId” indicates an identity of a resource, the field “resourceMapping” indicates time-domain information of the resource, and the field “freqDomainPosition” indicates frequency-domain information of the resource. The field “resourceType” indicates a periodicity of the resource and a time offset of the resource. The field “spatialRelationInfoSensing” indicates spatial-domain information of the resource. The field SensingSpatialRelationInfoSensing may contain an ID of reference RS and/or uplink BWP ID. It is to be understood that this example is merely for illustration, and is not intended for limitation.

[0063] Continuing to refer to FIG. 2, the terminal device 110 may perform 230, based on the configuration, the transmission or reception of the sensing signal in the inactive state. In some embodiments, the access network device 120, may transmit 231, to the terminal device 110, an indication (also referred to as a sensing activation/deactivation command herein) for activating or deactivating the transmission or reception of the sensing signal. If the indication indicates the activating of the transmission or reception of the sensing signal, the terminal device 110 may perform 232 the transmission or reception of the sensing signal.

[0064] In some embodiments, the access network device 120 may transmit, to the terminal device 110 in the inactive state, the indication via a SDT procedure. In other words, if there is an ongoing SDT, the access network device 120 may send a sensing activation/deactivation command (e.g., SP sensing activation/deactivation medium access control (MAC) control element (CE)) to the terminal device 110 in an inactive state without the need of state change.

[0065] In some embodiments, the access network device 120 may transmit, to the terminal device 110 in the inactive state, the indication along with the sensing configuration. In other words, the access network device 120 may send a sensing activation/deactivation command along with the sensing configuration (e.g., in an RRC release message) when the access network device 120 releases the terminal device 110 to the inactive state.

[0066] In some embodiments, the access network device 120 may transmit, to the terminal device 110 in the inactive state, the indication in the sensing configuration. For example, the access network device 120 may set a default sensing activation/deactivation status in the sensing configuration for an inactive state (e.g., in an RRC release message).

[0067] In some embodiments, the access network device 120 may transmit, to the terminal device 110 in the inactive state, a low-power wake-up signal (LPWUS) as the indication. In other words, the LPWUS may be used for activating/deactivating the sensing in the inactive state.

5 [0068] In some embodiments, the access network device 120 may transmit, to the terminal device 110 in the inactive state, the indication in a paging message in the inactive state. In other words, the paging message may be used for activating/deactivating the sensing in the inactive state.

10 [0069] In some embodiments, the access network device 120 may transmit, to the terminal device 110 in the inactive state, the indication in a short message in the inactive state. In other words, the short message may be used for activating/deactivating the sensing in the inactive state.

15 [0070] In some embodiments, the access network device 120 may transmit, to the terminal device 110 in the inactive state, the indication in a paging early indication (PEI) in the inactive state. In other words, the PEI may be used for activating/deactivating the sensing in the inactive state.

20 [0071] In some embodiments, the access network device 120 may transmit, to the terminal device 110 in the inactive state, downlink control information (DCI) used for the activating or deactivating as the indication. For example, the DCI may be DCI specific to the terminal device 110. In another example, the DCI may be group or broadcast DCI, e.g., in a specific search space. In other words, UE-specific DCI or group/broadcast DCI may be defined for activating/deactivating the sensing in the inactive state.

25 [0072] In some embodiments, the indication (i.e., the sensing activation/deactivation command) may be carried in a MAC CE. In some embodiments, the indication may be carried in DCI.

[0073] For illustration, an example MAC layer operation may be described as below.

The network may activate and deactivate the configured resource sets of Semi-Persistent Sensing of a Serving Cell by sending the Sensing Activation/Deactivation MAC CE. The configured resource sets Semi-Persistent Sensing (signal or resource) may be initially deactivated upon (re-)configuration by upper layers and after reconfiguration with sync (if the activation/deactivation status is not explicitly indicated).

30

The MAC entity shall:

1> if the MAC entity receives an Sensing Activation/Deactivation MAC CE on a Serving Cell:

2> indicate to lower layers (e.g., physical layer) the information regarding the Sensing Activation/Deactivation MAC CE.

[0074] In some alternative embodiments, the terminal device 110 may perform the transmission or reception of the sensing signal without the indication of the activation or deactivation from the access network device 120. That is, upon reception of the sensing configuration, the terminal device 110 may perform the transmission or reception of the sensing signal.

[0075] In some embodiments, if TA is valid, the terminal device 110 may transmit a sensing signal. In some embodiments, if a condition for sensing transmission is satisfied, the terminal device 110 may transmit a sensing signal.

[0076] For example, an example operation of a MAC layer of the terminal device 110 may be described as below.

A MAC entity shall, if TA of configured sensing is valid, and/or conditions for sensing transmission (defined by physical layer) are satisfied:

- instruct to a lower layer (e.g., physical (PHY) layer) to transmit Periodic Sensing signal or Semi-Persistent Sensing signal.

[0077] In some embodiments where spatial-domain information of a sensing resource comprises an identity of an RS, the terminal device 110 may transmit or receive, via the sensing resource, a sensing signal with a same spatial-domain transmission filter used for reception or transmission of the RS.

[0078] For example, an example operation of a PHY layer of the terminal device 110 may be described as below.

If UE is configured with a higher layer parameter `spatialRelationInfoSensing` containing an ID of a reference RS, the UE shall transmit or receive the target sensing resource (or signal) with the same spatial domain transmission filter used for the reception or transmission of the reference RS.

[0079] In some embodiments, upon reception of the sensing configuration, the terminal device 110 may apply the sensing configuration. In some embodiments, the terminal

device 110 may start the timer (e.g., inactiveSensing-TimeAlignmentTimer) configured for the time alignment.

[0080] For example, an example operation of an RRC layer of the terminal device 110 may be described as below.

5 1> if the RRCRelease includes suspendConfig:

 2> if a sensing configuration for RRC_INACTIVE state is configured:

 3> apply the configuration and/or instruct MAC entity to start the inactiveSensing-TimeAlignmentTimer.

[0081] In some embodiments, if the terminal device 110 is changed from the inactive state
10 to a connected state, the terminal device 110 may stop the timer. Alternatively or additionally, the terminal device 110 may release the sensing configuration.

[0082] For example, an example operation of an RRC layer of the terminal device 110 may be described as below.

 Upon reception of the RRCSetup:

15 1> if the RRCSetup is received in response to an RRCReestablishmentRequest or RRCResumeRequest:

 2> if sensingRRC-Inactive is configured:

 3> instruct the MAC entity to stop the inactiveSensing-TimeAlignmentTimer, if it is running;

20 2> discard any stored UE Inactive AS context and suspendConfig.

[0083] In another example, an example operation of an RRC layer of the terminal device 110 may be described as below.

 Upon reception of the RRCResume by the UE:

 1> if sensingRRC-Inactive is configured:

25 2> instruct the MAC entity to stop inactiveSensing-TimeAlignmentTimer, if it is running;

 1> release the suspendConfig.

[0084] In some embodiments, if an RRC layer of the terminal device 110 receives a request for releasing the sensing configuration, the RRC layer of the terminal device 110

may release the sensing configuration.

[0085] For example, an example operation of an RRC layer of the terminal device 110 may be described as below.

Upon receiving a sensing configuration for RRC_INACTIVE release request from
5 lower layers (e.g. MAC layer), the UE shall:

1> release the configured sensingRRC-Inactive.

[0086] In some embodiments, if the terminal device 110 is changed from a first cell to a second cell (e.g., cell reselection), the terminal device 110 may stop or invalidate the timer. Alternatively or additionally, the terminal device 110 may release the sensing configuration.

10 [0087] For example, an example operation of an RRC layer of the terminal device 110 may be described as below.

1> if cell reselection occurs when sensingRRC-Inactive is configured:

2> indicate to the lower layer (e.g., MAC layer) to stop
inactiveSensing-TimeAlignmentTimer;

15 2> release the sensingRRC-Inactive.

[0088] In some embodiments for time alignment, the terminal device 110 may determine that a TA command MAC CE is received and a TA value has been maintained. If the transmission of the sensing signal in the inactive state is to be performed or ongoing, the terminal device 110 may start or restart the timer configured for the time alignment.

20 [0089] For illustration, an example operation may be described as below.

1> when a Timing Advance Command MAC CE is received, and if a TA (e.g., N_{TA}) between downlink and uplink has been maintained with an indicated timing advance group (TAG):

2> apply the Timing Advance Command for the indicated TAG;

25 2> if there is ongoing sensing signal transmission in RRC_INACTIVE:

3> start or restart the inactiveSensing-TimeAlignmentTimer associated with the indicated TAG.

[0090] In some embodiments, if a lower layer of the terminal device 110 receives an indication for stopping the timer from a higher layer of the terminal device 110, the lower
30 layer may stop the timer. In some embodiments, if a lower layer of the terminal device

110 receives an indication for starting the timer from a higher layer of the terminal device 110, the lower layer may start the timer.

[0091] For illustration, an example operation may be described as below.

1> when the indication is received from upper layer (e.g., RRC layer) for stopping the
5 inactiveSensing-TimeAlignmentTimer :

2> stop the inactiveSensing-TimeAlignmentTimer.

1> when the indication is received from upper layer (e.g., RRC layer) for starting the inactiveSensing-TimeAlignmentTimer:

2> start or restart the inactiveSensing-TimeAlignmentTimer.

10 [0092] In some embodiments, if the timer expires, the terminal device 110 may release the configuration. For illustration, an example operation may be described as below.

1> when the inactiveSensing-TimeAlignmentTimer expires:

2> notify RRC layer to release sensing configuration for RRC_INACTIVE, e.g., indicates a sensing configuration for RRC_INACTIVE release request to RRC.

15 [0093] In some embodiments, if a reset of a MAC entity of the terminal device 110 is performed, the terminal device 110 may determine that the timer expires. For illustration, an example operation may be described as below.

If a reset of the MAC entity is requested by upper layers (e.g., RRC layer) or the reset of the MAC entity is triggered due to SCG deactivation or other reasons, the MAC entity
20 shall consider inactiveSensing-TimeAlignmentTimer, if configured, as expired and perform the corresponding actions describe above.

[0094] In some embodiments, the terminal device 110 may determine that a TA command is received in a random access response (RAR) message and a further timer configured for time alignment for wireless signal transmission is not running. If contention resolution is
25 successful and the transmission of the sensing signal in the inactive state is ongoing, the terminal device 110 may start or restart the timer configured for time alignment for sensing signal transmission.

[0095] For illustration, an example operation may be described as below.

1> when a Timing Advance Command is received in a Random Access Response
30 message for a Serving Cell belonging to a TAG or in a MSGB for an SpCell:

2> if the Random Access Preamble was not selected by the MAC entity among the contention-based Random Access Preamble:

- 3> apply the Timing Advance Command for this TAG;
- 3> start or restart the timeAlignmentTimer associated with this TAG.

5 2> else if the timeAlignmentTimer associated with this TAG is not running:

- 3> apply the Timing Advance Command for this TAG;
- 3> start the timeAlignmentTimer associated with this TAG;

...

3> when the Contention Resolution is considered successful for Random
10 Access procedure while Sensing signal transmission in RRC_INACTIVE is ongoing:

4> start or restart the inactiveSensing-TimeAlignmentTimer associated with this TAG.

[0096] In this example, the timer “timeAlignmentTimer” is used to control how long the MAC entity considers serving cells belonging to associated TAG to be uplink time aligned.
15 The timer “inactiveSensing-TimeAlignmentTimer” is used to control how long the MAC entity considers the sensing signal transmission in RRC_INACTIVE to be uplink time aligned.

[0097] In some embodiments, the terminal device 110 may determine that a TA command is received in a random access procedure. If the transmission of the sensing signal in the
20 inactive state is ongoing, the terminal device 110 may start or restart the timer.

[0098] For illustration, an example operation may be described as below.

1> When a Timing Advance Command is received in response to a MSGA transmission (which may or may not include C-RNTI MAC CE):

2> apply the Timing Advance Command for PTAG;

25 2> if there is ongoing sensing signal transmission in RRC_INACTIVE:

3> start or restart the inactiveSensing-TimeAlignmentTimer associated with the indicated TAG.

[0099] For illustration, some other example operations may be described as below.

- The MAC entity shall not perform any uplink transmission on a Serving Cell

except the Random Access Preamble and MSGA transmission when the timeAlignmentTimer associated with the TAG to which this Serving Cell belongs is not running, sensing transmission in RRC_INACTIVE is not on-gonging, and other operations in RRC_INACTIVE (if configured. e.g., CG-SDT procedure, SRS transmission in RRC_INACTIVE) is not on-going.

- When the timeAlignmentTimer associated with the PTAG is not running, sensing transmission in RRC_INACTIVE is not on-gonging, and other operations in RRC_INACTIVE (if configured. e.g., CG-SDT procedure, SRS transmission in RRC_INACTIVE) is not on-going, the MAC entity shall not perform any uplink transmission on any Serving Cell except the Random Access Preamble and MSGA transmission on the SpCell.

- The MAC entity shall not perform any uplink transmission except the Random Access Preamble and MSGA transmission when the TA timer for CG-SDT (if configured) is not running during the ongoing CG-SDT procedure as triggered and the TA timer for Positioning SRS transmission in RRC_INACTIVE (if configured) is not running, and inactiveSensing-TimeAlignmentTimer is not running.

[00100] In this way, TA for uplink sensing signal transmission in an inactive state may be maintained.

[00101] In some embodiments for time alignment validation, the terminal device 110 may measure signal strength of a path loss reference signal. If a variation between the measured signal strength and stored signal strength of the path loss reference signal is not more than a threshold of signal strength variation configured for validation of the time alignment, and if the timer is running, the terminal device 110 may determine that a TA value (i.e., current TA value) is valid. The terminal device 110 may perform the transmission of the sensing signal based on the TA value.

[00102] It is to be understood that the signal strength of the path loss reference signal may be represented by reference signal receiving power (RSRP), reference signal receiving power (RSRP), received signal strength indication (RSSI), signal-to-interference-plus-noise ratio (SINR), reference signal receiving quality (RSRQ) or other suitable metrics.

[00103] For illustration, an example operation may be described as below.

RRC configures the following parameters for validation for sensing signal transmission in RRC_INACTIVE:

- inactiveSensingSignal-RSRP-ChangeThreshold: RSRP threshold for the increase/decrease of RSRP for time alignment validation.

The MAC entity shall:

1> if the UE receives configuration for Sensing signal transmission in
5 RRC_INACTIVE:

2> store the RSRP of the downlink pathloss reference with the current RSRP value of the downlink pathloss reference.

1> else if the UE is configured with Sensing signal transmission in RRC_INACTIVE:

10 2> if Timing Advance Command MAC CE is received, or;

2> if Timing Advance Command or Absolute Timing Advance Command is received for Random Access procedure that is successfully completed:

3> update the stored the RSRP of the downlink pathloss reference with the current RSRP value of the downlink pathloss reference.

15 The MAC entity shall consider the TA to be valid when the following conditions are fulfilled:

1> compared to the stored downlink pathloss reference RSRP value, the current RSRP value of the downlink pathloss reference has not increased/decreased by more than inactiveSensingSignal-RSRP-ChangeThreshold, if configured; and

20 1> inactiveSensing-TimeAlignmentTimer is running.

[00104] In this way, TA validation for sensing signal transmission in an inactive state may be enabled.

[00105] With the process 200, a sensing operation in an inactive state may be carried out. It is to be understood that operations in the process 200 may be carried out in any suitable
25 combination or order and are not limited to the above examples.

EXAMPLE IMPLEMENTATION OF METHODS

[00106] Accordingly, embodiments of the present disclosure provide methods of communication implemented at a terminal device and an access network device. These methods will be described below with reference to FIGs. 3 and 4.

30 [00107] FIG. 3 illustrates an example method 300 of communication implemented at a

terminal device in accordance with some embodiments of the present disclosure. For example, the method 300 may be performed at the terminal device 110 as shown in FIG. 1. For the purpose of discussion, in the following, the method 300 will be described with reference to the terminal device 110 in FIG. 1. It is to be understood that the method 300
5 may include additional blocks not shown and/or may omit some blocks as shown, and the scope of the present disclosure is not limited in this regard.

[00108] At block 310, the terminal device 110 receives, from the access network device 120, a configuration for transmission or reception of a sensing signal in an inactive state. In some embodiments, the configuration may comprise at least one of the following: first
10 information of the transmission or reception of the sensing signal in a NUL carrier, second information of the transmission or reception of the sensing signal in an SUL carrier, or third information of time alignment for the transmission of the sensing signal.

[00109] In some embodiments, the first information may indicate at least one of the following: information of one or more resources for the transmission or reception of the
15 sensing signal in the NUL carrier, information of one or more resource sets for the transmission or reception of the sensing signal in the NUL carrier, or information of a bandwidth part for the transmission or reception of the sensing signal in the NUL carrier.

[00110] In some embodiments, the second information may indicate at least one of the following: information of one or more resources for the transmission or reception of the
20 sensing signal in the SUL carrier, information of one or more resource sets for the transmission or reception of the sensing signal in the SUL carrier, or information of a bandwidth part for the transmission or reception of the sensing signal in the SUL carrier.

[00111] In some embodiments, the information of the one or more resource sets in the first or second information may comprise at least one of the following: a list of resource sets to
25 be released, or a list of resource sets to be added.

[00112] In some embodiments, the information of the one or more resource sets in the first or second information may indicate at least one of the following: an identity of a resource set in the one or more resource sets, a list of identities of resources in the resource set, a configuration type of the resources in the resource set, or a path loss reference signal to be
30 used for a path loss estimation for the transmission or reception of the sensing signal.

[00113] In some embodiments, the information of the one or more resources in the first or second information may comprise at least one of the following: a list of resources to be

released, or a list of resources to be added.

[00114] In some embodiments, the information of the one or more resources in the first or second information may indicate at least one of the following: an identity of a resource in the one or more resources, time-domain information of the resource, frequency-domain
5 information of the resource, spatial-domain information of the resource, a periodicity of the resource, or a time offset of the resource. In some embodiments, the spatial-domain information may comprise at least one of an identity of an RS or an identity of an uplink BWP.

[00115] In some embodiments, the third information may indicate at least one of the
10 following: a value of a timer configured for the time alignment, or a threshold of signal strength variation configured for validation of the time alignment.

[00116] At block 330, the terminal device 110 performs, based on the configuration, the transmission or reception of the sensing signal in the inactive state.

[00117] In some embodiments where the spatial-domain information comprises an identity
15 of a reference signal, the terminal device 110 may perform the transmission or reception of the sensing signal with a same spatial-domain transmission filter used for reception or transmission of the reference signal.

[00118] In some embodiments, the terminal device 110 may perform the transmission or reception of the sensing signal by at least one of the following: applying the configuration
20 for sensing in the inactive state; or starting the timer configured for time alignment for sensing signal transmission.

[00119] In some embodiments, if the terminal device 110 is changed from the inactive state to a connected state or the terminal device 110 is changed from a first cell to a second cell, the terminal device 110 may perform an operation comprising at least one of the following:
25 stopping the timer; or releasing the configuration.

[00120] In some embodiments, the terminal device 110 may receive, from the access network device 120, an indication for activating or deactivating the transmission or reception of the sensing signal. If the indication indicates the activating of the transmission or reception of the sensing signal, the terminal device 110 may perform the
30 transmission or reception of the sensing signal.

[00121] In some embodiments, the terminal device 110 may receive the indication in the

inactive state via an SDT procedure. In some embodiments, the terminal device 110 may receive the indication along with the configuration. In some embodiments, the terminal device 110 may receive the indication in the configuration. In some embodiments, the terminal device 110 may receive, as the indication, an LPWUS signal in the inactive state.

5 In some embodiments, the terminal device 110 may receive the indication in a paging message in the inactive state. In some embodiments, the terminal device 110 may receive the indication in a short message in the inactive state. In some embodiments, the terminal device 110 may receive the indication in a PEI in the inactive state. In some embodiments, the terminal device 110 may receive, as the indication, DCI used for the activating or
10 deactivating.

[00122] In some embodiments, the terminal device 110 may determine that a TA command MAC CE is received and a TA value has been maintained. If the transmission of the sensing signal in the inactive state is to be performed or ongoing, the terminal device 110 may start or restart the timer.

15 [00123] In some embodiments, if the timer expires, the terminal device 110 may release the configuration. In some embodiments, if a reset of a MAC entity of the terminal device 110 is performed, the terminal device 110 may determine that the timer expires.

[00124] In some embodiments, the terminal device 110 may determine that a TA command is received in an RAR message and a further timer configured for time alignment for
20 transmission of a wireless signal is not running. In this case, if contention resolution is successful and the transmission of the sensing signal in the inactive state is ongoing, the terminal device 110 may start or restart the timer.

[00125] In some embodiments, the terminal device 110 may determine that a TA command is received in an RA procedure. In this case, if the transmission of the sensing signal in
25 the inactive state is ongoing, the terminal device 110 may start or restart the timer.

[00126] In some embodiments, the terminal device 110 may measure signal strength of a path loss reference signal. If a variation between the measured signal strength and stored signal strength of the path loss reference signal is not more than a threshold of signal strength variation configured for validation of the time alignment and the timer is running,
30 the terminal device 110 may determine that a TA value is valid. The terminal device 110 may perform the transmission of the sensing signal based on the TA value.

[00127] In some embodiments, the terminal device 110 may transmit, to the access network

device 120, capability of the terminal device 110. In some embodiments, the capability of the terminal device 110 may comprise at least one of the following: first capability of whether the terminal device 110 supports the transmission or reception of the sensing signal in the inactive state for an initial uplink BWP, second capability of whether the terminal device 110 supports the transmission or reception of the sensing signal in the inactive state outside the initial uplink BWP, third capability of whether the terminal device 110 supports the transmission of the sensing signal in the inactive state with semi-persistent sensing for the initial uplink BWP, fourth capability of whether the terminal device 110 supports the transmission of the sensing signal in the inactive state with semi-persistent sensing outside the initial uplink BWP, or fifth capability of whether the terminal device 110 supports a spatial relation for the sensing signal with respect to an RS in the inactive state.

[00128] In some embodiments, the first capability or the second capability may comprise at least one of the following: a maximum bandwidth for sensing supported for an SCS that the terminal device 110 supports within a single CC for FR1, a maximum bandwidth for sensing supported for an SCS that the terminal device 110 supports within a single CC for FR2, a maximum number of resource sets for sensing supported by the terminal device 110, a maximum number of periodic resources for sensing supported by the terminal device 110, a maximum number of periodic resources for sensing per slot supported by the terminal device 110, a maximum number of SP resources for sensing supported by the terminal device 110, a maximum number of SP resources for sensing per slot supported by the terminal device 110, a maximum number of periodic and SP resources for sensing supported by the terminal device 110, or a maximum number of periodic and SP resources for sensing per slot supported by the terminal device 110.

[00129] With the method 300, a sensing operation in an inactive state may be carried out.

[00130] FIG. 4 illustrates an example method 400 of communication implemented at an access network device in accordance with some embodiments of the present disclosure. For example, the method 400 may be performed at the access network device 120 as shown in FIG. 1. For the purpose of discussion, in the following, the method 400 will be described with reference to the access network device 120 in FIG. 1. It is to be understood that the method 400 may include additional blocks not shown and/or may omit some blocks as shown, and the scope of the present disclosure is not limited in this regard.

[00131] As shown in FIG. 4, at block 410, the access network device 120 transmits, to the

terminal device 110, a configuration for transmission or reception of a sensing signal in an inactive state. In some embodiments, the configuration may comprise at least one of the following: first information of the transmission or reception of the sensing signal in a NUL carrier, second information of the transmission or reception of the sensing signal in a SUL carrier, or third information of time alignment for the transmission of the sensing signal.

[00132] In some embodiments, the first information may indicate at least one of the following: information of one or more resources for the transmission or reception of the sensing signal in the NUL carrier, information of one or more resource sets for the transmission or reception of the sensing signal in the NUL carrier, or information of a bandwidth part for the transmission or reception of the sensing signal in the NUL carrier.

[00133] In some embodiments, the second information may indicate at least one of the following: information of one or more resources for the transmission or reception of the sensing signal in the SUL carrier, information of one or more resource sets for the transmission or reception of the sensing signal in the SUL carrier, or information of a bandwidth part for the transmission or reception of the sensing signal in the SUL carrier.

[00134] In some embodiments, the information of the one or more resource sets in the first or second information may comprise at least one of the following: a list of resource sets to be released, or a list of resource sets to be added.

[00135] In some embodiments, the information of the one or more resource sets in the first or second information may indicate at least one of the following: an identity of a resource set in the one or more resource sets, a list of identities of resources in the resource set, a configuration type of the resources in the resource set, or a path loss reference signal to be used for a path loss estimation for the transmission or reception of the sensing signal.

[00136] In some embodiments, the information of the one or more resources in the first or second information may comprise at least one of the following: a list of resources to be released, or a list of resources to be added.

[00137] In some embodiments, the information of the one or more resources in the first or second information may indicate at least one of the following: an identity of a resource in the one or more resources, time-domain information of the resource, frequency-domain information of the resource, spatial-domain information of the resource, a periodicity of the resource, or a time offset of the resource. In some embodiments, the spatial-domain information may comprise at least one of an identity of an RS or an identity of an uplink

BWP.

[00138] In some embodiments, the third information may indicate at least one of the following: a value of a timer configured for the time alignment, or a threshold of signal strength variation configured for validation of the time alignment.

5 [00139] In some embodiments, the access network device 120 may transmit an indication for activating or deactivating the transmission or reception of the sensing signal. In some embodiments, the access network device 120 may transmit the indication via an SDT procedure. In some embodiments, the access network device 120 may transmit the indication along with the configuration. In some embodiments, the access network device
10 120 may transmit the indication in the configuration. In some embodiments, the access network device 120 may transmit an LPWUS as the indication. In some embodiments, the access network device 120 may transmit the indication in a paging message. In some embodiments, the access network device 120 may transmit the indication in a short message. In some embodiments, the access network device 120 may transmit the
15 indication in a PEI. In some embodiments, the access network device 120 may transmit, as the indication, DCI used for the activating or deactivating.

[00140] In some embodiments, the access network device 120 may receive capability of the terminal device 110. In some embodiments, the capability of the terminal device 110 may comprise at least one of the following: first capability of whether the terminal device 110
20 supports the transmission or reception of the sensing signal in the inactive state for an initial uplink BWP, second capability of whether the terminal device 110 supports the transmission or reception of the sensing signal in the inactive state outside the initial uplink BWP, third capability of whether the terminal device 110 supports the transmission of the sensing signal in the inactive state with SP sensing for the initial uplink BWP, fourth
25 capability of whether the terminal device 110 supports the transmission of the sensing signal in the inactive state with SP sensing outside the initial uplink BWP, or fifth capability of whether the terminal device 110 supports a spatial relation for the sensing signal with respect to an RS in the inactive state.

[00141] In some embodiments, the first capability or the second capability may comprise at
30 least one of the following: a maximum bandwidth for sensing supported for an SCS that the terminal device 110 supports within a single CC for FR1, a maximum bandwidth for sensing supported for an SCS that the terminal device 110 supports within a single CC for

FR2, a maximum number of resource sets for sensing supported by the terminal device 110, a maximum number of periodic resources for sensing supported by the terminal device 110, a maximum number of periodic resources for sensing per slot supported by the terminal device 110, a maximum number of SP resources for sensing supported by the terminal device 110, a maximum number of SP resources for sensing per slot supported by the terminal device 110, a maximum number of periodic and SP resources for sensing supported by the terminal device 110, or a maximum number of periodic and SP resources for sensing per slot supported by the terminal device 110.

[00142] With the method 400, a sensing operation of a terminal device in an inactive state may be supported.

[00143] It is to be understood that operations of the methods 300 and 400 correspond to the process described in connection with FIG. 2, and thus other details are omitted here for concise.

EXAMPLE IMPLEMENTATION OF DEVICES

[00144] FIG. 5 is a simplified block diagram of a device 500 that is suitable for implementing embodiments of the present disclosure. The device 500 can be considered as a further example implementation of the terminal device 110 or the access network device 120 as shown in FIG. 1. Accordingly, the device 500 can be implemented at or as at least a part of the terminal device 110 or the access network device 120 or the core network device 130.

[00145] As shown, the device 500 includes a processor 510, a memory 520 coupled to the processor 510, a suitable transceiver 540 coupled to the processor 510, and a communication interface coupled to the transceiver 540. The memory 510 stores at least a part of a program 530. The transceiver 540 may be for bidirectional communications or a unidirectional communication based on requirements. The transceiver 540 may include at least one of a transmitter 542 or a receiver 544. The transmitter 542 and the receiver 544 may be functional modules or physical entities. The transceiver 540 has at least one antenna to facilitate communication, though in practice an Access Node mentioned in this application may have several ones. The communication interface may represent any interface that is necessary for communication with other network elements, such as X2/Xn interface for bidirectional communications between eNBs/gNBs, S1/NG interface for communication between a Mobility Management Entity (MME)/Access and Mobility

Management Function (AMF)/SGW/UPF and the eNB/gNB, Un interface for communication between the eNB/gNB and a relay node (RN), or Uu interface for communication between the eNB/gNB and a terminal device.

[00146] The program 530 is assumed to include program instructions that, when executed
5 by the associated processor 510, enable the device 500 to operate in accordance with the embodiments of the present disclosure, as discussed herein with reference to FIGs. 1 to 4. The embodiments herein may be implemented by computer software executable by the processor 510 of the device 500, or by hardware, or by a combination of software and hardware. The processor 510 may be configured to implement various embodiments of
10 the present disclosure. Furthermore, a combination of the processor 510 and memory 520 may form processing means 550 adapted to implement various embodiments of the present disclosure.

[00147] The memory 520 may be of any type suitable to the local technical network and may be implemented using any suitable data storage technology, such as a non-transitory
15 computer readable storage medium, semiconductor based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory, as non-limiting examples. While only one memory 520 is shown in the device 500, there may be several physically distinct memory modules in the device 500. The processor 510 may be of any type suitable to the local technical network, and may
20 include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multicore processor architecture, as non-limiting examples. The device 500 may have multiple processors, such as an application specific integrated circuit chip that is slaved in time to a clock which synchronizes the main processor.

[00148] In some embodiments, a terminal device comprises a circuitry configured to:
25 receive, from an access network device, a configuration for transmission or reception of a sensing signal in an inactive state, the configuration comprising at least one of the following: first information of the transmission or reception of the sensing signal in a normal uplink carrier, second information of the transmission or reception of the sensing
30 signal in a supplementary uplink carrier, or third information of time alignment for the transmission of the sensing signal; and perform, based on the configuration, the transmission or reception of the sensing signal in the inactive state.

[00149] In some embodiments, an access network device comprises a circuitry configured to: transmit, to a terminal device, a configuration for transmission or reception of a sensing signal in an inactive state, the configuration comprising at least one of the following: first information of the transmission or reception of the sensing signal in a normal uplink carrier,
5 second information of the transmission or reception of the sensing signal in a supplementary uplink carrier, or third information of time alignment for the transmission of the sensing signal.

[00150] The term “circuitry” used herein may refer to hardware circuits and/or combinations of hardware circuits and software. For example, the circuitry may be a
10 combination of analog and/or digital hardware circuits with software/firmware. As a further example, the circuitry may be any portions of hardware processors with software including digital signal processor(s), software, and memory(ies) that work together to cause an apparatus, such as a terminal device or a network device, to perform various functions. In a still further example, the circuitry may be hardware circuits and or processors, such as
15 a microprocessor or a portion of a microprocessor, that requires software/firmware for operation, but the software may not be present when it is not needed for operation. As used herein, the term circuitry also covers an implementation of merely a hardware circuit or processor(s) or a portion of a hardware circuit or processor(s) and its (or their) accompanying software and/or firmware.

[00151] In summary, embodiments of the present disclosure provide the following solutions.

[00152] In one solution, a terminal device comprises a processor configured to cause the terminal device to: receive, from an access network device, a configuration for transmission or reception of a sensing signal in an inactive state, the configuration comprising at least
25 one of the following: first information of the transmission or reception of the sensing signal in a normal uplink carrier, second information of the transmission or reception of the sensing signal in a supplementary uplink carrier, or third information of time alignment for the transmission of the sensing signal; and perform, based on the configuration, the transmission or reception of the sensing signal in the inactive state.

[00153] In some embodiments, the first information indicates at least one of the following: information of one or more resources for the transmission or reception of the sensing signal in the normal uplink carrier, information of one or more resource sets for the transmission

or reception of the sensing signal in the normal uplink carrier, or information of a bandwidth part for the transmission or reception of the sensing signal in the normal uplink carrier.

5 [00154] In some embodiments, the second information indicates at least one of the following: information of one or more resources for the transmission or reception of the sensing signal in the supplementary uplink carrier, information of one or more resource sets for the transmission or reception of the sensing signal in the supplementary uplink carrier, or information of a bandwidth part for the transmission or reception of the sensing signal in the supplementary uplink carrier.

10 [00155] In some embodiments, the information of the one or more resource sets comprises at least one of the following: a list of resource sets to be released, or a list of resource sets to be added.

15 [00156] In some embodiments, the information of the one or more resource sets indicates at least one of the following: an identity of a resource set in the one or more resource sets, a list of identities of resources in the resource set, a configuration type of the resources in the resource set, or a path loss reference signal to be used for a path loss estimation for the transmission or reception of the sensing signal.

20 [00157] In some embodiments, the information of the one or more resources comprises at least one of the following: a list of resources to be released, or a list of resources to be added.

25 [00158] In some embodiments, the information of the one or more resources indicates at least one of the following: an identity of a resource in the one or more resources, time-domain information of the resource, frequency-domain information of the resource, spatial-domain information of the resource, a periodicity of the resource, or a time offset of the resource.

30 [00159] In some embodiments, the spatial-domain information comprises an identity of a reference signal, and wherein the terminal device is caused to perform the transmission or reception of the sensing signal by: performing the transmission or reception of the sensing signal with a same spatial-domain transmission filter used for reception or transmission of the reference signal.

[00160] In some embodiments, the third information indicates at least one of the following: a value of a timer configured for the time alignment, or a threshold of signal strength

variation configured for validation of the time alignment.

[00161] In some embodiments, the terminal device is caused to perform the transmission or reception of the sensing signal by at least one of the following: applying the configuration; or starting the timer.

5 [00162] In some embodiments, the terminal device is further caused to: in accordance with a determination that the terminal device is changed from the inactive state to a connected state or the terminal device is changed from a first cell to a second cell, perform an operation comprising at least one of the following: stopping the timer; or releasing the configuration.

10 [00163] In some embodiments, the terminal device is caused to perform the transmission or reception of the sensing signal by: receiving, from the access network device, an indication for activating or deactivating the transmission or reception of the sensing signal; and in accordance with a determination that the indication indicates the activating of the transmission or reception of the sensing signal, performing the transmission or reception of
15 the sensing signal.

[00164] In some embodiments, the terminal device is caused to receive the indication by: receiving the indication in the inactive state via a small data transmission procedure; receiving the indication along with the configuration; receiving the indication in the configuration; receiving, as the indication, a low-power wake-up signal in the inactive state;
20 receiving the indication in a paging message in the inactive state; receiving the indication in a short message in the inactive state; receiving the indication in a paging early indication in the inactive state; or receiving, as the indication, downlink control information used for the activating or deactivating.

[00165] In some embodiments, the terminal device is further caused to: determine that a
25 timing advance command medium access control control element is received and a timing advance value has been maintained; and in accordance with a determination that the transmission of the sensing signal in the inactive state is to be performed or ongoing, start or restart the timer.

[00166] In some embodiments, the terminal device is further caused to: in accordance with
30 a determination that the timer expires, release the configuration.

[00167] In some embodiments, the terminal device is further caused to: in accordance with a determination that a reset of a medium access control entity of the terminal device is

performed, determine that the timer expires.

[00168] In some embodiments, the terminal device is further caused to: determine that a timing advance command is received in a random access response message and a further timer configured for time alignment for transmission of a wireless signal is not running; and
5 in accordance with a determination that contention resolution is successful and the transmission of the sensing signal in the inactive state is ongoing, start or restart the timer.

[00169] In some embodiments, the terminal device is further caused to: determine that a timing advance command is received in a random access procedure; and in accordance with a determination that the transmission of the sensing signal in the inactive state is ongoing,
10 start or restart the timer.

[00170] In some embodiments, the terminal device is caused to perform the transmission of the sensing signal by: measuring signal strength of a path loss reference signal; in accordance with a determination that a variation between the measured signal strength and stored signal strength of the path loss reference signal is not more than a threshold of signal
15 strength variation configured for validation of the time alignment and the timer is running, determining that a timing advance value is valid; and performing the transmission of the sensing signal based on the timing advance value.

[00171] In some embodiments, the terminal device is further caused to: transmit, to the access network device, capability of the terminal device comprising at least one of the
20 following: first capability of whether the terminal device supports the transmission or reception of the sensing signal in the inactive state for an initial uplink bandwidth part, second capability of whether the terminal device supports the transmission or reception of the sensing signal in the inactive state outside the initial uplink bandwidth part, third capability of whether the terminal device supports the transmission of the sensing signal in
25 the inactive state with semi-persistent sensing for the initial uplink bandwidth part, fourth capability of whether the terminal device supports the transmission of the sensing signal in the inactive state with semi-persistent sensing outside the initial uplink bandwidth part, or fifth capability of whether the terminal device supports a spatial relation for the sensing signal with respect to a reference signal in the inactive state.

[00172] In some embodiments, the first capability or the second capability comprises at least one of the following: a maximum bandwidth for sensing supported for a subcarrier spacing that the terminal device supports within a single component carrier for frequency

range 1, a maximum bandwidth for sensing supported for a subcarrier spacing that the terminal device supports within a single component carrier for frequency range 2, a maximum number of resource sets for sensing supported by the terminal device, a maximum number of periodic resources for sensing supported by the terminal device, a maximum number of periodic resources for sensing per slot supported by the terminal device, a maximum number of semi-persistent resources for sensing supported by the terminal device, a maximum number of semi-persistent resources for sensing per slot supported by the terminal device, a maximum number of periodic and semi-persistent resources for sensing supported by the terminal device, or a maximum number of periodic and semi-persistent resources for sensing per slot supported by the terminal device.

[00173] In another solution, an access network device comprises a processor configured to cause the access network device to: transmit, to a terminal device, a configuration for transmission or reception of a sensing signal in an inactive state, the configuration comprising at least one of the following: first information of the transmission or reception of the sensing signal in a normal uplink carrier, second information of the transmission or reception of the sensing signal in a supplementary uplink carrier, or third information of time alignment for the transmission of the sensing signal.

[00174] In some embodiments, the first information indicates at least one of the following: information of one or more resources for the transmission or reception of the sensing signal in the normal uplink carrier, information of one or more resource sets for the transmission or reception of the sensing signal in the normal uplink carrier, or information of a bandwidth part for the transmission or reception of the sensing signal in the normal uplink carrier.

[00175] In some embodiments, the second information indicates at least one of the following: information of one or more resources for the transmission or reception of the sensing signal in the supplementary uplink carrier, information of one or more resource sets for the transmission or reception of the sensing signal in the supplementary uplink carrier, or information of a bandwidth part for the transmission or reception of the sensing signal in the supplementary uplink carrier.

[00176] In some embodiments, the information of the one or more resource sets comprises at least one of the following: a list of resource sets to be released, or a list of resource sets to be added.

[00177] In some embodiments, the information of the one or more resource sets indicates at least one of the following: an identity of a resource set in the one or more resource sets, a list of identities of resources in the resource set, a configuration type of the resources in the resource set, or a path loss reference signal to be used for a path loss estimation for the transmission or reception of the sensing signal.

[00178] In some embodiments, the information of the one or more resources comprises at least one of the following: a list of resources to be released, or a list of resources to be added.

[00179] In some embodiments, the information of the one or more resources indicates at least one of the following: an identity of a resource in the one or more resources, time-domain information of the resource, frequency-domain information of the resource, spatial-domain information of the resource, a periodicity of the resource, or a time offset of the resource.

[00180] In some embodiments, the third information indicates at least one of the following: a value of a timer configured for the time alignment, or a threshold of signal strength variation configured for validation of the time alignment.

[00181] In some embodiments, the access network device is further caused to: transmit, to the terminal device, an indication for activating or deactivating the transmission or reception of the sensing signal.

[00182] In some embodiments, the access network device is caused to transmit the indication by: transmitting the indication via a small data transmission procedure; transmitting the indication along with the configuration; transmitting the indication in the configuration; transmitting, as the indication, a low-power wake-up signal; transmitting the indication in a paging message; transmitting the indication in a short message; transmitting the indication in a paging early indication; or transmitting, as the indication, downlink control information used for the activating or deactivating.

[00183] In some embodiments, the access network device is further caused to: receive, from the terminal device, capability of the terminal device comprising at least one of the following: first capability of whether the terminal device supports the transmission or reception of the sensing signal in the inactive state for an initial uplink bandwidth part, second capability of whether the terminal device supports the transmission or reception of the sensing signal in the inactive state outside the initial uplink bandwidth part, third

capability of whether the terminal device supports the transmission of the sensing signal in the inactive state with semi-persistent sensing for the initial uplink bandwidth part, fourth capability of whether the terminal device supports the transmission of the sensing signal in the inactive state with semi-persistent sensing outside the initial uplink bandwidth part, or
5 fifth capability of whether the terminal device supports a spatial relation for the sensing signal with respect to a reference signal in the inactive state.

[00184] In some embodiments, the first capability or the second capability comprises at least one of the following: a maximum bandwidth for sensing supported for a subcarrier spacing that the terminal device supports within a single component carrier for frequency
10 range 1, a maximum bandwidth for sensing supported for a subcarrier spacing that the terminal device supports within a single component carrier for frequency range 2, a maximum number of resource sets for sensing supported by the terminal device, a maximum number of periodic resources for sensing supported by the terminal device, a maximum number of periodic resources for sensing per slot supported by the terminal
15 device, a maximum number of semi-persistent resources for sensing supported by the terminal device, a maximum number of semi-persistent resources for sensing per slot supported by the terminal device, a maximum number of periodic and semi-persistent resources for sensing supported by the terminal device, or a maximum number of periodic and semi-persistent resources for sensing per slot supported by the terminal device.

[00185] Generally, various embodiments of the present disclosure may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device. While various aspects of embodiments of the present disclosure are
25 illustrated and described as block diagrams, flowcharts, or using some other pictorial representation, it will be appreciated that the blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[00186] The present disclosure also provides at least one computer program product tangibly stored on a non-transitory computer readable storage medium. The computer program product includes computer-executable instructions, such as those included in program modules, being executed in a device on a target real or virtual processor, to carry
30

out the process or method as described above with reference to FIGs. 1 to 4. Generally, program modules include routines, programs, libraries, objects, classes, components, data structures, or the like that perform particular tasks or implement particular abstract data types. The functionality of the program modules may be combined or split between
5 program modules as desired in various embodiments. Machine-executable instructions for program modules may be executed within a local or distributed device. In a distributed device, program modules may be located in both local and remote storage media.

[00187] Program code for carrying out methods of the present disclosure may be written in any combination of one or more programming languages. These program codes may be
10 provided to a processor or controller of a general purpose computer, special purpose computer, or other programmable data processing apparatus, such that the program codes, when executed by the processor or controller, cause the functions/operations specified in the flowcharts and/or block diagrams to be implemented. The program code may execute entirely on a machine, partly on the machine, as a stand-alone software package, partly on
15 the machine and partly on a remote machine or entirely on the remote machine or server.

[00188] The above program code may be embodied on a machine readable medium, which may be any tangible medium that may contain, or store a program for use by or in connection with an instruction execution system, apparatus, or device. The machine readable medium may be a machine readable signal medium or a machine readable storage
20 medium. A machine readable medium may include but not limited to an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing. More specific examples of the machine readable storage medium would include an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only
25 memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), an optical fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing.

[00189] Further, while operations are depicted in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or
30 in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Likewise, while several specific implementation details are contained in the above discussions, these should not be construed as limitations on the scope of the

present disclosure, but rather as descriptions of features that may be specific to particular embodiments. Certain features that are described in the context of separate embodiments may also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment may also be implemented
5 in multiple embodiments separately or in any suitable sub-combination.

[00190] Although the present disclosure has been described in language specific to structural features and/or methodological acts, it is to be understood that the present disclosure defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are
10 disclosed as example forms of implementing the claims.

WHAT IS CLAIMED IS:

1. A terminal device, comprising:

a processor configured to cause the terminal device to:

5 receive, from an access network device, a configuration for transmission or reception of a sensing signal in an inactive state, the configuration comprising at least one of the following:

first information of the transmission or reception of the sensing signal in a normal uplink carrier,

10 second information of the transmission or reception of the sensing signal in a supplementary uplink carrier, or

third information of time alignment for the transmission of the sensing signal; and

perform, based on the configuration, the transmission or reception of the sensing signal in the inactive state.

15

2. The terminal device of claim 1, wherein the first information indicates at least one of the following:

information of one or more resources for the transmission or reception of the sensing signal in the normal uplink carrier,

20 information of one or more resource sets for the transmission or reception of the sensing signal in the normal uplink carrier, or

information of a bandwidth part for the transmission or reception of the sensing signal in the normal uplink carrier.

25 3. The terminal device of claim 1, wherein the second information indicates at least one of the following:

information of one or more resources for the transmission or reception of the sensing signal in the supplementary uplink carrier,

30 information of one or more resource sets for the transmission or reception of the sensing signal in the supplementary uplink carrier, or

information of a bandwidth part for the transmission or reception of the sensing signal in the supplementary uplink carrier.

4. The terminal device of claim 2 or 3, wherein the information of the one or more

resource sets comprises at least one of the following:

- a list of resource sets to be released, or
- a list of resource sets to be added.

5 5. The terminal device of claim 2 or 3, wherein the information of the one or more resource sets indicates at least one of the following:

- an identity of a resource set in the one or more resource sets,
- a list of identities of resources in the resource set,
- a configuration type of the resources in the resource set, or

10 a path loss reference signal to be used for a path loss estimation for the transmission or reception of the sensing signal.

6. The terminal device of claim 2 or 3, wherein the information of the one or more resources comprises at least one of the following:

- 15 a list of resources to be released, or
- a list of resources to be added.

7. The terminal device of claim 2 or 3, wherein the information of the one or more resources indicates at least one of the following:

- 20 an identity of a resource in the one or more resources,
- time-domain information of the resource,
 - frequency-domain information of the resource,
 - spatial-domain information of the resource,
 - a periodicity of the resource, or
- 25 a time offset of the resource.

8. The terminal device of claim 7, wherein the spatial-domain information comprises an identity of a reference signal, and wherein the terminal device is caused to perform the transmission or reception of the sensing signal by:

30 performing the transmission or reception of the sensing signal with a same spatial-domain transmission filter used for reception or transmission of the reference signal.

9. The terminal device of claim 1, wherein the third information indicates at least one of the following:

a value of a timer configured for the time alignment, or
a threshold of signal strength variation configured for validation of the time alignment.

5 10. The terminal device of claim 9, wherein the terminal device is caused to perform the transmission or reception of the sensing signal by at least one of the following:
 applying the configuration; or
 starting the timer.

10 11. The terminal device of claim 10, wherein the terminal device is further caused to:
 in accordance with a determination that the terminal device is changed from the inactive state to a connected state or the terminal device is changed from a first cell to a second cell, perform an operation comprising at least one of the following:
15 stopping the timer; or
 releasing the configuration.

 12. The terminal device of claim 1, wherein the terminal device is caused to perform the transmission or reception of the sensing signal by:
20 receiving, from the access network device, an indication for activating or deactivating the transmission or reception of the sensing signal; and
 in accordance with a determination that the indication indicates the activating of the transmission or reception of the sensing signal, performing the transmission or reception of the sensing signal.

25 13. The terminal device of claim 12, wherein the terminal device is caused to receive the indication by:
 receiving the indication in the inactive state via a small data transmission procedure;
 receiving the indication along with the configuration;
30 receiving the indication in the configuration;
 receiving, as the indication, a low-power wake-up signal in the inactive state;
 receiving the indication in a paging message in the inactive state;
 receiving the indication in a short message in the inactive state;
 receiving the indication in a paging early indication in the inactive state; or

receiving, as the indication, downlink control information used for the activating or deactivating.

14. The terminal device of claim 9, wherein the terminal device is further caused to:
5 determine that a timing advance command medium access control control element is received and a timing advance value has been maintained; and
in accordance with a determination that the transmission of the sensing signal in the inactive state is to be performed or ongoing, start or restart the timer.

10 15. The terminal device of claim 10 or 14, wherein the terminal device is further caused to:
in accordance with a determination that the timer expires, release the configuration.

15 16. The terminal device of claim 15, wherein the terminal device is further caused to:
in accordance with a determination that a reset of a medium access control entity of the terminal device is performed, determine that the timer expires.

17. The terminal device of claim 9, wherein the terminal device is further caused to:
20 determine that a timing advance command is received in a random access response message and a further timer configured for time alignment for transmission of a wireless signal is not running; and
in accordance with a determination that contention resolution is successful and the transmission of the sensing signal in the inactive state is ongoing, start or restart the timer.

25 18. The terminal device of claim 9, wherein the terminal device is further caused to:
determine that a timing advance command is received in a random access procedure;
and
in accordance with a determination that the transmission of the sensing signal in the
30 inactive state is ongoing, start or restart the timer.

19. The terminal device of claim 9, wherein the terminal device is caused to perform the transmission of the sensing signal by:
measuring signal strength of a path loss reference signal;

in accordance with a determination that a variation between the measured signal strength and stored signal strength of the path loss reference signal is not more than a threshold of signal strength variation configured for validation of the time alignment and the timer is running, determining that a timing advance value is valid; and

- 5 performing the transmission of the sensing signal based on the timing advance value.

20. The terminal device of claim 1, wherein the terminal device is further caused to: transmit, to the access network device, capability of the terminal device comprising
10 at least one of the following:

first capability of whether the terminal device supports the transmission or reception of the sensing signal in the inactive state for an initial uplink bandwidth part,

second capability of whether the terminal device supports the transmission or reception of the sensing signal in the inactive state outside the initial uplink bandwidth part,

15 third capability of whether the terminal device supports the transmission of the sensing signal in the inactive state with semi-persistent sensing for the initial uplink bandwidth part,

fourth capability of whether the terminal device supports the transmission of the sensing signal in the inactive state with semi-persistent sensing outside the initial uplink
20 bandwidth part, or

fifth capability of whether the terminal device supports a spatial relation for the sensing signal with respect to a reference signal in the inactive state.

DRAWINGS

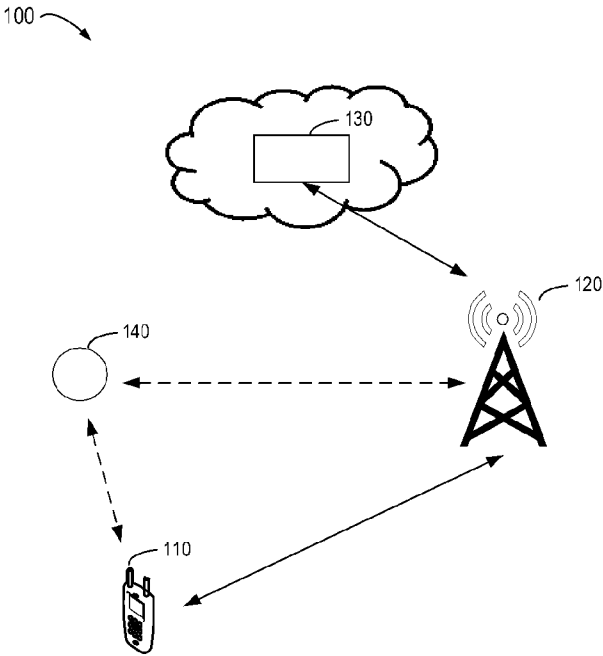


FIG. 1

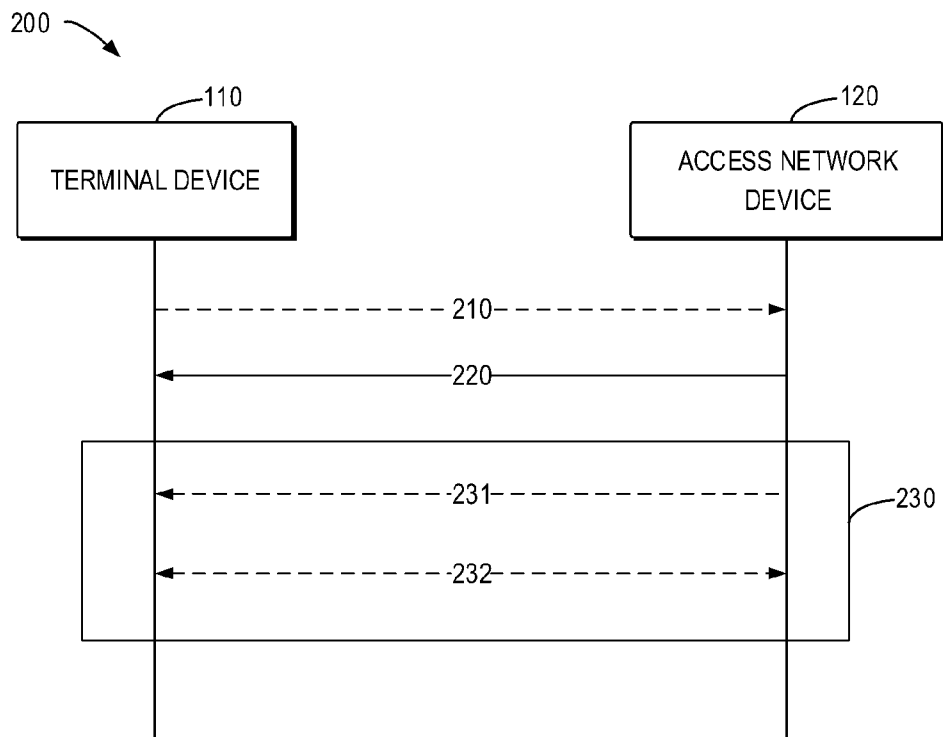


FIG. 2

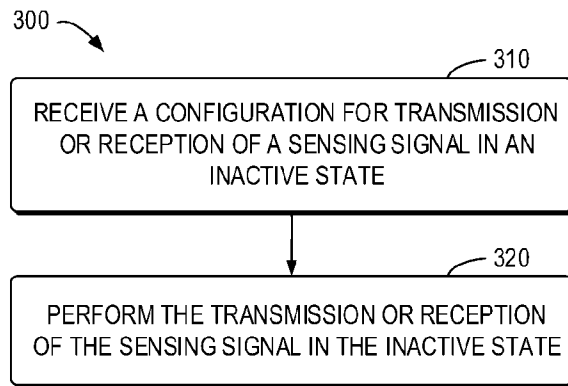


FIG. 3

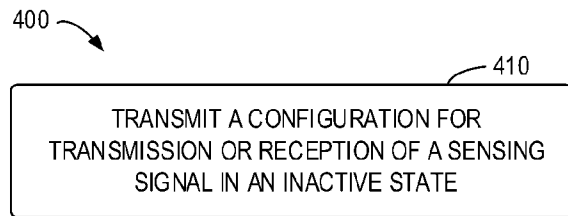


FIG. 4

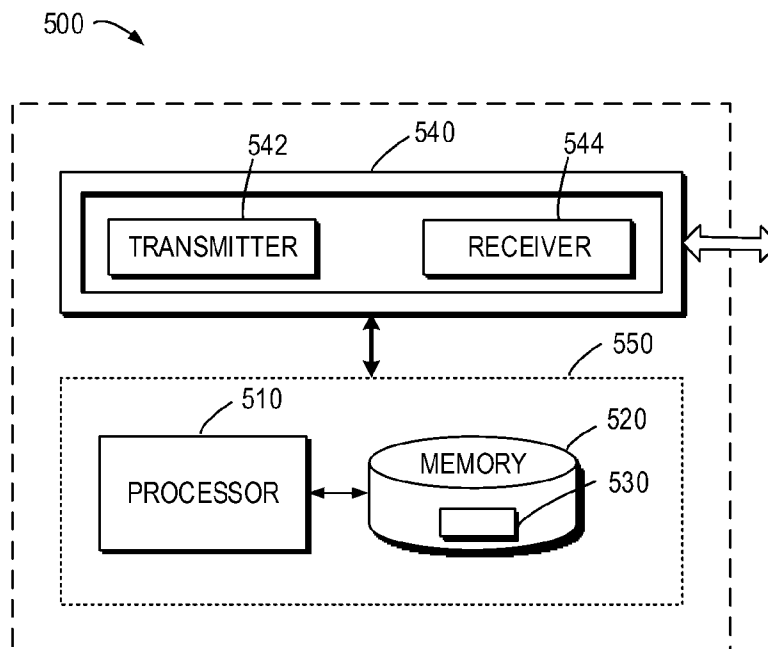


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/100671

A. CLASSIFICATION OF SUBJECT MATTER

H04W72/0446(2023.01)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: H04W H04L

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

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

CNTXT, ENTXT, DWPI, 3GPP: configuration, transmission, reception, sensing, signal, inactive, idle, normal uplink carrier, supplementary uplink carrier, alignment, NUL, SUL, SSB, PRS, SRS, CSI-RS, DMRS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2022094495 A1 (GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.) 24 March 2022 (2022-03-24) claims 1 to 20	1-20
Y	HUAWEI et al. "Summary of AI 8.11.3 for INACTIVE POS" 3GPP TSG-RAN WG2 Meeting #114-e R2-2106447, 27 May 2021 (2021-05-27), parts 3.2 and 4.2	1-20
A	US 2023030443 A1 (FG INNOVATION COMPANY LIMITED) 02 February 2023 (2023-02-02) the whole document	1-20
A	US 2021259040 A1 (BABAEI, Alireza) 19 August 2021 (2021-08-19) the whole document	1-20
A	WO 2023040822 A1 (VIVO MOBILE COMMUNICATION CO., LTD.) 23 March 2023 (2023-03-23) the whole document	1-20

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

05 December 2023

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/100671

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 115190446 A (DATANG MOBILE COMMUNICATIONS EQUIPMENT CO., LTD.) 14 October 2022 (2022-10-14) the whole document	1-20

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/100671

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				WO	2021136474	A1	08 July 2021
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				VN	89787	A	26 September 2022
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