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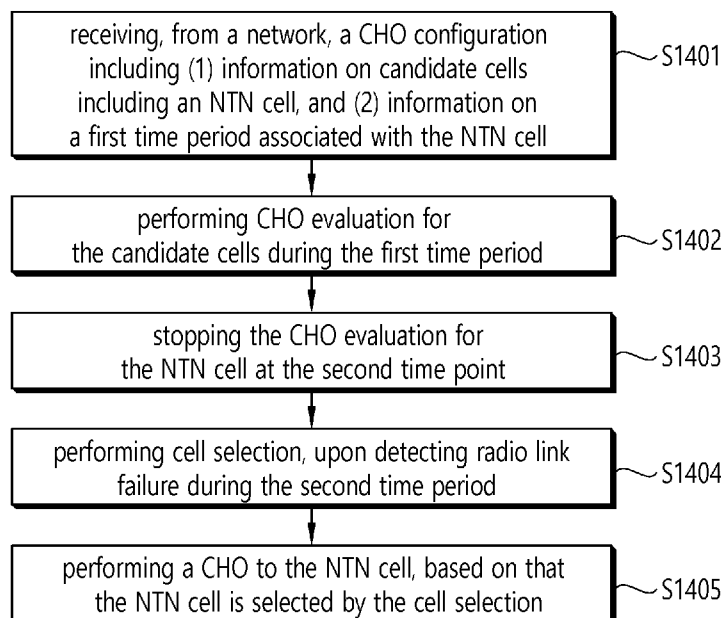
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(54) Title: METHOD AND APPARATUS FOR USING A CHO CONFIGURATION FOR RLF RECOVERY IN A WIRELESS COMMUNICATION SYSTEM



(57) Abstract: A method and apparatus for using a CHO configuration for RLF recovery in a wireless communication system is provided. A wireless device may receive, from a network, a CHO configuration including (1) information on candidate cells including a NTN cell, and (2) information on a first time period associated with the NTN cell. The wireless device may stop the CHO evaluation for the NTN cell after the first time period. The wireless device may perform cell selection, upon detecting radio link failure during the second time period. The wireless device may perform a CHO to the NTN cell, based on that the NTN cell is selected by the cell selection.

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Description

Title of Invention: METHOD AND APPARATUS FOR USING A CHO CONFIGURATION FOR RLF RECOVERY IN A WIRELESS COMMUNICATION SYSTEM

Technical Field

- [1] The present disclosure relates to a method and apparatus for using a CHO configuration for RLF recovery in a wireless communication system.

Background Art

- [2] 3rd generation partnership project (3GPP) long-term evolution (LTE) is a technology for enabling high-speed packet communications. Many schemes have been proposed for the LTE objective including those that aim to reduce user and provider costs, improve service quality, and expand and improve coverage and system capacity. The 3GPP LTE requires reduced cost per bit, increased service availability, flexible use of a frequency band, a simple structure, an open interface, and adequate power consumption of a terminal as an upper-level requirement.
- [3] Work has started in international telecommunication union (ITU) and 3GPP to develop requirements and specifications for new radio (NR) systems. 3GPP has to identify and develop the technology components needed for successfully standardizing the new RAT timely satisfying both the urgent market needs, and the more long-term requirements set forth by the ITU radio communication sector (ITU-R) international mobile telecommunications (IMT)-2020 process. Further, the NR should be able to use any spectrum band ranging at least up to 100 GHz that may be made available for wireless communications even in a more distant future.
- [4] The NR targets a single technical framework addressing all usage scenarios, requirements and deployment scenarios including enhanced mobile broadband (eMBB), massive machine-type-communications (mMTC), ultra-reliable and low latency communications (URLLC), etc. The NR shall be inherently forward compatible.
- [5] Thanks to the wide service coverage capabilities and reduced vulnerability of space/airborne vehicles to physical attacks and natural disasters, non-terrestrial networks (NTN) are expected to:
- [6] - foster the roll out of 5G service in un-served areas that cannot be covered by terrestrial 5G network (isolated/remote areas, on board aircrafts or vessels) and underserved areas (e.g., sub-urban/rural areas) to upgrade the performance of limited terrestrial networks in cost effective manner,
- [7] - reinforce the 5G service reliability by providing service continuity for machine-to-machine (M2M)/Internet-of-things (IoT) devices or for passengers on board moving

platforms (e.g., passenger vehicles-aircraft, ships, high speed trains, bus) or ensuring service availability anywhere especially for critical communications, future railway/maritime/aeronautical communications, and to

- [8] - enable 5G network scalability by providing efficient multicast/broadcast resources for data delivery towards the network edges or even user terminal.

Disclosure of Invention

Technical Problem

- [9] In conventional CHO, UE shall execute CHO when a configured RRM condition is met. The CHO configuration can be deleted when the network command. If RLF occurs while CHO is configured, if the selected cell is one of CHO candidate cells, the UE executes CHO to the selected cell instead of triggering re-establishment procedure.
- [10] In NTN, time duration [t1, t2] of CHO candidate cell may be provided to UE. UE may be allowed to perform CHO to the cell only during [t1, t2]. After the time point t2, how to delete the CHO configuration is not yet discussed. If the CHO configuration is not deleted at t2, the UE can use the candidate cell for the RLF recovery as described in the present disclosure. For example, the CHO candidate cell may be serviceable for a while after t2, but the network needs to maintain the CHO radio resource. If the CHO candidate cell is deleted after the time point t2, the network can save the CHO radio resource, but the UE cannot use it for the RLF recovery later.
- [11] Thus, upon providing CHO configuration, the time, when to delete the CHO configuration of the CHO candidate cell, could be set after the time point t2. In this case, the UE can perform CHO to the cell instead of the re-establishment procedure after t2 when RLF occurs. Then, the network only needs to maintain the CHO radio resource until t3 and release it.
- [12] Therefore, studies for using a CHO configuration for RLF recovery considering the NTN in a wireless communication system are required.

Solution to Problem

- [13] In an aspect, a method performed by a wireless device in a wireless communication system is provided. The wireless device may receive, from a network, a Conditional Handover (CHO) configuration including (1) information on candidate cells including a Non-Terrestrial Networks (NTN) cell, and (2) information on a first time period associated with the NTN cell. The first time period may start at a first time point and terminate at a second time point. The wireless device may perform a CHO evaluation for the candidate cells during the first time period. The wireless device may stop the CHO evaluation for the NTN cell at the second time point. The wireless device may perform cell selection, upon detecting radio link failure during the second time period. The second time period may start at the second time point and terminate at a third time

point. The wireless device may perform a CHO to the NTN cell, based on that the NTN cell is selected by the cell selection.

[14] In another aspect, an apparatus for implementing the above method is provided.

Advantageous Effects of Invention

[15] The present disclosure can have various advantageous effects.

[16] According to some embodiments of the present disclosure, a wireless device could efficiently perform the RLF recovery by using a conditional handover (CHO) configuration after the time duration for the CHO.

[17] That is, even after the time duration [t1, t2] has elapsed, the wireless device could perform the CHO for the purpose of RLF recovery when RLF occurs for a certain period of time.

[18] For example, while the wireless device is allowed to perform CHO to a CHO candidate cell only during [t1, t2], the wireless device may not discard the cell from the CHO configuration. The wireless device may perform CHO to the cell for the RLF recovery instead of triggering RRC re-establishment procedure which requires much longer delay than CHO.

[19] Advantageous effects which can be obtained through specific embodiments of the present disclosure are not limited to the advantageous effects listed above. For example, there may be a variety of technical effects that a person having ordinary skill in the related art can understand and/or derive from the present disclosure. Accordingly, the specific effects of the present disclosure are not limited to those explicitly described herein, but may include various effects that may be understood or derived from the technical features of the present disclosure.

Brief Description of Drawings

[20] FIG. 1 shows an example of a communication system to which implementations of the present disclosure is applied.

[21] FIG. 2 shows an example of wireless devices to which implementations of the present disclosure is applied.

[22] FIG. 3 shows an example of a wireless device to which implementations of the present disclosure is applied.

[23] FIG. 4 shows another example of wireless devices to which implementations of the present disclosure is applied.

[24] FIG. 5 shows an example of UE to which implementations of the present disclosure is applied.

[25] FIGS. 6 and 7 show an example of protocol stacks in a 3GPP based wireless communication system to which implementations of the present disclosure is applied.

[26] FIG. 8 shows a frame structure in a 3GPP based wireless communication system to

which implementations of the present disclosure is applied.

- [27] FIG. 9 shows a data flow example in the 3GPP NR system to which implementations of the present disclosure is applied.
- [28] FIG. 10 shows Non-terrestrial network typical scenario based on transparent payload to which implementations of the present disclosure is applied.
- [29] FIG. 11 shows Non-terrestrial network typical scenario based on regenerative payload to which implementations of the present disclosure is applied.
- [30] FIG. 12 shows Earth-Centered, Earth-Fixed (ECEF) coordinates in relation to latitude and longitude to which implementations of the present disclosure is applied.
- [31] FIG. 13 shows two phases govern the behaviour associated to radio link failure to which implementations of the present disclosure is applied.
- [32] FIG. 14 shows an example of a method for using a CHO configuration for RLF recovery in a wireless communication system, according to some embodiments of the present disclosure.
- [33] FIG. 15 shows an example of UE operations for using a CHO configuration for RLF recovery in a wireless communication system, according to some embodiments of the present disclosure.

Mode for the Invention

- [34] The following techniques, apparatuses, and systems may be applied to a variety of wireless multiple access systems. Examples of the multiple access systems include a code division multiple access (CDMA) system, a frequency division multiple access (FDMA) system, a time division multiple access (TDMA) system, an orthogonal frequency division multiple access (OFDMA) system, a single carrier frequency division multiple access (SC-FDMA) system, and a multicarrier frequency division multiple access (MC-FDMA) system. CDMA may be embodied through radio technology such as universal terrestrial radio access (UTRA) or CDMA2000. TDMA may be embodied through radio technology such as global system for mobile communications (GSM), general packet radio service (GPRS), or enhanced data rates for GSM evolution (EDGE). OFDMA may be embodied through radio technology such as institute of electrical and electronics engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, or evolved UTRA (E-UTRA). UTRA is a part of a universal mobile telecommunications system (UMTS). 3rd generation partnership project (3GPP) long term evolution (LTE) is a part of evolved UMTS (E-UMTS) using E-UTRA. 3GPP LTE employs OFDMA in DL and SC-FDMA in UL. LTE-advanced (LTE-A) is an evolved version of 3GPP LTE.
- [35] For convenience of description, implementations of the present disclosure are mainly described in regards to a 3GPP based wireless communication system. However, the

technical features of the present disclosure are not limited thereto. For example, although the following detailed description is given based on a mobile communication system corresponding to a 3GPP based wireless communication system, aspects of the present disclosure that are not limited to 3GPP based wireless communication system are applicable to other mobile communication systems.

- [36] For terms and technologies which are not specifically described among the terms of and technologies employed in the present disclosure, the wireless communication standard documents published before the present disclosure may be referenced.
- [37] In the present disclosure, "A or B" may mean "only A", "only B", or "both A and B". In other words, "A or B" in the present disclosure may be interpreted as "A and/or B". For example, "A, B or C" in the present disclosure may mean "only A", "only B", "only C", or "any combination of A, B and C".
- [38] In the present disclosure, slash (/) or comma (,) may mean "and/or". For example, "A/B" may mean "A and/or B". Accordingly, "A/B" may mean "only A", "only B", or "both A and B". For example, "A, B, C" may mean "A, B or C".
- [39] In the present disclosure, "at least one of A and B" may mean "only A", "only B" or "both A and B". In addition, the expression "at least one of A or B" or "at least one of A and/or B" in the present disclosure may be interpreted as same as "at least one of A and B".
- [40] In addition, in the present disclosure, "at least one of A, B and C" may mean "only A", "only B", "only C", or "any combination of A, B and C". In addition, "at least one of A, B or C" or "at least one of A, B and/or C" may mean "at least one of A, B and C".
- [41] Also, parentheses used in the present disclosure may mean "for example". In detail, when it is shown as "control information (PDCCH)", "PDCCH" may be proposed as an example of "control information". In other words, "control information" in the present disclosure is not limited to "PDCCH", and "PDCCH" may be proposed as an example of "control information". In addition, even when shown as "control information (i.e., PDCCH)", "PDCCH" may be proposed as an example of "control information".
- [42] Technical features that are separately described in one drawing in the present disclosure may be implemented separately or simultaneously.
- [43] Although not limited thereto, various descriptions, functions, procedures, suggestions, methods and/or operational flowcharts of the present disclosure disclosed herein can be applied to various fields requiring wireless communication and/or connection (e.g., 5G) between devices.
- [44] Hereinafter, the present disclosure will be described in more detail with reference to drawings. The same reference numerals in the following drawings and/or descriptions may refer to the same and/or corresponding hardware blocks, software blocks, and/or

functional blocks unless otherwise indicated.

[45] FIG. 1 shows an example of a communication system to which implementations of the present disclosure is applied.

[46] The 5G usage scenarios shown in FIG. 1 are only exemplary, and the technical features of the present disclosure can be applied to other 5G usage scenarios which are not shown in FIG. 1.

[47] Three main requirement categories for 5G include (1) a category of enhanced mobile broadband (eMBB), (2) a category of massive machine type communication (mMTC), (3) a category of ultra-reliable and low latency communications (URLLC).

[48] Partial use cases may require a plurality of categories for optimization and other use cases may focus only upon one key performance indicator (KPI). 5G supports such various use cases using a flexible and reliable method.

[49] eMBB far surpasses basic mobile Internet access and covers abundant bidirectional work and media and entertainment applications in cloud and augmented reality. Data is one of 5G core motive forces and, in a 5G era, a dedicated voice service may not be provided for the first time. In 5G, it is expected that voice will be simply processed as an application program using data connection provided by a communication system. Main causes for increased traffic volume are due to an increase in the size of content and an increase in the number of applications requiring high data transmission rate. A streaming service (of audio and video), conversational video, and mobile Internet access will be more widely used as more devices are connected to the Internet. These many application programs require connectivity of an always turned-on state in order to push real-time information and alarm for users. Cloud storage and applications are rapidly increasing in a mobile communication platform and may be applied to both work and entertainment. The cloud storage is a special use case which accelerates growth of uplink data transmission rate. 5G is also used for remote work of cloud. When a tactile interface is used, 5G demands much lower end-to-end latency to maintain user good experience. Entertainment, for example, cloud gaming and video streaming, is another core element which increases demand for mobile broadband capability. Entertainment is essential for a smartphone and a tablet in any place including high mobility environments such as a train, a vehicle, and an airplane. Other use cases are augmented reality for entertainment and information search. In this case, the augmented reality requires very low latency and instantaneous data volume.

[50] In addition, one of the most expected 5G use cases relates a function capable of smoothly connecting embedded sensors in all fields, i.e., mMTC. It is expected that the number of potential Internet-of-things (IoT) devices will reach 204 hundred million up to the year of 2020. An industrial IoT is one of categories of performing a main role enabling a smart city, asset tracking, smart utility, agriculture, and security infras-

tructure through 5G.

- [51] URLLC includes a new service that will change industry through remote control of main infrastructure and an ultra-reliable/available low-latency link such as a self-driving vehicle. A level of reliability and latency is essential to control a smart grid, automatize industry, achieve robotics, and control and adjust a drone.
- [52] 5G is a means of providing streaming evaluated as a few hundred megabits per second to gigabits per second and may complement fiber-to-the-home (FTTH) and cable-based broadband (or DOCSIS). Such fast speed is needed to deliver TV in resolution of 4K or more (6K, 8K, and more), as well as virtual reality and augmented reality. Virtual reality (VR) and augmented reality (AR) applications include almost immersive sports games. A specific application program may require a special network configuration. For example, for VR games, gaming companies need to incorporate a core server into an edge network server of a network operator in order to minimize latency.
- [53] Automotive is expected to be a new important motivated force in 5G together with many use cases for mobile communication for vehicles. For example, entertainment for passengers requires high simultaneous capacity and mobile broadband with high mobility. This is because future users continue to expect connection of high quality regardless of their locations and speeds. Another use case of an automotive field is an AR dashboard. The AR dashboard causes a driver to identify an object in the dark in addition to an object seen from a front window and displays a distance from the object and a movement of the object by overlapping information talking to the driver. In the future, a wireless module enables communication between vehicles, information exchange between a vehicle and supporting infrastructure, and information exchange between a vehicle and other connected devices (e.g., devices accompanied by a pedestrian). A safety system guides alternative courses of a behavior so that a driver may drive more safely drive, thereby lowering the danger of an accident. The next stage will be a remotely controlled or self-driven vehicle. This requires very high reliability and very fast communication between different self-driven vehicles and between a vehicle and infrastructure. In the future, a self-driven vehicle will perform all driving activities and a driver will focus only upon abnormal traffic that the vehicle cannot identify. Technical requirements of a self-driven vehicle demand ultra-low latency and ultra-high reliability so that traffic safety is increased to a level that cannot be achieved by human being.
- [54] A smart city and a smart home/building mentioned as a smart society will be embedded in a high-density wireless sensor network. A distributed network of an intelligent sensor will identify conditions for costs and energy-efficient maintenance of a city or a home. Similar configurations may be performed for respective households.

All of temperature sensors, window and heating controllers, burglar alarms, and home appliances are wirelessly connected. Many of these sensors are typically low in data transmission rate, power, and cost. However, real-time HD video may be demanded by a specific type of device to perform monitoring.

- [55] Consumption and distribution of energy including heat or gas is distributed at a higher level so that automated control of the distribution sensor network is demanded. The smart grid collects information and connects the sensors to each other using digital information and communication technology so as to act according to the collected information. Since this information may include behaviors of a supply company and a consumer, the smart grid may improve distribution of fuels such as electricity by a method having efficiency, reliability, economic feasibility, production sustainability, and automation. The smart grid may also be regarded as another sensor network having low latency.
- [56] Mission critical application (e.g., e-health) is one of 5G use scenarios. A health part contains many application programs capable of enjoying benefit of mobile communication. A communication system may support remote treatment that provides clinical treatment in a faraway place. Remote treatment may aid in reducing a barrier against distance and improve access to medical services that cannot be continuously available in a faraway rural area. Remote treatment is also used to perform important treatment and save lives in an emergency situation. The wireless sensor network based on mobile communication may provide remote monitoring and sensors for parameters such as heart rate and blood pressure.
- [57] Wireless and mobile communication gradually becomes important in the field of an industrial application. Wiring is high in installation and maintenance cost. Therefore, a possibility of replacing a cable with reconstructible wireless links is an attractive opportunity in many industrial fields. However, in order to achieve this replacement, it is necessary for wireless connection to be established with latency, reliability, and capacity similar to those of the cable and management of wireless connection needs to be simplified. Low latency and a very low error probability are new requirements when connection to 5G is needed.
- [58] Logistics and freight tracking are important use cases for mobile communication that enables inventory and package tracking anywhere using a location-based information system. The use cases of logistics and freight typically demand low data rate but require location information with a wide range and reliability.
- [59] Referring to FIG. 1, the communication system 1 includes wireless devices 100a to 100f, base stations (BSs) 200, and a network 300. Although FIG. 1 illustrates a 5G network as an example of the network of the communication system 1, the implementations of the present disclosure are not limited to the 5G system, and can be

applied to the future communication system beyond the 5G system.

[60] The BSs 200 and the network 300 may be implemented as wireless devices and a specific wireless device may operate as a BS/network node with respect to other wireless devices.

[61] The wireless devices 100a to 100f represent devices performing communication using radio access technology (RAT) (e.g., 5G new RAT (NR)) or LTE) and may be referred to as communication/radio/5G devices. The wireless devices 100a to 100f may include, without being limited to, a robot 100a, vehicles 100b-1 and 100b-2, an extended reality (XR) device 100c, a hand-held device 100d, a home appliance 100e, an IoT device 100f, and an artificial intelligence (AI) device/server 400. For example, the vehicles may include a vehicle having a wireless communication function, an autonomous driving vehicle, and a vehicle capable of performing communication between vehicles. The vehicles may include an unmanned aerial vehicle (UAV) (e.g., a drone). The XR device may include an AR/VR/Mixed Reality (MR) device and may be implemented in the form of a head-mounted device (HMD), a head-up display (HUD) mounted in a vehicle, a television, a smartphone, a computer, a wearable device, a home appliance device, a digital signage, a vehicle, a robot, etc. The hand-held device may include a smartphone, a smartpad, a wearable device (e.g., a smartwatch or a smartglasses), and a computer (e.g., a notebook). The home appliance may include a TV, a refrigerator, and a washing machine. The IoT device may include a sensor and a smartmeter.

[62] In the present disclosure, the wireless devices 100a to 100f may be called user equipments (UEs). A UE may include, for example, a cellular phone, a smartphone, a laptop computer, a digital broadcast terminal, a personal digital assistant (PDA), a portable multimedia player (PMP), a navigation system, a slate personal computer (PC), a tablet PC, an ultrabook, a vehicle, a vehicle having an autonomous traveling function, a connected car, an UAV, an AI module, a robot, an AR device, a VR device, an MR device, a hologram device, a public safety device, an MTC device, an IoT device, a medical device, a FinTech device (or a financial device), a security device, a weather/environment device, a device related to a 5G service, or a device related to a fourth industrial revolution field.

[63] The UAV may be, for example, an aircraft aviated by a wireless control signal without a human being onboard.

[64] The VR device may include, for example, a device for implementing an object or a background of the virtual world. The AR device may include, for example, a device implemented by connecting an object or a background of the virtual world to an object or a background of the real world. The MR device may include, for example, a device implemented by merging an object or a background of the virtual world into an object

or a background of the real world. The hologram device may include, for example, a device for implementing a stereoscopic image of 360 degrees by recording and reproducing stereoscopic information, using an interference phenomenon of light generated when two laser lights called holography meet.

- [65] The public safety device may include, for example, an image relay device or an image device that is wearable on the body of a user.
- [66] The MTC device and the IoT device may be, for example, devices that do not require direct human intervention or manipulation. For example, the MTC device and the IoT device may include smartmeters, vending machines, thermometers, smartbulbs, door locks, or various sensors.
- [67] The medical device may be, for example, a device used for the purpose of diagnosing, treating, relieving, curing, or preventing disease. For example, the medical device may be a device used for the purpose of diagnosing, treating, relieving, or correcting injury or impairment. For example, the medical device may be a device used for the purpose of inspecting, replacing, or modifying a structure or a function. For example, the medical device may be a device used for the purpose of adjusting pregnancy. For example, the medical device may include a device for treatment, a device for operation, a device for (in vitro) diagnosis, a hearing aid, or a device for procedure.
- [68] The security device may be, for example, a device installed to prevent a danger that may arise and to maintain safety. For example, the security device may be a camera, a closed-circuit TV (CCTV), a recorder, or a black box.
- [69] The FinTech device may be, for example, a device capable of providing a financial service such as mobile payment. For example, the FinTech device may include a payment device or a point of sales (POS) system.
- [70] The weather/environment device may include, for example, a device for monitoring or predicting a weather/environment.
- [71] The wireless devices 100a to 100f may be connected to the network 300 via the BSs 200. An AI technology may be applied to the wireless devices 100a to 100f and the wireless devices 100a to 100f may be connected to the AI server 400 via the network 300. The network 300 may be configured using a 3G network, a 4G (e.g., LTE) network, a 5G (e.g., NR) network, and a beyond-5G network. Although the wireless devices 100a to 100f may communicate with each other through the BSs 200/network 300, the wireless devices 100a to 100f may perform direct communication (e.g., sidelink communication) with each other without passing through the BSs 200/network 300. For example, the vehicles 100b-1 and 100b-2 may perform direct communication (e.g., vehicle-to-vehicle (V2V)/vehicle-to-everything (V2X) communication). The IoT device (e.g., a sensor) may perform direct communication with other IoT devices (e.g.,

sensors) or other wireless devices 100a to 100f.

[72] Wireless communication/connections 150a, 150b and 150c may be established between the wireless devices 100a to 100f and/or between wireless device 100a to 100f and BS 200 and/or between BSs 200. Herein, the wireless communication/connections may be established through various RATs (e.g., 5G NR) such as uplink/downlink communication 150a, sidelink communication (or device-to-device (D2D) communication) 150b, inter-base station communication 150c (e.g., relay, integrated access and backhaul (IAB)), etc. The wireless devices 100a to 100f and the BSs 200/the wireless devices 100a to 100f may transmit/receive radio signals to/from each other through the wireless communication/connections 150a, 150b and 150c. For example, the wireless communication/connections 150a, 150b and 150c may transmit/receive signals through various physical channels. To this end, at least a part of various configuration information configuring processes, various signal processing processes (e.g., channel encoding/decoding, modulation/demodulation, and resource mapping/de-mapping), and resource allocating processes, for transmitting/receiving radio signals, may be performed based on the various proposals of the present disclosure.

[73] Here, the radio communication technologies implemented in the wireless devices in the present disclosure may include narrowband internet-of-things (NB-IoT) technology for low-power communication as well as LTE, NR and 6G. For example, NB-IoT technology may be an example of low power wide area network (LPWAN) technology, may be implemented in specifications such as LTE Cat NB1 and/or LTE Cat NB2, and may not be limited to the above-mentioned names. Additionally and/or alternatively, the radio communication technologies implemented in the wireless devices in the present disclosure may communicate based on LTE-M technology. For example, LTE-M technology may be an example of LPWAN technology and be called by various names such as enhanced machine type communication (eMTC). For example, LTE-M technology may be implemented in at least one of the various specifications, such as 1) LTE Cat 0, 2) LTE Cat M1, 3) LTE Cat M2, 4) LTE non-bandwidth limited (non-BL), 5) LTE-MTC, 6) LTE Machine Type Communication, and/or 7) LTE M, and may not be limited to the above-mentioned names. Additionally and/or alternatively, the radio communication technologies implemented in the wireless devices in the present disclosure may include at least one of ZigBee, Bluetooth, and/or LPWAN which take into account low-power communication, and may not be limited to the above-mentioned names. For example, ZigBee technology may generate personal area networks (PANs) associated with small/low-power digital communication based on various specifications such as IEEE 802.15.4 and may be called various names.

[74] FIG. 2 shows an example of wireless devices to which implementations of the

present disclosure is applied.

- [75] Referring to FIG. 2, a first wireless device 100 and a second wireless device 200 may transmit/receive radio signals to/from an external device through a variety of RATs (e.g., LTE and NR). In FIG. 2, {the first wireless device 100 and the second wireless device 200} may correspond to at least one of {the wireless device 100a to 100f and the BS 200}, {the wireless device 100a to 100f and the wireless device 100a to 100f} and/or {the BS 200 and the BS 200} of FIG. 1.
- [76] The first wireless device 100 may include one or more processors 102 and one or more memories 104 and additionally further include one or more transceivers 106 and/or one or more antennas 108. The processor(s) 102 may control the memory(s) 104 and/or the transceiver(s) 106 and may be configured to implement the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts described in the present disclosure. For example, the processor(s) 102 may process information within the memory(s) 104 to generate first information/signals and then transmit radio signals including the first information/signals through the transceiver(s) 106. The processor(s) 102 may receive radio signals including second information/signals through the transceiver(s) 106 and then store information obtained by processing the second information/signals in the memory(s) 104. The memory(s) 104 may be connected to the processor(s) 102 and may store a variety of information related to operations of the processor(s) 102. For example, the memory(s) 104 may store software code including commands for performing a part or the entirety of processes controlled by the processor(s) 102 or for performing the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts described in the present disclosure. Herein, the processor(s) 102 and the memory(s) 104 may be a part of a communication modem/circuit/chip designed to implement RAT (e.g., LTE or NR). The transceiver(s) 106 may be connected to the processor(s) 102 and transmit and/or receive radio signals through one or more antennas 108. Each of the transceiver(s) 106 may include a transmitter and/or a receiver. The transceiver(s) 106 may be interchangeably used with radio frequency (RF) unit(s). In the present disclosure, the first wireless device 100 may represent a communication modem/circuit/chip.
- [77] The second wireless device 200 may include one or more processors 202 and one or more memories 204 and additionally further include one or more transceivers 206 and/or one or more antennas 208. The processor(s) 202 may control the memory(s) 204 and/or the transceiver(s) 206 and may be configured to implement the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts described in the present disclosure. For example, the processor(s) 202 may process information within the memory(s) 204 to generate third information/signals and then transmit radio signals including the third information/signals through the transceiver(s) 206. The

processor(s) 202 may receive radio signals including fourth information/signals through the transceiver(s) 106 and then store information obtained by processing the fourth information/signals in the memory(s) 204. The memory(s) 204 may be connected to the processor(s) 202 and may store a variety of information related to operations of the processor(s) 202. For example, the memory(s) 204 may store software code including commands for performing a part or the entirety of processes controlled by the processor(s) 202 or for performing the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts described in the present disclosure. Herein, the processor(s) 202 and the memory(s) 204 may be a part of a communication modem/circuit/chip designed to implement RAT (e.g., LTE or NR). The transceiver(s) 206 may be connected to the processor(s) 202 and transmit and/or receive radio signals through one or more antennas 208. Each of the transceiver(s) 206 may include a transmitter and/or a receiver. The transceiver(s) 206 may be interchangeably used with RF unit(s). In the present disclosure, the second wireless device 200 may represent a communication modem/circuit/chip.

[78] Hereinafter, hardware elements of the wireless devices 100 and 200 will be described more specifically. One or more protocol layers may be implemented by, without being limited to, one or more processors 102 and 202. For example, the one or more processors 102 and 202 may implement one or more layers (e.g., functional layers such as physical (PHY) layer, media access control (MAC) layer, radio link control (RLC) layer, packet data convergence protocol (PDCP) layer, radio resource control (RRC) layer, and service data adaptation protocol (SDAP) layer). The one or more processors 102 and 202 may generate one or more protocol data units (PDUs) and/or one or more service data unit (SDUs) according to the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. The one or more processors 102 and 202 may generate messages, control information, data, or information according to the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. The one or more processors 102 and 202 may generate signals (e.g., baseband signals) including PDUs, SDUs, messages, control information, data, or information according to the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure and provide the generated signals to the one or more transceivers 106 and 206. The one or more processors 102 and 202 may receive the signals (e.g., baseband signals) from the one or more transceivers 106 and 206 and acquire the PDUs, SDUs, messages, control information, data, or information according to the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure.

[79] The one or more processors 102 and 202 may be referred to as controllers, microcon-

trollers, microprocessors, or microcomputers. The one or more processors 102 and 202 may be implemented by hardware, firmware, software, or a combination thereof. As an example, one or more application specific integrated circuits (ASICs), one or more digital signal processors (DSPs), one or more digital signal processing devices (DSPDs), one or more programmable logic devices (PLDs), or one or more field programmable gate arrays (FPGAs) may be included in the one or more processors 102 and 202. descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure may be implemented using firmware or software and the firmware or software may be configured to include the modules, procedures, or functions. Firmware or software configured to perform the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure may be included in the one or more processors 102 and 202 or stored in the one or more memories 104 and 204 so as to be driven by the one or more processors 102 and 202. The descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure may be implemented using firmware or software in the form of code, commands, and/or a set of commands.

[80] The one or more memories 104 and 204 may be connected to the one or more processors 102 and 202 and store various types of data, signals, messages, information, programs, code, instructions, and/or commands. The one or more memories 104 and 204 may be configured by read-only memories (ROMs), random access memories (RAMs), electrically erasable programmable read-only memories (EPROMs), flash memories, hard drives, registers, cash memories, computer-readable storage media, and/or combinations thereof. The one or more memories 104 and 204 may be located at the interior and/or exterior of the one or more processors 102 and 202. The one or more memories 104 and 204 may be connected to the one or more processors 102 and 202 through various technologies such as wired or wireless connection.

[81] The one or more transceivers 106 and 206 may transmit user data, control information, and/or radio signals/channels, mentioned in the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure, to one or more other devices. The one or more transceivers 106 and 206 may receive user data, control information, and/or radio signals/channels, mentioned in the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure, from one or more other devices. For example, the one or more transceivers 106 and 206 may be connected to the one or more processors 102 and 202 and transmit and receive radio signals. For example, the one or more processors 102 and 202 may perform control so that the one or more transceivers 106 and 206 may transmit user data, control information, or radio signals to one or more other devices. The one or more processors 102 and 202 may

perform control so that the one or more transceivers 106 and 206 may receive user data, control information, or radio signals from one or more other devices.

[82] The one or more transceivers 106 and 206 may be connected to the one or more antennas 108 and 208 and the one or more transceivers 106 and 206 may be configured to transmit and receive user data, control information, and/or radio signals/channels, mentioned in the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure, through the one or more antennas 108 and 208. In the present disclosure, the one or more antennas may be a plurality of physical antennas or a plurality of logical antennas (e.g., antenna ports).

[83] The one or more transceivers 106 and 206 may convert received radio signals/channels, etc., from RF band signals into baseband signals in order to process received user data, control information, radio signals/channels, etc., using the one or more processors 102 and 202. The one or more transceivers 106 and 206 may convert the user data, control information, radio signals/channels, etc., processed using the one or more processors 102 and 202 from the base band signals into the RF band signals. To this end, the one or more transceivers 106 and 206 may include (analog) oscillators and/or filters. For example, the transceivers 106 and 206 can up-convert OFDM baseband signals to a carrier frequency by their (analog) oscillators and/or filters under the control of the processors 102 and 202 and transmit the up-converted OFDM signals at the carrier frequency. The transceivers 106 and 206 may receive OFDM signals at a carrier frequency and down-convert the OFDM signals into OFDM baseband signals by their (analog) oscillators and/or filters under the control of the transceivers 102 and 202.

[84] In the implementations of the present disclosure, a UE may operate as a transmitting device in uplink (UL) and as a receiving device in downlink (DL). In the implementations of the present disclosure, a BS may operate as a receiving device in UL and as a transmitting device in DL. Hereinafter, for convenience of description, it is mainly assumed that the first wireless device 100 acts as the UE, and the second wireless device 200 acts as the BS. For example, the processor(s) 102 connected to, mounted on or launched in the first wireless device 100 may be configured to perform the UE behavior according to an implementation of the present disclosure or control the transceiver(s) 106 to perform the UE behavior according to an implementation of the present disclosure. The processor(s) 202 connected to, mounted on or launched in the second wireless device 200 may be configured to perform the BS behavior according to an implementation of the present disclosure or control the transceiver(s) 206 to perform the BS behavior according to an implementation of the present disclosure.

[85] In the present disclosure, a BS is also referred to as a node B (NB), an eNode B (eNB), or a gNB.

- [86] FIG. 3 shows an example of a wireless device to which implementations of the present disclosure is applied.
- [87] The wireless device may be implemented in various forms according to a use-case/service (refer to FIG. 1).
- [88] Referring to FIG. 3, wireless devices 100 and 200 may correspond to the wireless devices 100 and 200 of FIG. 2 and may be configured by various elements, components, units/portions, and/or modules. For example, each of the wireless devices 100 and 200 may include a communication unit 110, a control unit 120, a memory unit 130, and additional components 140. The communication unit 110 may include a communication circuit 112 and transceiver(s) 114. For example, the communication circuit 112 may include the one or more processors 102 and 202 of FIG. 2 and/or the one or more memories 104 and 204 of FIG. 2. For example, the transceiver(s) 114 may include the one or more transceivers 106 and 206 of FIG. 2 and/or the one or more antennas 108 and 208 of FIG. 2. The control unit 120 is electrically connected to the communication unit 110, the memory 130, and the additional components 140 and controls overall operation of each of the wireless devices 100 and 200. For example, the control unit 120 may control an electric/mechanical operation of each of the wireless devices 100 and 200 based on programs/code/commands/information stored in the memory unit 130. The control unit 120 may transmit the information stored in the memory unit 130 to the exterior (e.g., other communication devices) via the communication unit 110 through a wireless/wired interface or store, in the memory unit 130, information received through the wireless/wired interface from the exterior (e.g., other communication devices) via the communication unit 110.
- [89] The additional components 140 may be variously configured according to types of the wireless devices 100 and 200. For example, the additional components 140 may include at least one of a power unit/battery, input/output (I/O) unit (e.g., audio I/O port, video I/O port), a driving unit, and a computing unit. The wireless devices 100 and 200 may be implemented in the form of, without being limited to, the robot (100a of FIG. 1), the vehicles (100b-1 and 100b-2 of FIG. 1), the XR device (100c of FIG. 1), the hand-held device (100d of FIG. 1), the home appliance (100e of FIG. 1), the IoT device (100f of FIG. 1), a digital broadcast terminal, a hologram device, a public safety device, an MTC device, a medicine device, a FinTech device (or a finance device), a security device, a climate/environment device, the AI server/device (400 of FIG. 1), the BSs (200 of FIG. 1), a network node, etc. The wireless devices 100 and 200 may be used in a mobile or fixed place according to a use-example/service.
- [90] In FIG. 3, the entirety of the various elements, components, units/portions, and/or modules in the wireless devices 100 and 200 may be connected to each other through a wired interface or at least a part thereof may be wirelessly connected through the com-

munication unit 110. For example, in each of the wireless devices 100 and 200, the control unit 120 and the communication unit 110 may be connected by wire and the control unit 120 and first units (e.g., 130 and 140) may be wirelessly connected through the communication unit 110. Each element, component, unit/portion, and/or module within the wireless devices 100 and 200 may further include one or more elements. For example, the control unit 120 may be configured by a set of one or more processors. As an example, the control unit 120 may be configured by a set of a communication control processor, an application processor (AP), an electronic control unit (ECU), a graphical processing unit, and a memory control processor. As another example, the memory 130 may be configured by a RAM, a DRAM, a ROM, a flash memory, a volatile memory, a non-volatile memory, and/or a combination thereof.

[91] FIG. 4 shows another example of wireless devices to which implementations of the present disclosure is applied.

[92] Referring to FIG. 4, wireless devices 100 and 200 may correspond to the wireless devices 100 and 200 of FIG. 2 and may be configured by various elements, components, units/portions, and/or modules.

[93] The first wireless device 100 may include at least one transceiver, such as a transceiver 106, and at least one processing chip, such as a processing chip 101. The processing chip 101 may include at least one processor, such a processor 102, and at least one memory, such as a memory 104. The memory 104 may be operably connectable to the processor 102. The memory 104 may store various types of information and/or instructions. The memory 104 may store a software code 105 which implements instructions that, when executed by the processor 102, perform the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. For example, the software code 105 may implement instructions that, when executed by the processor 102, perform the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. For example, the software code 105 may control the processor 102 to perform one or more protocols. For example, the software code 105 may control the processor 102 may perform one or more layers of the radio interface protocol.

[94] The second wireless device 200 may include at least one transceiver, such as a transceiver 206, and at least one processing chip, such as a processing chip 201. The processing chip 201 may include at least one processor, such a processor 202, and at least one memory, such as a memory 204. The memory 204 may be operably connectable to the processor 202. The memory 204 may store various types of information and/or instructions. The memory 204 may store a software code 205 which implements instructions that, when executed by the processor 202, perform the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in

the present disclosure. For example, the software code 205 may implement instructions that, when executed by the processor 202, perform the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. For example, the software code 205 may control the processor 202 to perform one or more protocols. For example, the software code 205 may control the processor 202 may perform one or more layers of the radio interface protocol.

[95] FIG. 5 shows an example of UE to which implementations of the present disclosure is applied.

[96] Referring to FIG. 5, a UE 100 may correspond to the first wireless device 100 of FIG. 2 and/or the first wireless device 100 of FIG. 4.

[97] A UE 100 includes a processor 102, a memory 104, a transceiver 106, one or more antennas 108, a power management module 110, a battery 112, a display 114, a keypad 116, a subscriber identification module (SIM) card 118, a speaker 120, and a microphone 122.

[98] The processor 102 may be configured to implement the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. The processor 102 may be configured to control one or more other components of the UE 100 to implement the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. Layers of the radio interface protocol may be implemented in the processor 102. The processor 102 may include ASIC, other chipset, logic circuit and/or data processing device. The processor 102 may be an application processor. The processor 102 may include at least one of a digital signal processor (DSP), a central processing unit (CPU), a graphics processing unit (GPU), a modem (modulator and demodulator). An example of the processor 102 may be found in SNAPDRAGON™ series of processors made by Qualcomm®, EXYNOS™ series of processors made by Samsung®, A series of processors made by Apple®, HELIO™ series of processors made by MediaTek®, ATOM™ series of processors made by Intel® or a corresponding next generation processor.

[99] The memory 104 is operatively coupled with the processor 102 and stores a variety of information to operate the processor 102. The memory 104 may include ROM, RAM, flash memory, memory card, storage medium and/or other storage device. When the embodiments are implemented in software, the techniques described herein can be implemented with modules (e.g., procedures, functions, etc.) that perform the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. The modules can be stored in the memory 104 and executed by the processor 102. The memory 104 can be implemented within the processor 102 or external to the processor 102 in which case those can be

communicatively coupled to the processor 102 via various means as is known in the art.

- [100] The transceiver 106 is operatively coupled with the processor 102, and transmits and/or receives a radio signal. The transceiver 106 includes a transmitter and a receiver. The transceiver 106 may include baseband circuitry to process radio frequency signals. The transceiver 106 controls the one or more antennas 108 to transmit and/or receive a radio signal.
- [101] The power management module 110 manages power for the processor 102 and/or the transceiver 106. The battery 112 supplies power to the power management module 110.
- [102] The display 114 outputs results processed by the processor 102. The keypad 116 receives inputs to be used by the processor 102. The keypad 16 may be shown on the display 114.
- [103] The SIM card 118 is an integrated circuit that is intended to securely store the international mobile subscriber identity (IMSI) number and its related key, which are used to identify and authenticate subscribers on mobile telephony devices (such as mobile phones and computers). It is also possible to store contact information on many SIM cards.
- [104] The speaker 120 outputs sound-related results processed by the processor 102. The microphone 122 receives sound-related inputs to be used by the processor 102.
- [105] FIGS. 6 and 7 show an example of protocol stacks in a 3GPP based wireless communication system to which implementations of the present disclosure is applied.
- [106] In particular, FIG. 6 illustrates an example of a radio interface user plane protocol stack between a UE and a BS and FIG. 7 illustrates an example of a radio interface control plane protocol stack between a UE and a BS. The control plane refers to a path through which control messages used to manage call by a UE and a network are transported. The user plane refers to a path through which data generated in an application layer, for example, voice data or Internet packet data are transported. Referring to FIG. 6, the user plane protocol stack may be divided into Layer 1 (i.e., a PHY layer) and Layer 2. Referring to FIG. 7, the control plane protocol stack may be divided into Layer 1 (i.e., a PHY layer), Layer 2, Layer 3 (e.g., an RRC layer), and a non-access stratum (NAS) layer. Layer 1, Layer 2 and Layer 3 are referred to as an access stratum (AS).
- [107] In the 3GPP LTE system, the Layer 2 is split into the following sublayers: MAC, RLC, and PDCP. In the 3GPP NR system, the Layer 2 is split into the following sublayers: MAC, RLC, PDCP and SDAP. The PHY layer offers to the MAC sublayer transport channels, the MAC sublayer offers to the RLC sublayer logical channels, the RLC sublayer offers to the PDCP sublayer RLC channels, the PDCP sublayer offers to

the SDAP sublayer radio bearers. The SDAP sublayer offers to 5G core network quality of service (QoS) flows.

- [108] In the 3GPP NR system, the main services and functions of the MAC sublayer include: mapping between logical channels and transport channels; multiplexing/de-multiplexing of MAC SDUs belonging to one or different logical channels into/from transport blocks (TB) delivered to/from the physical layer on transport channels; scheduling information reporting; error correction through hybrid automatic repeat request (HARQ) (one HARQ entity per cell in case of carrier aggregation (CA)); priority handling between UEs by means of dynamic scheduling; priority handling between logical channels of one UE by means of logical channel prioritization; padding. A single MAC entity may support multiple numerologies, transmission timings and cells. Mapping restrictions in logical channel prioritization control which numerology(ies), cell(s), and transmission timing(s) a logical channel can use.
- [109] Different kinds of data transfer services are offered by MAC. To accommodate different kinds of data transfer services, multiple types of logical channels are defined, i.e., each supporting transfer of a particular type of information. Each logical channel type is defined by what type of information is transferred. Logical channels are classified into two groups: control channels and traffic channels. Control channels are used for the transfer of control plane information only, and traffic channels are used for the transfer of user plane information only. Broadcast control channel (BCCH) is a downlink logical channel for broadcasting system control information, paging control channel (PCCH) is a downlink logical channel that transfers paging information, system information change notifications and indications of ongoing public warning service (PWS) broadcasts, common control channel (CCCH) is a logical channel for transmitting control information between UEs and network and used for UEs having no RRC connection with the network, and dedicated control channel (DCCH) is a point-to-point bi-directional logical channel that transmits dedicated control information between a UE and the network and used by UEs having an RRC connection. Dedicated traffic channel (DTCH) is a point-to-point logical channel, dedicated to one UE, for the transfer of user information. A DTCH can exist in both uplink and downlink. In downlink, the following connections between logical channels and transport channels exist: BCCH can be mapped to broadcast channel (BCH); BCCH can be mapped to downlink shared channel (DL-SCH); PCCH can be mapped to paging channel (PCH); CCCH can be mapped to DL-SCH; DCCH can be mapped to DL-SCH; and DTCH can be mapped to DL-SCH. In uplink, the following connections between logical channels and transport channels exist: CCCH can be mapped to uplink shared channel (UL-SCH); DCCH can be mapped to UL-SCH; and DTCH can be mapped to UL-SCH.

- [110] The RLC sublayer supports three transmission modes: transparent mode (TM), unacknowledged mode (UM), and acknowledged mode (AM). The RLC configuration is per logical channel with no dependency on numerologies and/or transmission durations. In the 3GPP NR system, the main services and functions of the RLC sublayer depend on the transmission mode and include: transfer of upper layer PDUs; sequence numbering independent of the one in PDCP (UM and AM); error correction through ARQ (AM only); segmentation (AM and UM) and re-segmentation (AM only) of RLC SDUs; re-assembly of SDU (AM and UM); duplicate detection (AM only); RLC SDU discard (AM and UM); RLC re-establishment; protocol error detection (AM only).
- [111] In the 3GPP NR system, the main services and functions of the PDCP sublayer for the user plane include: sequence numbering; header compression and decompression using robust header compression (ROHC); transfer of user data; reordering and duplicate detection; in-order delivery; PDCP PDU routing (in case of split bearers); re-transmission of PDCP SDUs; ciphering, deciphering and integrity protection; PDCP SDU discard; PDCP re-establishment and data recovery for RLC AM; PDCP status reporting for RLC AM; duplication of PDCP PDUs and duplicate discard indication to lower layers. The main services and functions of the PDCP sublayer for the control plane include: sequence numbering; ciphering, deciphering and integrity protection; transfer of control plane data; reordering and duplicate detection; in-order delivery; duplication of PDCP PDUs and duplicate discard indication to lower layers.
- [112] In the 3GPP NR system, the main services and functions of SDAP include: mapping between a QoS flow and a data radio bearer; marking QoS flow ID (QFI) in both DL and UL packets. A single protocol entity of SDAP is configured for each individual PDU session.
- [113] In the 3GPP NR system, the main services and functions of the RRC sublayer include: broadcast of system information related to AS and NAS; paging initiated by 5GC or NG-RAN; establishment, maintenance and release of an RRC connection between the UE and NG-RAN; security functions including key management; establishment, configuration, maintenance and release of signaling radio bearers (SRBs) and data radio bearers (DRBs); mobility functions (including: handover and context transfer, UE cell selection and reselection and control of cell selection and reselection, inter-RAT mobility); QoS management functions; UE measurement reporting and control of the reporting; detection of and recovery from radio link failure; NAS message transfer to/from NAS from/to UE.
- [114] FIG. 8 shows a frame structure in a 3GPP based wireless communication system to which implementations of the present disclosure is applied.
- [115] The frame structure shown in FIG. 8 is purely exemplary and the number of subframes, the number of slots, and/or the number of symbols in a frame may be

variously changed. In the 3GPP based wireless communication system, OFDM numerologies (e.g., subcarrier spacing (SCS), transmission time interval (TTI) duration) may be differently configured between a plurality of cells aggregated for one UE. For example, if a UE is configured with different SCSs for cells aggregated for the cell, an (absolute time) duration of a time resource (e.g., a subframe, a slot, or a TTI) including the same number of symbols may be different among the aggregated cells. Herein, symbols may include OFDM symbols (or CP-OFDM symbols), SC-FDMA symbols (or discrete Fourier transform-spread-OFDM (DFT-s-OFDM) symbols).

[116] Referring to FIG. 8, downlink and uplink transmissions are organized into frames. Each frame has $T_f = 10\text{ms}$ duration. Each frame is divided into two half-frames, where each of the half-frames has 5ms duration. Each half-frame consists of 5 subframes, where the duration T_{sf} per subframe is 1ms. Each subframe is divided into slots and the number of slots in a subframe depends on a subcarrier spacing. Each slot includes 14 or 12 OFDM symbols based on a cyclic prefix (CP). In a normal CP, each slot includes 14 OFDM symbols and, in an extended CP, each slot includes 12 OFDM symbols. The numerology is based on exponentially scalable subcarrier spacing $\beta f = 2^u * 15 \text{ kHz}$.

[117] Table 1 shows the number of OFDM symbols per slot $N_{\text{slot}}^{\text{symb}}$, the number of slots per frame $N_{\text{slot}}^{\text{frame},u}$, and the number of slots per subframe $N_{\text{slot}}^{\text{subframe},u}$ for the normal CP, according to the subcarrier spacing $\beta f = 2^u * 15 \text{ kHz}$.

[118] [Table 1]

u	$N_{\text{slot}}^{\text{symb}}$	$N_{\text{slot}}^{\text{frame},u}$	$N_{\text{slot}}^{\text{subframe},u}$
0	14	10	1
1	14	20	2
2	14	40	4
3	14	80	8
4	14	160	16

[119] Table 2 shows the number of OFDM symbols per slot $N_{\text{slot}}^{\text{symb}}$, the number of slots per frame $N_{\text{slot}}^{\text{frame},u}$, and the number of slots per subframe $N_{\text{slot}}^{\text{subframe},u}$ for the extended CP, according to the subcarrier spacing $\beta f = 2^u * 15 \text{ kHz}$.

[120] [Table 2]

u	$N_{\text{slot}}^{\text{symb}}$	$N_{\text{slot}}^{\text{frame},u}$	$N_{\text{slot}}^{\text{subframe},u}$
2	12	40	4

[121] A slot includes plural symbols (e.g., 14 or 12 symbols) in the time domain. For each numerology (e.g., subcarrier spacing) and carrier, a resource grid of $N_{\text{grid},x}^{\text{size},u} * N_{\text{sc}}^{\text{RB}}$ subcarriers and $N_{\text{symb}}^{\text{subframe},u}$ OFDM symbols is defined, starting at common resource

block (CRB) $N_{\text{grid}}^{\text{start},u}$ indicated by higher-layer signaling (e.g., RRC signaling), where $N_{\text{grid},x}^{\text{size},u}$ is the number of resource blocks (RBs) in the resource grid and the subscript x is DL for downlink and UL for uplink. $N_{\text{sc}}^{\text{RB}}$ is the number of subcarriers per RB. In the 3GPP based wireless communication system, $N_{\text{sc}}^{\text{RB}}$ is 12 generally. There is one resource grid for a given antenna port p , subcarrier spacing configuration u , and transmission direction (DL or UL). The carrier bandwidth $N_{\text{grid}}^{\text{size},u}$ for subcarrier spacing configuration u is given by the higher-layer parameter (e.g., RRC parameter). Each element in the resource grid for the antenna port p and the subcarrier spacing configuration u is referred to as a resource element (RE) and one complex symbol may be mapped to each RE. Each RE in the resource grid is uniquely identified by an index k in the frequency domain and an index l representing a symbol location relative to a reference point in the time domain. In the 3GPP based wireless communication system, an RB is defined by 12 consecutive subcarriers in the frequency domain.

- [122] In the 3GPP NR system, RBs are classified into CRBs and physical resource blocks (PRBs). CRBs are numbered from 0 and upwards in the frequency domain for subcarrier spacing configuration u . The center of subcarrier 0 of CRB 0 for subcarrier spacing configuration u coincides with 'point A' which serves as a common reference point for resource block grids. In the 3GPP NR system, PRBs are defined within a bandwidth part (BWP) and numbered from 0 to $N_{\text{BWP},i}^{\text{size}}-1$, where i is the number of the bandwidth part. The relation between the physical resource block n_{PRB} in the bandwidth part i and the common resource block n_{CRB} is as follows: $n_{\text{PRB}} = n_{\text{CRB}} + N_{\text{BWP},i}^{\text{size}}$, where $N_{\text{BWP},i}^{\text{size}}$ is the common resource block where bandwidth part starts relative to CRB 0. The BWP includes a plurality of consecutive RBs. A carrier may include a maximum of N (e.g., 5) BWPs. A UE may be configured with one or more BWPs on a given component carrier. Only one BWP among BWPs configured to the UE can active at a time. The active BWP defines the UE's operating bandwidth within the cell's operating bandwidth.

- [123] The NR frequency band may be defined as two types of frequency range, i.e., FR1 and FR2. The numerical value of the frequency range may be changed. For example, the frequency ranges of the two types (FR1 and FR2) may be as shown in Table 3 below. For ease of explanation, in the frequency ranges used in the NR system, FR1 may mean "sub 6 GHz range", FR2 may mean "above 6 GHz range," and may be referred to as millimeter wave (mmW).

- [124] [Table 3]

Frequency Range designation	Corresponding frequency range	Subcarrier Spacing
FR1	450MHz - 6000MHz	15, 30, 60kHz
FR2	24250MHz - 52600MHz	60, 120, 240kHz

[125] As mentioned above, the numerical value of the frequency range of the NR system may be changed. For example, FR1 may include a frequency band of 410MHz to 7125MHz as shown in Table 4 below. That is, FR1 may include a frequency band of 6GHz (or 5850, 5900, 5925 MHz, etc.) or more. For example, a frequency band of 6 GHz (or 5850, 5900, 5925 MHz, etc.) or more included in FR1 may include an unlicensed band. Unlicensed bands may be used for a variety of purposes, for example for communication for vehicles (e.g., autonomous driving).

[126] [Table 4]

Frequency Range designation	Corresponding frequency range	Subcarrier Spacing
FR1	410MHz – 7125MHz	15, 30, 60kHz
FR2	24250MHz – 52600MHz	60, 120, 240kHz

[127] In the present disclosure, the term "cell" may refer to a geographic area to which one or more nodes provide a communication system, or refer to radio resources. A "cell" as a geographic area may be understood as coverage within which a node can provide service using a carrier and a "cell" as radio resources (e.g., time-frequency resources) is associated with bandwidth which is a frequency range configured by the carrier. The "cell" associated with the radio resources is defined by a combination of downlink resources and uplink resources, for example, a combination of a DL component carrier (CC) and a UL CC. The cell may be configured by downlink resources only, or may be configured by downlink resources and uplink resources. Since DL coverage, which is a range within which the node is capable of transmitting a valid signal, and UL coverage, which is a range within which the node is capable of receiving the valid signal from the UE, depends upon a carrier carrying the signal, the coverage of the node may be associated with coverage of the "cell" of radio resources used by the node. Accordingly, the term "cell" may be used to represent service coverage of the node sometimes, radio resources at other times, or a range that signals using the radio resources can reach with valid strength at other times.

[128] In CA, two or more CCs are aggregated. A UE may simultaneously receive or transmit on one or multiple CCs depending on its capabilities. CA is supported for both contiguous and non-contiguous CCs. When CA is configured, the UE only has one RRC connection with the network. At RRC connection establishment/re-establishment/handover, one serving cell provides the NAS mobility information, and at RRC connection re-establishment/handover, one serving cell provides the security input. This cell is referred to as the primary cell (PCell). The PCell is a cell, operating on the primary frequency, in which the UE either performs the initial connection establishment procedure or initiates the connection re-establishment procedure. Depending on UE capabilities, secondary cells (SCells) can be configured

to form together with the PCell a set of serving cells. An SCell is a cell providing additional radio resources on top of special cell (SpCell). The configured set of serving cells for a UE therefore always consists of one PCell and one or more SCells. For dual connectivity (DC) operation, the term SpCell refers to the PCell of the master cell group (MCG) or the primary SCell (PSCell) of the secondary cell group (SCG). An SpCell supports PUCCH transmission and contention-based random access, and is always activated. The MCG is a group of serving cells associated with a master node, comprised of the SpCell (PCell) and optionally one or more SCells. The SCG is the subset of serving cells associated with a secondary node, comprised of the PSCell and zero or more SCells, for a UE configured with DC. For a UE in RRC_CONNECTED not configured with CA/DC, there is only one serving cell comprised of the PCell. For a UE in RRC_CONNECTED configured with CA/DC, the term "serving cells" is used to denote the set of cells comprised of the SpCell(s) and all SCells. In DC, two MAC entities are configured in a UE: one for the MCG and one for the SCG.

- [129] FIG. 9 shows a data flow example in the 3GPP NR system to which implementations of the present disclosure is applied.
- [130] Referring to FIG. 9, "RB" denotes a radio bearer, and "H" denotes a header. Radio bearers are categorized into two groups: DRBs for user plane data and SRBs for control plane data. The MAC PDU is transmitted/received using radio resources through the PHY layer to/from an external device. The MAC PDU arrives to the PHY layer in the form of a transport block.
- [131] In the PHY layer, the uplink transport channels UL-SCH and RACH are mapped to their physical channels PUSCH and PRACH, respectively, and the downlink transport channels DL-SCH, BCH and PCH are mapped to PDSCH, PBCH and PDSCH, respectively. In the PHY layer, uplink control information (UCI) is mapped to PUCCH, and downlink control information (DCI) is mapped to PDCCH. A MAC PDU related to UL-SCH is transmitted by a UE via a PUSCH based on an UL grant, and a MAC PDU related to DL-SCH is transmitted by a BS via a PDSCH based on a DL assignment.
- [132] Hereinafter, technical features related to Conditional Reconfiguration are described. Section 5.3.5.13 of 3GPP TS 38.331 v16.6.0 may be referred.
- [133] The network configures the UE with one or more candidate target SpCells in the conditional reconfiguration. The UE evaluates the condition of each configured candidate target SpCell. The UE applies the conditional reconfiguration associated with one of the target SpCells which fulfills associated execution condition. The network provides the configuration parameters for the target SpCell in the *ConditionalReconfiguration* IE.
- [134] The UE performs the following actions based on a received *ConditionalRecon-*

figuration IE:

- [135] 1> if the *ConditionalReconfiguration* contains the *condReconfigToRemoveList*:
- [136] 2> perform conditional reconfiguration removal procedure;
- [137] 1> if the *ConditionalReconfiguration* contains the *condReconfigToAddModList*:
- [138] 2> perform conditional reconfiguration addition/modification;
- [139] Conditional reconfiguration removal is described.
- [140] The UE shall:
- [141] 1> for each *condReconfigId* value included in the *condReconfigToRemoveList* that is part of the current UE conditional reconfiguration in *VarConditionalReconfig*:
- [142] 2> remove the entry with the matching *condReconfigId* from the *VarConditionalReconfig*;
- [143] The UE does not consider the message as erroneous if the *condReconfigToRemoveList* includes any *condReconfigId* value that is not part of the current UE configuration.
- [144] Conditional reconfiguration addition/modification is described.
- [145] For each *condReconfigId* received in the *condReconfigToAddModList* IE the UE shall:
- [146] 1> if an entry with the matching *condReconfigId* exists in the *condReconfigToAddModList* within the *VarConditionalReconfig*:
- [147] 2> if the entry in *condReconfigToAddModList* includes an *condExecutionCond*;
- [148] 3> replace *condExecutionCond* within the *VarConditionalReconfig* with the value received for this *condReconfigId*;
- [149] 2> if the entry in *condReconfigToAddModList* includes an *condRRCReconfig*;
- [150] 3> replace *condRRCReconfig* within the *VarConditionalReconfig* with the value received for this *condReconfigId*;
- [151] 1> else:
- [152] 2> add a new entry for this *condReconfigId* within the *VarConditionalReconfig*;
- [153] 1> perform conditional reconfiguration evaluation;
- [154] Conditional reconfiguration evaluation is described.
- [155] The UE shall:
- [156] 1> for each *condReconfigId* within the *VarConditionalReconfig*:
- [157] 2> consider the cell which has a physical cell identity matching the value indicated in the *ServingCellConfigCommon* included in the *reconfigurationWithSync* in the received *condRRCReconfig* to be applicable cell;
- [158] 2> for each *measId* included in the *measIdList* within *VarMeasConfig* indicated in the *condExecutionCond* associated to *condReconfigId*:
- [159] 3> if the entry condition(s) applicable for this event associated with the *condReconfigId*, i.e. the event corresponding with the *condEventId*(s) of the corresponding

condTriggerConfig within *VarConditionalReconfig*, is fulfilled for the applicable cells for all measurements after layer 3 filtering taken during the corresponding *time-ToTrigger* defined for this event within the *VarConditionalReconfig*:

- [160] 4> consider the event associated to that *measId* to be fulfilled;
- [161] 3> if the *measId* for this event associated with the *condReconfigId* has been modified; or
- [162] 3> if the leaving condition(s) applicable for this event associated with the *condReconfigId*, i.e. the event corresponding with the *condEventId(s)* of the corresponding *condTriggerConfig* within *VarConditionalReconfig*, is fulfilled for the applicable cells for all measurements after layer 3 filtering taken during the corresponding *time-ToTrigger* defined for this event within the *VarConditionalReconfig*:
- [163] 4> consider the event associated to that *measId* to be not fulfilled;
- [164] 2> if event(s) associated to all *measId(s)* within *condTriggerConfig* for a target candidate cell within the stored *condRRCReconfig* are fulfilled:
- [165] 3> consider the target candidate cell within the stored *condRRCReconfig*, associated to that *condReconfigId*, as a triggered cell;
- [166] 3> initiate the conditional reconfiguration execution;
- [167] Up to 2 *MeasId* can be configured for each *condReconfigId*. The conditional reconfiguration event of the 2 *MeasId* may have the same or different event conditions, triggering quantity, time to trigger, and triggering threshold.
- [168] Conditional reconfiguration execution is described.
- [169] The UE shall:
- [170] 1> if more than one triggered cell exists:
- [171] 2> select one of the triggered cells as the selected cell for conditional reconfiguration execution;
- [172] 1> for the selected cell of conditional reconfiguration execution:
- [173] 2> apply the stored *condRRCReconfig* of the selected cell;
- [174] If multiple NR cells are triggered in conditional reconfiguration execution, it is up to UE implementation which one to select, e.g. the UE considers beams and beam quality to select one of the triggered cells for execution.
- [175] Hereinafter, technical features related to Non-terrestrial networks are described. Sections 3, 4, and Annex A of 3GPP TS 38.821 v16.0.0 may be referred.
- [176] Terms related to the NTN are described.
- [177] Availability: % of time during which the RAN is available for the targeted communication. Unavailable communication for shorter period than [Y] ms shall not be counted. The RAN may contain several access network components among which an NTN to achieve multi-connectivity or link aggregation.
- [178] Feeder link: Wireless link between NTN Gateway and satellite

- [179] Geostationary Earth orbit: Circular orbit at 35,786 km above the Earth's equator and following the direction of the Earth's rotation. An object in such an orbit has an orbital period equal to the Earth's rotational period and thus appears motionless, at a fixed position in the sky, to ground observers.
- [180] Low Earth Orbit: Orbit around the Earth with an altitude between 300 km, and 1500 km.
- [181] Medium Earth Orbit: region of space around the Earth above low Earth orbit and below geostationary Earth Orbit.
- [182] Minimum Elevation angle: minimum angle under which the satellite or UAS platform can be seen by a terminal.
- [183] Mobile Services: a radio-communication service between mobile and land stations, or between mobile stations
- [184] Mobile Satellite Services: A radio-communication service between mobile earth stations and one or more space stations, or between space stations used by this service; or between mobile earth stations by means of one or more space stations
- [185] Non-Geostationary Satellites: Satellites (LEO and MEO) orbiting around the Earth with a period that varies approximately between 1.5 hour and 10 hours. It is necessary to have a constellation of several Non-Geostationary satellites associated with handover mechanisms to ensure a service continuity.
- [186] Non-terrestrial networks: Networks, or segments of networks, using an airborne or space-borne vehicle to embark a transmission equipment relay node or base station.
- [187] NTN-gateway: an earth station or gateway is located at the surface of Earth, and providing sufficient RF power and RF sensitivity for accessing to the satellite (resp. HAPS). NTN Gateway is a transport network layer (TNL) node.
- [188] On Board processing: digital processing carried out on uplink RF signals aboard a satellite or an aerial.
- [189] On board NTN gNB: gNB implemented in the regenerative payload on board a satellite (respectively HAPS).
- [190] On ground NTN gNB: gNB of a transparent satellite (respectively HAPS) payload implemented on ground.
- [191] One-way latency: time required to propagate through a telecommunication system from a terminal to the public data network or from the public data network to the terminal. This is especially used for voice and video conference applications.
- [192] Regenerative payload: payload that transforms and amplifies an uplink RF signal before transmitting it on the downlink. The transformation of the signal refers to digital processing that may include demodulation, decoding, re-encoding, re-modulation and/or filtering.
- [193] Round Trip Delay: time required for a signal to travel from a terminal to the sat-

gateway or from the sat-gateway to the terminal and back. This is especially used for web-based applications.

- [194] Satellite: a space-borne vehicle embarking a bent pipe payload or a regenerative payload telecommunication transmitter, placed into Low-Earth Orbit (LEO), Medium-Earth Orbit (MEO), or Geostationary Earth Orbit (GEO).
- [195] Satellite beam: A beam generated by an antenna on-board a satellite
- [196] Service link: Radio link between satellite and UE
- [197] Transparent payload: payload that changes the frequency carrier of the uplink RF signal, filters and amplifies it before transmitting it on the downlink
- [198] Unmanned Aircraft Systems: Systems encompassing Tethered UAS (TUA), Lighter Than Air UAS (LTA), Heavier Than Air UAS (HTA), all operating in altitudes typically between 8 and 50 km including High Altitude Platforms (HAPs)
- [199] User Connectivity: capability to establish and maintain data / voice / video transfer between networks and Terminals
- [200] User Throughput: data rate provided to a terminal
- [201] Non-Terrestrial Networks overview
- [202] A non-terrestrial network refers to a network, or segment of networks using RF resources on board a satellite (or UAS platform).
- [203] The typical scenario of a non-terrestrial network providing access to user equipment is depicted in FIGS. 10 and 11 shows.
- [204] FIG. 10 shows Non-terrestrial network typical scenario based on transparent payload to which implementations of the present disclosure is applied.
- [205] FIG. 11 shows Non-terrestrial network typical scenario based on regenerative payload to which implementations of the present disclosure is applied.
- [206] Non-Terrestrial Network typically features the following elements:
- [207] - One or several sat-gateways that connect the Non-Terrestrial Network to a public data network
- [208] - a GEO satellite is fed by one or several sat-gateways which are deployed across the satellite targeted coverage (e.g. regional or even continental coverage). We assume that UE in a cell are served by only one sat-gateway
- [209] - A Non-GEO satellite served successively by one or several sat-gateways at a time. The system ensures service and feeder link continuity between the successive serving sat-gateways with sufficient time duration to proceed with mobility anchoring and hand-over
- [210] - A Feeder link or radio link between a sat-gateway and the satellite (or UAS platform)
- [211] - A service link or radio link between the user equipment and the satellite (or UAS platform).

- [212] - A satellite (or UAS platform) which may implement either a transparent or a re-generative (with on board processing) payload. The satellite (or UAS platform) generate beams typically generate several beams over a given service area bounded by its field of view. The footprints of the beams are typically of elliptic shape. The field of view of a satellites (or UAS platforms) depends on the on board antenna diagram and min elevation angle.
- [213] - A transparent payload: Radio Frequency filtering, Frequency conversion and amplification. Hence, the waveform signal repeated by the payload is un-changed;
- [214] - A regenerative payload: Radio Frequency filtering, Frequency conversion and amplification as well as demodulation/decoding, switch and/or routing, coding/modulation. This is effectively equivalent to having all or part of base station functions (e.g. gNB) on board the satellite (or UAS platform).
- [215] - Inter-satellite links (ISL) optionally in case of a constellation of satellites. This will require regenerative payloads on board the satellites. ISL may operate in RF frequency or optical bands.
- [216] - User Equipment are served by the satellite (or UAS platform) within the targeted service area.
- [217] There may be different types of satellites (or UAS platforms). Table 5 shows types of NTN platforms.
- [218] [Table 5]

Platforms	Altitude range	Orbit	Typical beam footprint size
Low-Earth Orbit (LEO) satellite	300 – 1500 km	Circular around the earth	100 – 1000 km
Medium-Earth Orbit (MEO) satellite	7000 – 25000 km		100 – 1000 km
Geostationary Earth Orbit (GEO) satellite	35 786 km	notional station keeping position fixed in terms of elevation/azimuth with respect to a given earth point	200 – 3500 km
UAS platform (including HAPS)	8 – 50 km (20 km for HAPS)		5 - 200 km
High Elliptical Orbit (HEO) satellite	400 – 50000 km	Elliptical around the earth	200 – 3500 km

- [219] Typically,
- [220] - GEO satellite and UAS are used to provide continental, regional or local service.
- [221] - a constellation of LEO and MEO is used to provide services in both Northern and Southern hemispheres. In some case, the constellation can even provide global coverage including polar regions. For the later, this requires appropriate orbit inclination, sufficient beams generated and inter-satellite links.
- [222] Non-Terrestrial Networks reference scenarios
- [223] Non-terrestrial networks provides access to user equipment in six reference scenarios

including

- [224] - Circular orbiting and notional station keeping platforms.
- [225] - Highest RTD constraint
- [226] - Highest Doppler constraint
- [227] - A transparent and a regenerative payload
- [228] - One ISL case and one without ISL. Regenerative payload is mandatory in the case of inter-satellite links.
- [229] - Fixed or steerable beams resulting respectively in moving or fixed beam foot print on the ground
- [230] Six scenarios are considered as depicted in table 6 and are detailed in tables 7 and 8.
- [231] Table 6 shows reference scenarios.
- [232] [Table 6]

	Transparent satellite	Regenerative satellite
GEO based non-terrestrial access network	Scenario A	Scenario B
LEO based non-terrestrial access network: steerable beams	Scenario C1	Scenario D1
LEO based non-terrestrial access network: the beams move with the satellite	Scenario C2	Scenario D2

- [233] Tables 7 and 8 shows reference scenario parameters.

[234] [Table 7]

Scenarios	GEO based non-terrestrial access network (Scenario A and B)	LEO based non-terrestrial access network (Scenario C & D)
Orbit type	notional station keeping position fixed in terms of elevation/azimuth with respect to a given earth point	circular orbiting around the earth
Altitude	35,786 km	600 km 1,200 km
Spectrum (service link)	<6 GHz (e.g. 2 GHz) >6 GHz (e.g. DL 20 GHz, UL 30 GHz)	
Max channel bandwidth capability (service link)	30 MHz for band < 6 GHz 1 GHz for band > 6 GHz	
Payload	Scenario A: Transparent (including radio frequency function only) Scenario B: regenerative (including all or part of RAN functions)	Scenario C: Transparent (including radio frequency function only) Scenario D: Regenerative (including all or part of RAN functions)
Inter-Satellite link	No	Scenario C: No Scenario D: Yes/No (Both cases are possible.)
Earth-fixed beams	Yes	Scenario C1: Yes (steerable beams), see note 1 Scenario C2: No (the beams move with the satellite) Scenario D 1: Yes (steerable beams), see note 1 Scenario D 2: No (the beams move with the satellite)
Max beam foot print size (edge to edge) regardless of the elevation angle	3500 km (Note 5)	1000 km
Min Elevation angle for both sat-gateway and user equipment	10° for service link and 10° for feeder link	10° for service link and 10° for feeder link
Max distance between satellite and user equipment at min elevation angle	40,581 km	1,932 km (600 km altitude) 3,131 km (1,200 km altitude)

[235] [Table 8]

Max Round Trip Delay (propagation delay only)	Scenario A: 541.46 ms (service and feeder links) Scenario B: 270.73 ms (service link only)	Scenario C: (transparent payload: service and feeder links) 25.77 ms (600km) 41.77 ms (1200km) Scenario D: (regenerative payload: service link only) 12.89 ms (600km) 20.89 ms (1200km)
Max differential delay within a cell (Note 6)	10.3 ms	3.12 ms and 3.18 ms for respectively 600km and 1200km
Max Doppler shift (earth fixed user equipment)	0.93 ppm	24 ppm (600km) 21ppm(1200km)
Max Doppler shift variation (earth fixed user equipment)	0.000 045 ppm/s	0.27ppm/s (600km) 0.13ppm/s(1200km)
User equipment motion on the earth	1200 km/h (e.g. aircraft)	500 km/h (e.g. high speed train) Possibly 1200 km/h (e.g. aircraft)
User equipment antenna types	Omnidirectional antenna (linear polarisation), assuming 0 dBi Directive antenna (up to 60 cm equivalent aperture diameter in circular polarisation)	
User equipment Tx power	Omnidirectional antenna: UE power class 3 with up to 200 mW Directive antenna: up to 20 W	
User equipment Noise figure	Omnidirectional antenna: 7 dB Directive antenna: 1.2 dB	
Service link	3GPP defined New Radio	
Feeder link	3GPP or non-3GPP defined Radio interface	3GPP or non-3GPP defined Radio interface
NOTE 1: Each satellite has the capability to steer beams towards fixed points on earth using beamforming techniques. This is applicable for a period of time corresponding to the visibility time of the satellite		
NOTE 2: Max delay variation within a beam (earth fixed user equipment) is calculated based on Min Elevation angle for both gateway and user equipment		
NOTE 3: Max differential delay within a beam is calculated based on Max beam foot print diameter at nadir		
NOTE 4: Speed of light used for delay calculation is 299792458 m/s.		
NOTE 5: The Maximum beam foot print size for GEO is based on current state of the art GEO High Throughput systems, assuming either spot beams at the edge of coverage (low elevation).		
NOTE 6: The maximum differential delay at cell level has been computed considering the one at beam level for largest beam size. It does not preclude that cell may include more than one beam when beam size are small or medium size. However the cumulated differential delay of all beams within a cell will not exceed the maximum differential delay at cell level in the table above.		

[236] The NTN study results apply to GEO scenarios as well as all NGSO scenarios with circular orbit at altitude greater than or equal to 600 km.

[237] Technical features related to satellite ephemeris are described.

[238] Key parameters

[239] Key parameters of orbital mechanics of all commercial satellites are publicly available from multiple sources. This information is called ephemeris, which is used by astronomers to describe the location and orbital behaviour of stars and any other astronomical bodies.

[240] Typically, ephemeris is expressed in an ASCII file using Two-Line Element (TLE) format. The TLE data format encodes a list of orbital elements of an Earth-orbiting object in two 70-column lines. The contents of the TLE table are reproduced below.

[241] Table 9 shows first line of the ephemeris.

[242] [Table 9]

Field	Columns	Content
1	01-01	Line number (1)
2	03-07	Satellite number
3	08-08	Classification (U=Unclassified)
4	10-11	International Designator (Last two digits of launch year)
5	12-14	International Designator (Launch number of the year)
6	15-17	International Designator (piece of the launch)
7	19-20	Epoch Year (last two digits of year)
8	21-32	Epoch (day of the year and fractional portion of the day)
9	34-43	First Time Derivative of the Mean Motion divided by two
10	45-52	Second Time Derivative of Mean Motion divided by six (decimal point assumed)
11	54-61	BSTAR drag term (decimal point assumed)
12	63-63	The number 0 (originally this should have been "Ephemeris type")
13	65-68	Element set number. Incremented when a new TLE is generated for this object.
14	69-69	Checksum (modulo 10)

[243] Table 10 shows second line of the ephemeris.

[244] [Table 10]

Field	Columns	Content
1	01-01	Line number (2)
2	03-07	Satellite number
3	09-16	Inclination (degrees)
4	18-25	Right ascension of the ascending node (degrees)
5	27-33	Eccentricity (decimal point assumed)
6	35-42	Argument of perigee (degrees)
7	44-51	Mean Anomaly (degrees)
8	53-63	Mean Motion (revolutions per day)
9	64-68	Revolution number at epoch (revolutions)
10	69-69	Checksum (modulo 10)

[245] The TLE format is an expression of mean orbital parameters "True Equator, Mean Equinox", filtering out short term perturbations.

[246] From its TLE format data, the SGP4 (Simplified General Propagation) model is used to calculate the location of the space object revolving about the earth in True Equator Mean Equinox (TEME) coordinate. Then it can be converted into the Earth-Centered, Earth-Fixed (ECEF) Cartesian x, y, z coordinate as a function of time.

[247] The instantaneous velocity at that time can also be obtained. In ECEF coordinate, z-axis points to the true North, while x axis and y axis intersects 0-degrees latitude and longitude respectively.

[248] FIG. 12 shows Earth-Centered, Earth-Fixed (ECEF) coordinates in relation to latitude and longitude to which implementations of the present disclosure is applied.

[249] Table 11 shows an example of ephemeris converted into ECEF format for the

Telestar-19 satellite.

[250] [Table 11]

Epoch (day, hr, min, sec)	X[km]	Y[km]	Z[km]	dX/dt[km/s]	dY/dt[km/s]	dZ/dt [km/s]
2018-10-26 02:00:00.000	19151.529	-37578.251	17.682	-0.00151	-0.00102	-0.00106
2018-10-26 02:05:00.000	19151.073	-37578.556	17.359	-0.00152	-0.00101	-0.00109
2018-10-26 02:10:00.000	19150.614	-37578.855	17.029	-0.00154	-0.00099	-0.00112
2018-10-26 02:15:00.000	19150.150	-37579.151	16.690	-0.00155	-0.00098	-0.00114

- [251] Given a specific point in time, it is straightforward to calculate the satellite location by interpolation. The example given above refers to a geosynchronous (GEO) satellite, in which the epoch interval is 5 minutes. For LEO satellites, the intervals may be much shorter, on the order of seconds.
- [252] In NR, the following technical features could be applied to some embodiments of the present disclosure.
- [253] - Broadcast of cell stop time in SIB is applicable to a quasi-earth fixed cell (not to a moving cell).
- [254] - For a quasi-earth fixed cell, the reference location of the cell (serving cell or the neighbor cells) is broadcast in system information.
- [255] - For a quasi-earth fixed cell, UE should start measurements on neighbor cells before the serving cell stops covering the current area.
- [256] - For a quasi-earth fixed cell, the broadcast "timing information on when a cell is going to stop serving the area" refers to the time when a cell stops covering the current area.
- [257] - For a quasi-earth fixed cell, specify that UE should start measurements on neighbor cells before the broadcast stop time of the serving cell, i.e. the time when the serving cell stops covering the current area, and the exact time to start measurements is up to UE implementation.
- [258] - Location assisted cell reselection, with the distance between UE and the reference location of the cell (serving cell and/or neighbor cell) taken into account, is supported for quasi-earth fixed cell, if UE has valid location information, which means location acquisition will not be triggered at UE side only for location assisted cell reselection.
- [259] Hereinafter, technical features related to Radio Link Failure are described. The operations described below could be applied to implementations of the present disclosure. Section 10.1.6 of 3GPP TS 36.300 v16.6.0 may be referred.
- [260] FIG. 13 shows two phases govern the behaviour associated to radio link failure to

which implementations of the present disclosure is applied.

[261] - First phase:

[262] > started upon radio problem detection;

[263] > leads to radio link failure detection;

[264] > no UE-based mobility;

[265] > based on timer or other (e.g. counting) criteria (T1).

[266] - Second Phase:

[267] > started upon radio link failure detection or handover failure;

[268] > leads to RRC_IDLE;

[269] > UE-based mobility;

[270] > Timer based (T2).

[271] Table 12 shows how mobility is handled with respect to radio link failure.

[272] [Table 12]

Cases	First Phase	Second Phase	T2 expired
UE returns to the same cell	Continue as if no radio problems occurred	Activity is resumed by means of explicit signalling between UE and eNB	Go via RRC_IDLE
UE selects a different cell from the same eNB	N/A	Activity is resumed by means of explicit signalling between UE and eNB	Go via RRC_IDLE
UE selects a cell of a prepared eNB (NOTE)	N/A	Activity is resumed by means of explicit signalling between UE and eNB	Go via RRC_IDLE
UE selects a cell of a different eNB that is not prepared (NOTE)	N/A	Go via RRC_IDLE	Go via RRC_IDLE
NOTE: a prepared eNB is an eNB which has admitted the UE during an earlier executed HO preparation phase, or obtains the UE context during the Second Phase.			

[273] For a NB-IoT UE that only uses Control Plane CIoT EPS/5GS optimisations and does not support RRC Connection re-establishment for the control plane, at the end of the first phase, the UE enters RRC_IDLE (there is no second phase). In the Second Phase, in order to resume activity and avoid going via RRC_IDLE when the UE returns to the same cell or when the UE selects a different cell from the same eNB, or when the UE selects a cell from a different eNB, the following procedure applies:

[274] - The UE stays in RRC_CONNECTED;

[275] - The UE accesses the cell through the random access procedure;

[276] - Except for a NB-IoT UE using only Control Plane CIoT EPS/5GS optimisations, the UE identifier used in the random access procedure for contention resolution (i.e. C-RNTI of the UE in the cell where the RLF occurred + physical layer identity of that cell + short MAC-I based on the keys of that cell) is used by the selected eNB to authenticate the UE and check whether it has a context stored for that UE:

[277] - If the eNB finds a context that matches the identity of the UE, or obtains this context from the previously serving eNB, it indicates to the UE that its connection can be resumed;

- [278] - If the context is not found, RRC connection is released and UE initiates procedure to establish new RRC connection. In this case UE is required to go via RRC_IDLE.
- [279] - For a NB-IoT UE using only Control Plane CIoT EPS/5GS optimisations, the UE identifier used in the random access procedure for contention resolution (i.e. S-TMSI (for EPS) or truncated 5G-S-TMSI (for 5GS) of the UE at the time where the RLF occurred + UL NAS MAC + UL NAS COUNT) is used by the selected (ng-)eNB to request the MME/AMF to authenticate the UE's re-establishment request and provide the UE context:
- [280] - If the authentication of the UE is successful and a context is provided, it indicates to the UE that its connection can be resumed;
- [281] - If no context is provided, the RRC connection is released and UE initiates procedure to establish new RRC connection. In this case UE is required to go via RRC_IDLE.
- [282] The radio link failure procedure applies also for RNs, with the exception that the RN is limited to select a cell from its DeNB cell list. Upon detecting radio link failure, the RN discards any current RN subframe configuration (for communication with its DeNB), enabling the RN to perform normal contention-based RACH as part of the re-establishment. Upon successful re-establishment, an RN subframe configuration can be configured again using the RN reconfiguration procedure.
- [283] For DC, PCell supports above phases. In addition, the first phase of the radio link failure procedure is supported for PSCell. However, upon detecting RLF on the PSCell, the re-establishment procedure is not triggered at the end of the first phase. Instead, UE shall inform the radio link failure of PSCell to the MeNB.
- [284] If the recovery attempt in the second phase fails, the details of the RN behavior in RRC_IDLE to recover an RRC connection are up to the RN implementation.
- [285] In case of DAPS handover, the UE continues the detection of radio link failure at the source cell until the successful completion of the random access procedure to the target cell. If RLF is declared in the source cell, the UE:
- [286] - stays in RRC_CONNECTED;
- [287] - stops any data transmission or reception via the source link and releases the source link, but maintains the source RRC configuration;
- [288] - if handover failure is declared at the target cell after source cell RLF was declared,
- [289] - selects a suitable cell and initiates RRC re-establishment;
- [290] - enters RRC_IDLE if a suitable cell was not found within a certain time after handover failure was declared.
- [291] In case of CHO, after RLF is declared in the source cell, the UE:
- [292] - stays in RRC_CONNECTED;
- [293] - selects a suitable cell and if the selected cell is a CHO candidate and if network

configured the UE to try CHO at the selected CHO candidate cell after RLF, then the UE attempts CHO execution, otherwise re-establishment is performed;

[294] - enters RRC_IDLE if a suitable cell was not found within a certain time after RLF was declared.

[295] Hereinafter, radio link failure related actions are described. The operations described below could be applied to implementations of the present disclosure. Section 5.3.10 of 3GPP TS 38.331 V15.15.0 may be referred.

[296] Detection of physical layer problems in RRC_CONNECTED

[297] The UE shall:

[298] 1> upon receiving N310 consecutive "out-of-sync" indications for the SpCell from lower layers while neither T300, T301, T304, T311 nor T319 are running:

[299] 2> start timer T310 for the corresponding SpCell.

[300] Recovery of physical layer problems

[301] Upon receiving N311 consecutive "in-sync" indications for the SpCell from lower layers while T310 is running, the UE shall:

[302] 1> stop timer T310 for the corresponding SpCell.

[303] In this case, the UE maintains the RRC connection without explicit signalling, i.e. the UE maintains the entire radio resource configuration.

[304] Periods in time where neither "in-sync" nor "out-of-sync" is reported by L1 do not affect the evaluation of the number of consecutive "in-sync" or "out-of-sync" indications.

[305] Detection of radio link failure

[306] The UE shall:

[307] 1> upon T310 expiry in PCell; or

[308] 1> upon random access problem indication from MCG MAC while neither T300, T301, T304, T311 nor T319 are running; or

[309] 1> upon indication from MCG RLC that the maximum number of retransmissions has been reached:

[310] 2> if the indication is from MCG RLC and CA duplication is configured and activated, and for the corresponding logical channel *allowedServingCells* only includes SCell(s):

[311] 3> initiate the failure information procedure to report RLC failure.

[312] 2> else:

[313] 3> consider radio link failure to be detected for the MCG, i.e. MCG RLF;

[314] 3> if AS security has not been activated:

[315] 4> perform the actions upon going to RRC_IDLE as specified in 5.3.11, with release cause 'other';-

[316] 3> else if AS security has been activated but SRB2 and at least one DRB have not

been setup:

- [317] 4> perform the actions upon going to RRC_IDLE, with release cause 'RRC connection failure';
- [318] 3> else:
- [319] 4> initiate the connection re-establishment procedure.
- [320] The UE shall:
- [321] 1> upon T310 expiry in PSCell; or
- [322] 1> upon random access problem indication from SCG MAC; or
- [323] 1> upon indication from SCG RLC that the maximum number of retransmissions has been reached:
- [324] 2> if the indication is from SCG RLC and CA duplication is configured and activated, and for the corresponding logical channel *allowedServingCells* only includes SCell(s):
- [325] 3> initiate the failure information procedure to report RLC failure.
- [326] 2> else:
- [327] 3> consider radio link failure to be detected for the SCG, i.e. SCG RLF;
- [328] 3> initiate the SCG failure information procedure to report SCG radio link failure.
- [329] Meanwhile, in conventional CHO, UE shall execute CHO when a configured RRM condition is met. The CHO configuration can be deleted when the network command. If RLF occurs while CHO is configured, if the selected cell is one of CHO candidate cells, the UE executes CHO to the selected cell instead of triggering the re-establishment procedure.
- [330] In NTN, time duration [t1, t2] of CHO candidate cell may be provided to UE. UE may be allowed to perform CHO to the cell only during [t1, t2]. After the time point t2, how to delete the CHO configuration is not yet discussed. If the CHO configuration is not deleted at t2, the UE can use the candidate cell for the RLF recovery as described in the present disclosure. For example, the CHO candidate cell may be serviceable for a while after t2, but the network needs to maintain the CHO radio resource. If the CHO candidate cell is deleted after the time point t2, the network can save the CHO radio resource, but the UE cannot use it for the RLF recovery later.
- [331] Thus, upon providing CHO configuration, the time, when to delete the CHO configuration of the CHO candidate cell, could be set after the time point t2. In this case, the UE can perform CHO to the cell instead of the re-establishment procedure after t2 when RLF occurs. Then, the network only needs to maintain the CHO radio resource until t3 and release it.
- [332] Therefore, studies for using a CHO configuration for RLF recovery considering the NTN cell in a wireless communication system are required.
- [333] Hereinafter, a method for using a CHO configuration for RLF recovery considering

the NTN cell in a wireless communication system, according to some embodiments of the present disclosure, will be described with reference to the following drawings.

- [334] The following drawings are created to explain specific embodiments of the present disclosure. The names of the specific devices or the names of the specific signals/messages/fields shown in the drawings are provided by way of example, and thus the technical features of the present disclosure are not limited to the specific names used in the following drawings. Herein, a wireless device may be referred to as a user equipment (UE).
- [335] FIG. 14 shows an example of a method for using a CHO configuration for RLF recovery in a wireless communication system, according to some embodiments of the present disclosure.
- [336] In particular, FIG. 14 shows an example of a method performed by a wireless device.
- [337] In step S1401, a wireless device may receive, from a network, a Conditional Handover (CHO) configuration including (1) information on candidate cells including a Non-Terrestrial Networks (NTN) cell, and (2) information on a first time period associated with the NTN cell.
- [338] The first time period may start at a first time point and terminate at a second time point. The first period (and the second period below) described in FIG. 14 is separate (or independent) from the time duration described in FIG. 13.
- [339] For example, the CHO configuration may include a CHO triggering condition for each of the candidate cells. The CHO triggering condition for the NTN cell may be satisfied based on that (1) measured cell quality of the NTN cell is equal to or greater than a threshold and (2) a current time point is within the first time period.
- [340] In step S1402, a wireless device may perform a CHO evaluation for the candidate cells during the first time period.
- [341] For example, the CHO evaluation may be performed based on measurements on the candidate cells.
- [342] According to some embodiments of the present disclosure, the wireless device may evaluate whether the CHO triggering condition for the NTN cell is satisfied, during the first time period.
- [343] In step S1403, a wireless device may stop the CHO evaluation for the NTN cell at the second time point.
- [344] The wireless device may keep the information on the NTN cell after the second time point, without discarding the information on the NTN cell from the CHO configuration.
- [345] According to some embodiments of the present disclosure, the wireless device may stop to evaluate whether the CHO triggering condition for the NTN cell is satisfied, after the second time point.

- [346] For example, the wireless device may discard the CHO triggering condition for the NTN cell at the second time point.
- [347] In step S1404, a wireless device may perform cell selection, upon detecting radio link failure during the second time period. The second time period may start at the second time point and terminate at a third time point.
- [348] For example, the cell selection may be performed based on the CHO evaluation performed during the first time period.
- [349] According to some embodiments of the present disclosure, the wireless device may discard the information on the NTN cell from the CHO configuration, at the third time point. For example, the wireless device may discard a cell identifier (ID) for the NTN cell and a corresponding configuration for the NTN cell.
- [350] According to some embodiments of the present disclosure, a wireless device may use a radio link failure (RLF) timer (for example, T310) to declare an RLF on a connection with a network. For example, the wireless device may start the RLF timer upon detecting a radio link problem (for example, a consecutive Out-of-Sync indication from a physical layer). The wireless device may declare the RLF upon expiry of the RLF timer.
- [351] In step S1405, a wireless device may perform a CHO to the NTN cell, based on that the NTN cell is selected by the cell selection.
- [352] Alternatively, a wireless device may perform the re-establishment procedure to the NTN cell, based on that the NTN cell is not selected by the cell selection.
- [353] According to some embodiments of the present disclosure, a wireless device may perform cell selection, upon detecting radio link failure after the third time point. In this case, the wireless device may perform the re-establishment procedure to the NTN cell, since information on the NTN cell (for example, a CHO configuration corresponding to the NTN cell) is discarded at the third time point.
- [354] According to some embodiments of the present disclosure, the wireless device may be in communication with at least one of a user equipment, a network, or an autonomous vehicle other than the wireless device.
- [355] FIG. 15 shows an example of UE operations for using a CHO configuration for RLF recovery in a wireless communication system, according to some embodiments of the present disclosure.
- [356] In the present disclosure, UE may be configured with CHO configuration for at least one cell, where the CHO configuration of the cell includes time information indicating a time duration [t1, t2]. The UE can perform CHO to the cell if the CHO execution condition is met within the time duration.
- [357] Additional time point t3 is defined or provided to the UE, where the time point t3 may be a time point being later than the time point t2. During [t2, t3], the UE cannot

execute CHO to the cell for the UE mobility, but can use the cell for a faster recovery from RLF. That is, if RLF occurs during the [t2, t3], the UE can execute CHO to the cell instead of proceeding with the re-establishment procedure upon selecting the cell during cell selection after RLF.

- [358] In step S1501, a UE may receive a CHO configuration.
- [359] - The CHO configuration may be *ConditionalReconfiguration*, as specified above.
- [360] - The CHO configuration may include a CHO candidate cell list. The member of a cell in the CHO candidate cell list may be a CHO candidate cell to the UE. The UE may execute CHO to the CHO candidate cell in the CHO candidate cell list if the cell satisfies the CHO triggering condition of the cell.
- [361] > Each CHO candidate cell in the CHO candidate cell list may include a CHO triggering condition.
- [362] > The CHO triggering condition may include cell quality condition. The cell quality condition may be *condTriggerConfig* (for example, *condEventA3*, *condEventA5*).
- [363] >> The cell quality condition may include a threshold. The cell quality condition may be satisfied when the measured cell quality of the CHO candidate cell is above the threshold.
- [364] > The CHO triggering condition may include a time condition. The time condition may be time duration [t1, t2] which is time duration between time point t1 and time point t2. The UE may execute CHO to the CHO candidate cell only during [t1, t2]. In other words, the UE may execute CHO to the CHO candidate cell only when the current time point is within the time duration [t1, t2]. The current time point may be the current UTC time.
- [365] > Each CHO candidate cell in the CHO candidate cell list may include time point t3. At the time point t3, the UE may discard the CHO candidate cell from the CHO candidate cell list.
- [366] In step S1502, the UE may perform measurements on a cell in the CHO candidate cell list.
- [367] In step S1503, based on the measurement results, the UE may perform a CHO evaluation of the cell. The CHO evaluation may be a conditional reconfiguration evaluation as specified above.
- [368] - Based on the CHO evaluation, if the cell satisfies the cell quality condition as specified in step S1501, the UE may perform CHO to the cell.
- [369] - Based on the CHO evaluation, if the cell satisfies the time condition as specified in step S1501, the UE may perform CHO to the cell.
- [370] - If both the cell quality condition and the time condition are configured for the CHO triggering condition, the UE may perform CHO to the cell when both conditions are satisfied.

- [371] - If both the cell quality condition and the time condition are configured for the CHO triggering condition, the UE may perform CHO to the cell when either cell quality condition or time condition is satisfied.
- [372] In step S1504, during the time period [t1, t2] of the cell, if the UE detects a radio link failure, the UE may perform cell selection. If the selected cell is the cell in which the UE has been performing the CHO evaluation, the UE may perform CHO to the cell based on the provided CHO configuration of the cell.
- [373] In step S1505, at the time point t2, the UE may stop the CHO evaluation of the cell. To stop the CHO evaluation at t2, the UE may discard the CHO execution condition for which the time duration [t1, t2] is configured. However, the UE may keep the configuration of the cell in the CHO candidate cell list.
- [374] In step S1506, during the time period [t2, t3] of the cell, if the UE detects a radio link failure, the UE may perform cell selection as part of RRC connection re-establishment. If the cell is selected, the UE may perform CHO to the cell based on the provided CHO configuration of the cell.
- [375] In step S1507, at the time point t3, the UE may discard the cell from the CHO candidate cell list, that is, discarding the cell ID and corresponding configuration of the cell. If the discarded cell is the last cell from the CHO candidate cell list and there is no more cell in the CHO candidate cell list, the UE may discard the CHO configuration.
- [376] In step S1508, after the time point t3, if the UE detects a radio link failure, the UE may perform cell selection. If the selected cell is the cell discarded from the CHO candidate cell list at the time point t3, the UE keeps continuing to perform the re-establishment procedure. For the re-establishment procedure, the UE may transmit an *RRCReestablishmentRequest* message.
- [377] In step S1509, the UE may perform the RRC re-establishment procedure.
- [378] According to some embodiments of the present disclosure, a UE may receive a CHO configuration of a CHO candidate cell which includes time point t1, t2, and t3. The UE may perform the measurements on the cell. The UE may trigger CHO evaluation to the CHO candidate cell at time point t1, based on the measurement results. The UE may stop the CHO evaluation at time point t2 and keep the CHO configuration. The UE may detect RLF between the time period. The UE may select a cell. The UE may perform CHO to the cell, if the selected cell is the CHO candidate cell and the time point of the cell selection is before the time point t3.
- [379] Some of the detailed steps shown in the examples of FIGS. 14 and 15 may not be essential steps and may be omitted. In addition to the steps shown in FIGS. 14 and 15, other steps may be added, and the order of the steps may vary. Some of the above steps may have their own technical meaning.
- [380] Hereinafter, an apparatus for using a CHO configuration for RLF recovery in a

wireless communication system, according to some embodiments of the present disclosure, will be described. Herein, the apparatus may be a wireless device (100 or 200) in FIGS. 2, 3, and 5.

[381] For example, a wireless device may perform the methods described above. The detailed description overlapping with the above-described contents could be simplified or omitted.

[382] Referring to FIG. 5, a wireless device 100 may include a processor 102, a memory 104, and a transceiver 106.

[383] According to some embodiments of the present disclosure, the processor 102 may be configured to be coupled operably with the memory 104 and the transceiver 106.

[384] The processor 102 may be configured to control the transceiver 106 to receive, from a network, a Conditional Handover (CHO) configuration including (1) information on candidate cells including a Non-Terrestrial Networks (NTN) cell, and (2) information on a first time period associated with the NTN cell. The first time period may start at a first time point and terminate at a second time point. The processor 102 may be configured to perform a CHO evaluation for the candidate cells during the first time period. The processor 102 may be configured to stop the CHO evaluation for the NTN cell at the second time point. The processor 102 may be configured to perform cell selection, upon detecting radio link failure during the second time period. The second time period may start at the second time point and terminate at a third time point. The processor 102 may be configured to perform a CHO to the NTN cell, based on that the NTN cell is selected by the cell selection.

[385] For example, the processor 102 may be configured to keep the information on the NTN cell after the second time point, without discarding the information on the NTN cell from the CHO configuration. The processor 102 may be configured to discard the information on the NTN cell from the CHO configuration, at the third time point. The discarding the information on the NTN cell from the CHO configuration may include discarding a cell identifier (ID) for the NTN cell and a corresponding configuration for the NTN cell.

[386] For example, the processor 102 may be configured to perform cell selection, upon detecting radio link failure after the third time point. The processor 102 may be configured to perform re-establishment procedure to the NTN cell.

[387] For example, the processor 102 may be configured to perform re-establishment procedure to the NTN cell, based on that the NTN cell is not selected by the cell selection.

[388] For example, the CHO configuration may include a CHO triggering condition for each of the candidate cells. The CHO triggering condition for the NTN cell may be satisfied based on that (1) measured cell quality of the NTN cell is equal to or greater

than a threshold and (2) a current time point is within the first time period. For example, the processor 102 may be configured to stop to evaluate whether the CHO triggering condition for the NTN cell is satisfied, after the second time point. For example, the processor 102 may be configured to discard the CHO triggering condition for the NTN cell at the second time point.

[389] For example, the CHO evaluation may be performed based on measurements on the candidate cells.

[390] For example, the cell selection may be performed based on the CHO evaluation performed during the first time period.

[391] According to some embodiments of the present disclosure, the processor 102 may be configured to be in communication with at least one of a user equipment, a network, or an autonomous vehicle other than the wireless device.

[392] Hereinafter, a processor for a wireless device for using a CHO configuration for RLF recovery in a wireless communication system, according to some embodiments of the present disclosure, will be described.

[393] The processor may be configured to control the wireless device to receive, from a network, a Conditional Handover (CHO) configuration including (1) information on candidate cells including a Non-Terrestrial Networks (NTN) cell, and (2) information on a first time period associated with the NTN cell. The first time period may start at a first time point and terminate at a second time point. The processor may be configured to control the wireless device to perform a CHO evaluation for the candidate cells during the first time period. The processor may be configured to control the wireless device to stop the CHO evaluation for the NTN cell at the second time point. The processor may be configured to control the wireless device to perform cell selection, upon detecting radio link failure during the second time period. The second time period may start at the second time point and terminate at a third time point. The processor may be configured to control the wireless device to perform a CHO to the NTN cell, based on that the NTN cell is selected by the cell selection.

[394] For example, the processor may be configured to control the wireless device to keep the information on the NTN cell after the second time point, without discarding the information on the NTN cell from the CHO configuration. The processor may be configured to control the wireless device to discard the information on the NTN cell from the CHO configuration, at the third time point. The discarding the information on the NTN cell from the CHO configuration may include discarding a cell identifier (ID) for the NTN cell and a corresponding configuration for the NTN cell.

[395] For example, the processor may be configured to control the wireless device to perform cell selection, upon detecting radio link failure after the third time point. The processor may be configured to control the wireless device to perform re-establishment

procedure to the NTN cell.

[396] For example, the processor may be configured to control the wireless device to perform re-establishment procedure to the NTN cell, based on that the NTN cell is not selected by the cell selection.

[397] For example, the CHO configuration may include a CHO triggering condition for each of the candidate cells. The CHO triggering condition for the NTN cell may be satisfied based on that (1) measured cell quality of the NTN cell is equal to or greater than a threshold and (2) a current time point is within the first time period. For example, the processor may be configured to control the wireless device to stop to evaluate whether the CHO triggering condition for the NTN cell is satisfied, after the second time point. For example, the processor may be configured to control the wireless device to discard the CHO triggering condition for the NTN cell at the second time point.

[398] For example, the CHO evaluation may be performed based on measurements on the candidate cells.

[399] For example, the cell selection may be performed based on the CHO evaluation performed during the first time period.

[400] According to some embodiments of the present disclosure, the processor may be configured to control the wireless device to be in communication with at least one of a user equipment, a network, or an autonomous vehicle other than the wireless device.

[401] Hereinafter, a non-transitory computer-readable medium has stored thereon a plurality of instructions for using a CHO configuration for RLF recovery in a wireless communication system, according to some embodiments of the present disclosure, will be described.

[402] According to some embodiment of the present disclosure, the technical features of the present disclosure could be embodied directly in hardware, in a software executed by a processor, or in a combination of the two. For example, a method performed by a wireless device in a wireless communication may be implemented in hardware, software, firmware, or any combination thereof. For example, a software may reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, hard disk, a removable disk, a CD-ROM, or any other storage medium.

[403] Some example of storage medium is coupled to the processor such that the processor can read information from the storage medium. In the alternative, the storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. For another example, the processor and the storage medium may reside as discrete components.

[404] The computer-readable medium may include a tangible and non-transitory computer-readable storage medium.

- [405] For example, non-transitory computer-readable media may include random access memory (RAM) such as synchronous dynamic random access memory (SDRAM), read-only memory (ROM), non-volatile random access memory (NVRAM), electrically erasable programmable read-only memory (EEPROM), FLASH memory, magnetic or optical data storage media, or any other medium that can be used to store instructions or data structures. Non-transitory computer-readable media may also include combinations of the above.
- [406] In addition, the method described herein may be realized at least in part by a computer-readable communication medium that carries or communicates code in the form of instructions or data structures and that can be accessed, read, and/or executed by a computer.
- [407] According to some embodiment of the present disclosure, a non-transitory computer-readable medium has stored thereon a plurality of instructions. The stored a plurality of instructions may be executed by a processor of a wireless device.
- [408] The stored a plurality of instructions may cause the wireless device to receive, from a network, a Conditional Handover (CHO) configuration including (1) information on candidate cells including a Non-Terrestrial Networks (NTN) cell, and (2) information on a first time period associated with the NTN cell. The first time period may start at a first time point and terminate at a second time point. The stored a plurality of instructions may cause the wireless device to perform a CHO evaluation for the candidate cells during the first time period. The stored a plurality of instructions may cause the wireless device to stop the CHO evaluation for the NTN cell at the second time point. The stored a plurality of instructions may cause the wireless device to perform cell selection, upon detecting radio link failure during the second time period. The second time period may start at the second time point and terminate at a third time point. The stored a plurality of instructions may cause the wireless device to perform a CHO to the NTN cell, based on that the NTN cell is selected by the cell selection.
- [409] For example, the stored a plurality of instructions may cause the wireless device to keep the information on the NTN cell after the second time point, without discarding the information on the NTN cell from the CHO configuration. The stored a plurality of instructions may cause the wireless device to discard the information on the NTN cell from the CHO configuration, at the third time point. The discarding the information on the NTN cell from the CHO configuration may include discarding a cell identifier (ID) for the NTN cell and a corresponding configuration for the NTN cell.
- [410] For example, the stored a plurality of instructions may cause the wireless device to perform cell selection, upon detecting radio link failure after the third time point. The stored a plurality of instructions may cause the wireless device to perform re-establishment procedure to the NTN cell.

- [411] For example, the stored a plurality of instructions may cause the wireless device to perform re-establishment procedure to the NTN cell, based on that the NTN cell is not selected by the cell selection.
- [412] For example, the CHO configuration may include a CHO triggering condition for each of the candidate cells. The CHO triggering condition for the NTN cell may be satisfied based on that (1) measured cell quality of the NTN cell is equal to or greater than a threshold and (2) a current time point is within the first time period. For example, the stored a plurality of instructions may cause the wireless device to stop to evaluate whether the CHO triggering condition for the NTN cell is satisfied, after the second time point. For example, the stored a plurality of instructions may cause the wireless device to discard the CHO triggering condition for the NTN cell at the second time point.
- [413] For example, the CHO evaluation may be performed based on measurements on the candidate cells.
- [414] For example, the cell selection may be performed based on the CHO evaluation performed during the first time period.
- [415] According to some embodiments of the present disclosure, the stored a plurality of instructions may cause the wireless device to be in communication with at least one of a user equipment, a network, or an autonomous vehicle other than the wireless device.
- [416] Hereinafter, a method performed by a base station (BS) for a CHO configuration for RLF recovery in a wireless communication system, according to some embodiments of the present disclosure, will be described.
- [417] The BS may transmit, to a wireless device, a Conditional Handover (CHO) configuration including (1) information on candidate cells including a Non-Terrestrial Networks (NTN) cell, (2) information on a first time period as a CHO triggering condition to the NTN cell, and (3) information on a second time period for performing a CHO to the NTN cell as a radio link failure recovery.
- [418] The first time period may start at a first time point and terminate at a second time point. The second time period may start at the second time point and terminate a third time point.
- [419] Hereinafter, a base station (BS) for a CHO configuration for RLF recovery in a wireless communication system, according to some embodiments of the present disclosure, will be described.
- [420] The BS may include a transceiver, a memory, and a processor operatively coupled to the transceiver and the memory.
- [421] The processor may be configured to control the transceiver to transmit, to a wireless device, a Conditional Handover (CHO) configuration including (1) information on candidate cells including a Non-Terrestrial Networks (NTN) cell, (2) information on a

first time period as a CHO triggering condition to the NTN cell, and (3) information on a second time period for performing a CHO to the NTN cell as a radio link failure recovery.

- [422] The first time period may start at a first time point and terminate at a second time point. The second time period may start at the second time point and terminate at a third time point.
- [423] The present disclosure can have various advantageous effects.
- [424] According to some embodiments of the present disclosure, a wireless device could efficiently perform the RLF recovery by using a conditional handover (CHO) configuration after the time duration for the CHO.
- [425] That is, even after the time duration [t1, t2] has elapsed, the wireless device could perform the CHO for the purpose of RLF recovery when RLF occurs for a certain period of time.
- [426] For example, while the wireless device is allowed to perform CHO to a CHO candidate cell only during [t1, t2], the wireless device may not discard the cell from the CHO configuration. The wireless device may perform CHO to the cell for the RLF recovery instead of triggering RRC re-establishment procedure which requires much longer delay than CHO.
- [427] Advantageous effects which can be obtained through specific embodiments of the present disclosure are not limited to the advantageous effects listed above. For example, there may be a variety of technical effects that a person having ordinary skill in the related art can understand and/or derive from the present disclosure. Accordingly, the specific effects of the present disclosure are not limited to those explicitly described herein, but may include various effects that may be understood or derived from the technical features of the present disclosure.
- [428] Claims in the present disclosure can be combined in a various way. For instance, technical features in method claims of the present disclosure can be combined to be implemented or performed in an apparatus, and technical features in apparatus claims can be combined to be implemented or performed in a method. Further, technical features in method claim(s) and apparatus claim(s) can be combined to be implemented or performed in an apparatus. Further, technical features in method claim(s) and apparatus claim(s) can be combined to be implemented or performed in a method. Other implementations are within the scope of the following claims.

Claims

- [Claim 1] A method performed by a wireless device in a wireless communication system, the method comprising,
receiving, from a network, a Conditional Handover (CHO) configuration including (1) information on candidate cells including a Non-Terrestrial Networks (NTN) cell, and (2) information on a first time period associated with the NTN cell, wherein the first time period starts at a first time point and terminates at a second time point;
performing a CHO evaluation for the candidate cells during the first time period;
stopping the CHO evaluation for the NTN cell at the second time point;
performing cell selection, upon detecting radio link failure during the second time period, wherein the second time period starts at the second time point and terminates at a third time point; and
performing a CHO to the NTN cell, based on that the NTN cell is selected by the cell selection.
- [Claim 2] The method of claim 1, wherein method further comprises,
keeping the information on the NTN cell after the second time point, without discarding the information on the NTN cell from the CHO configuration.
- [Claim 3] The method of claim 2, wherein the method further comprises,
discarding the information on the NTN cell from the CHO configuration, at the third time point.
- [Claim 4] The method of claim 3, wherein the discarding the information on the NTN cell from the CHO configuration comprises,
discarding a cell identifier (ID) for the NTN cell and a corresponding configuration for the NTN cell.
- [Claim 5] The method of claim 1, wherein the method further comprises,
performing cell selection, upon detecting radio link failure after the third time point; and
performing re-establishment procedure to the NTN cell.
- [Claim 6] The method of claim 1, wherein the method further comprises,
performing re-establishment procedure to the NTN cell, based on that the NTN cell is not selected by the cell selection.
- [Claim 7] The method of claim 1, wherein the CHO configuration includes a CHO triggering condition for each of the candidate cells.
- [Claim 8] The method of claim 7, wherein the CHO triggering condition for the

- NTN cell is satisfied based on that (1) measured cell quality of the NTN cell is equal to or greater than a threshold and (2) a current time point is within the first time period.
- [Claim 9] The method of claim 7, wherein the method further comprises, stopping to evaluate whether the CHO triggering condition for the NTN cell is satisfied, after the second time point.
- [Claim 10] The method of claim 7, wherein the method further comprises, discarding the CHO triggering condition for the NTN cell at the second time point.
- [Claim 11] The method of claim 1, wherein the CHO evaluation is performed based on measurements on the candidate cells.
- [Claim 12] The method of claim 1, wherein the cell selection is performed based on the CHO evaluation performed during the first time period.
- [Claim 13] The method of claim 1, wherein the wireless device is in communication with at least one of a user equipment, a network, or an autonomous vehicle other than the wireless device.
- [Claim 14] A wireless device in a wireless communication system comprising:
a transceiver;
a memory; and
at least one processor operatively coupled to the transceiver and the memory, and configured to:
control the transceiver to receive, from a network, a Conditional Handover (CHO) configuration including (1) information on candidate cells including a Non-Terrestrial Networks (NTN) cell, and (2) information on a first time period associated with the NTN cell, wherein the first time period starts at a first time point and terminates at a second time point;
perform a CHO evaluation for the candidate cells during the first time period;
stop the CHO evaluation for the NTN cell at the second time point;
perform cell selection, upon detecting radio link failure during the second time period, wherein the second time period starts at the second time point and terminates at a third time point; and
perform a CHO to the NTN cell, based on that the NTN cell is selected by the cell selection.
- [Claim 15] The wireless device of claim 15, wherein the at least one processor is further configured to,
keep the information on the NTN cell after the second time point,

- without discarding the information on the NTN cell from the CHO configuration.
- [Claim 16] The wireless device of claim 15, wherein the at least one processor is further configured to,
discard the information on the NTN cell from the CHO configuration,
at the third time point.
- [Claim 17] The wireless device of claim 16, wherein the discarding the information on the NTN cell from the CHO configuration comprises,
discarding a cell identifier (ID) for the NTN cell and a corresponding configuration for the NTN cell.
- [Claim 18] The wireless device of claim 14, wherein the at least one processor is further configured to,
perform cell selection, upon detecting radio link failure after the third time point; and
perform re-establishment procedure to the NTN cell.
- [Claim 19] The wireless device of claim 14, wherein the at least one processor is further configured to,
perform re-establishment procedure to the NTN cell, based on that the NTN cell is not selected by the cell selection.
- [Claim 20] The wireless device of claim 14, wherein the CHO configuration includes a CHO triggering condition for each of the candidate cells.
- [Claim 21] The wireless device of claim 20, wherein the CHO triggering condition for the NTN cell is satisfied based on that (1) measured cell quality of the NTN cell is equal to or greater than a threshold and (2) a current time point is within the first time period.
- [Claim 22] The wireless device of claim 20, wherein the at least one processor is further configured to,
stop to evaluate whether the CHO triggering condition for the NTN cell is satisfied, after the second time point.
- [Claim 23] The wireless device of claim 20, wherein the at least one processor is further configured to,
discard the CHO triggering condition for the NTN cell at the second time point.
- [Claim 24] The wireless device of claim 14, wherein the CHO evaluation is performed based on measurements on the candidate cells.
- [Claim 25] The wireless device of claim 14, wherein the cell selection is performed based on the CHO evaluation performed during the first time period.
- [Claim 26] The wireless device of claim 14, wherein the at least one processor is

further configured to be in communication with at least one of a user equipment, a network, or an autonomous vehicle other than the wireless device.

[Claim 27]

A processor for a wireless device in a wireless communication system, wherein the processor is configured to control the wireless device to perform operations comprising:
receiving, from a network, a Conditional Handover (CHO) configuration including (1) information on candidate cells including a Non-Terrestrial Networks (NTN) cell, and (2) information on a first time period associated with the NTN cell, wherein the first time period starts at a first time point and terminates at a second time point;
performing a CHO evaluation for the candidate cells during the first time period;
stopping the CHO evaluation for the NTN cell at the second time point;
performing cell selection, upon detecting radio link failure during the second time period, wherein the second time period starts at the second time point and terminates at a third time point; and
performing a CHO to the NTN cell, based on that the NTN cell is selected by the cell selection.

[Claim 28]

A non-transitory computer-readable medium having stored thereon a plurality of instructions, which, when executed by a processor of a wireless device, cause the wireless device to perform operations, the operations comprises,
receiving, from a network, a Conditional Handover (CHO) configuration including (1) information on candidate cells including a Non-Terrestrial Networks (NTN) cell, and (2) information on a first time period associated with the NTN cell, wherein the first time period starts at a first time point and terminates at a second time point;
performing a CHO evaluation for the candidate cells during the first time period;
stopping the CHO evaluation for the NTN cell at the second time point;
performing cell selection, upon detecting radio link failure during the second time period, wherein the second time period starts at the second time point and terminates at a third time point; and
performing a CHO to the NTN cell, based on that the NTN cell is selected by the cell selection.

[Claim 29]

A method performed by a base station in a wireless communication system, the method comprising,

transmitting, to a wireless device, a Conditional Handover (CHO) configuration including (1) information on candidate cells including a Non-Terrestrial Networks (NTN) cell, (2) information on a first time period as a CHO triggering condition to the NTN cell, and (3) information on a second time period for performing a CHO to the NTN cell as a radio link failure recovery,

wherein the first time period starts at a first time point and terminates at a second time point, and the second time period starts at the second time point and terminates a third time point.

[Claim 30]

A base station in a wireless communication system comprising:

a transceiver;

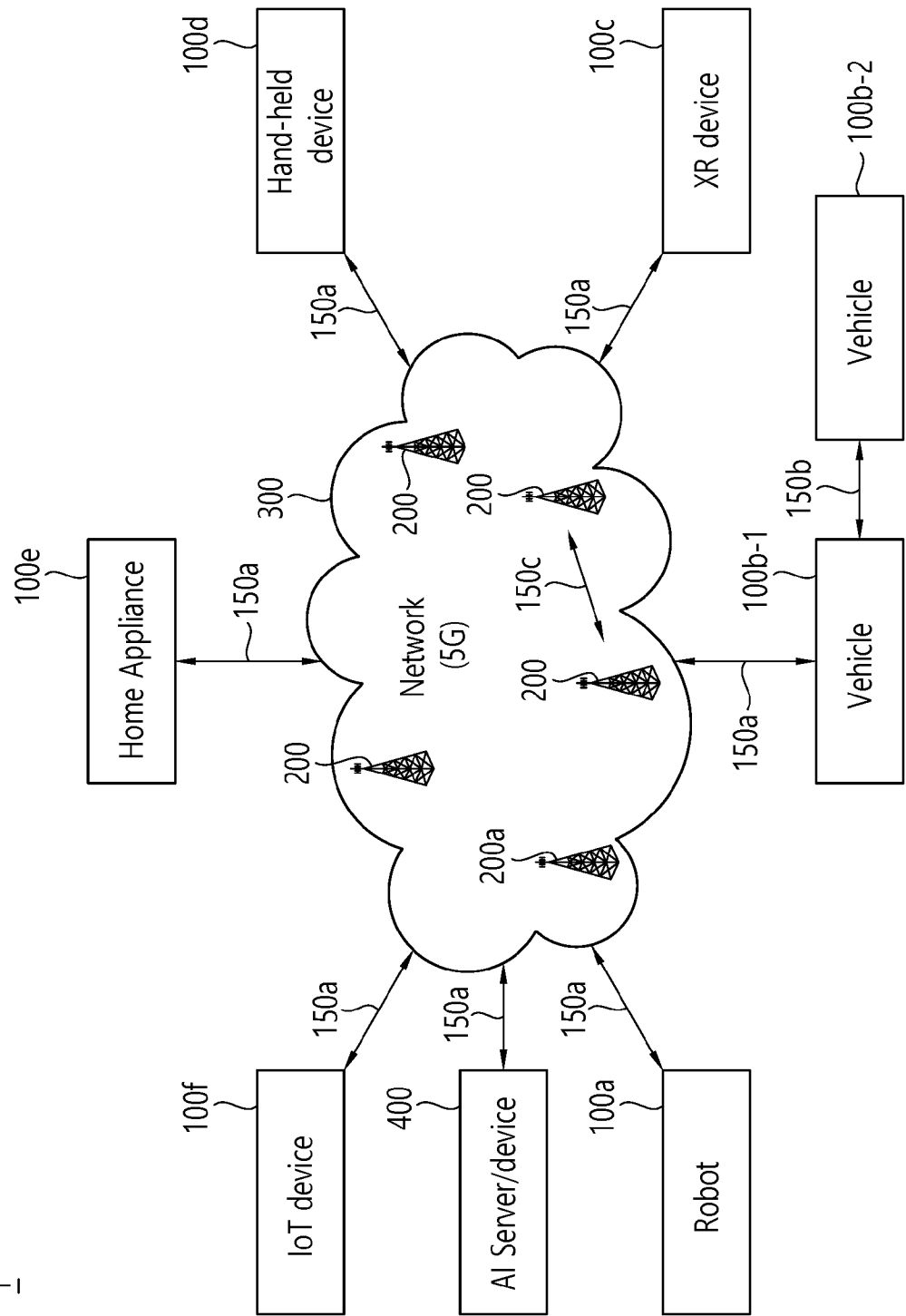
a memory; and

a processor operatively coupled to the transceiver and the memory, and configured to:

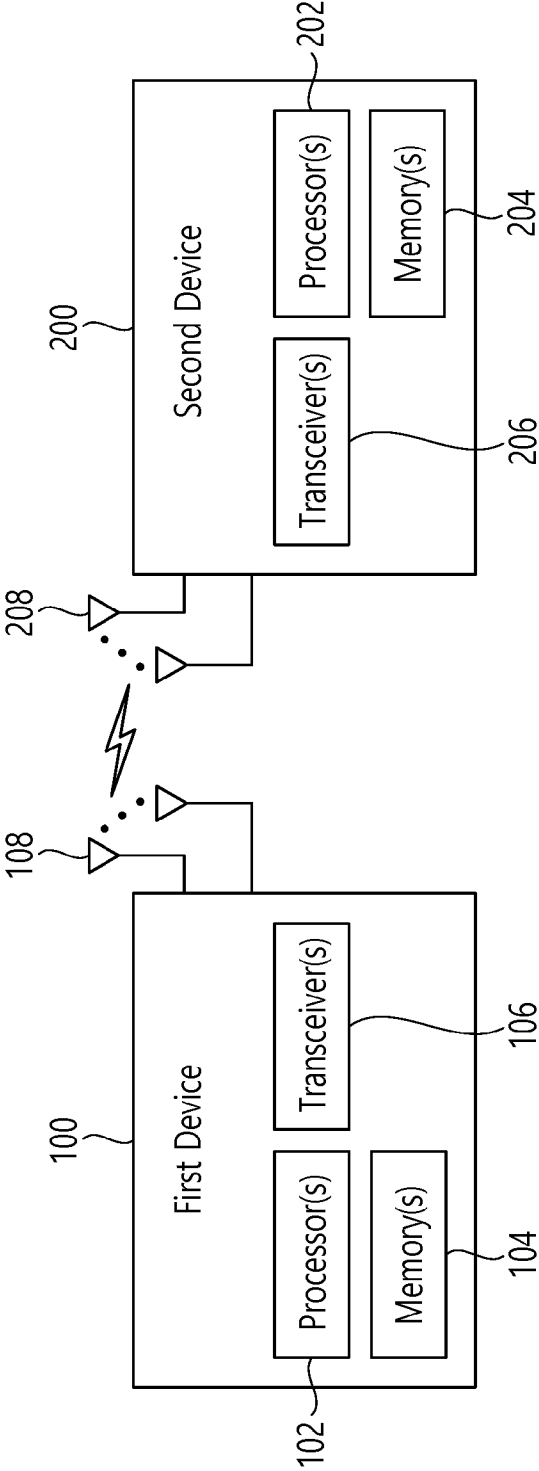
control the transceiver to transmit, to a wireless device, a Conditional Handover (CHO) configuration including (1) information on candidate cells including a Non-Terrestrial Networks (NTN) cell, (2) information on a first time period as a CHO triggering condition to the NTN cell, and (3) information on a second time period for performing a CHO to the NTN cell as a radio link failure recovery,

wherein the first time period starts at a first time point and terminates at a second time point, and the second time period starts at the second time point and terminates a third time point.

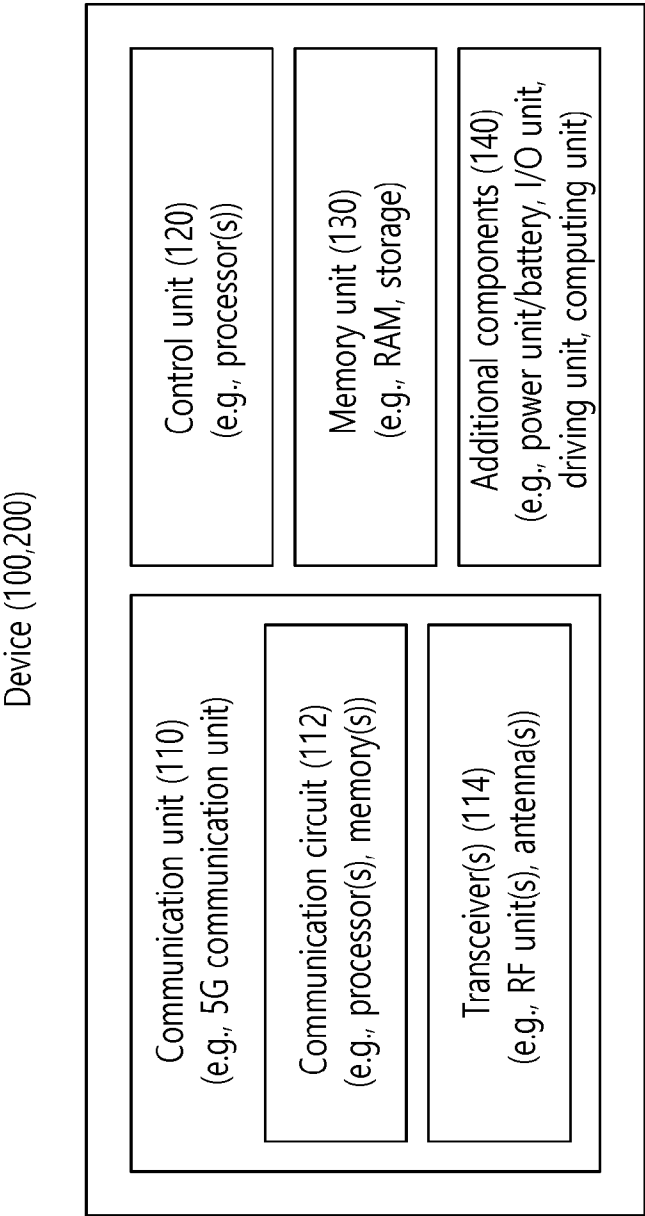
[Fig. 1]



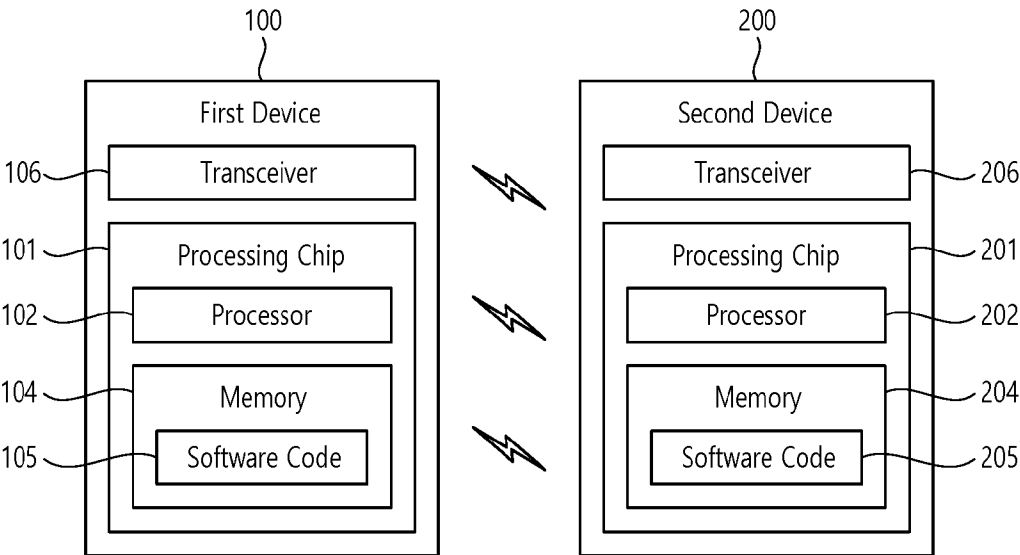
[Fig. 2]



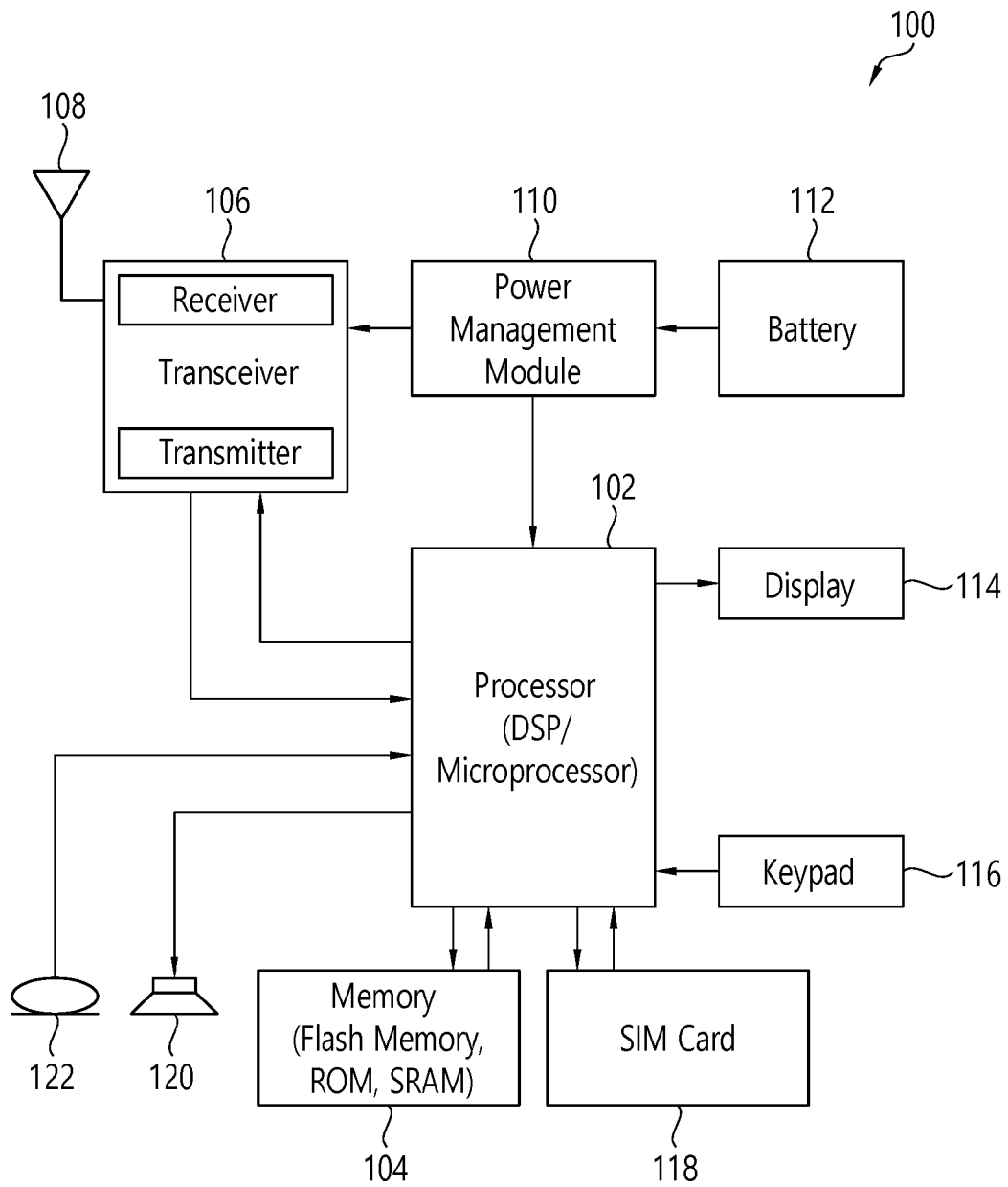
[Fig. 3]



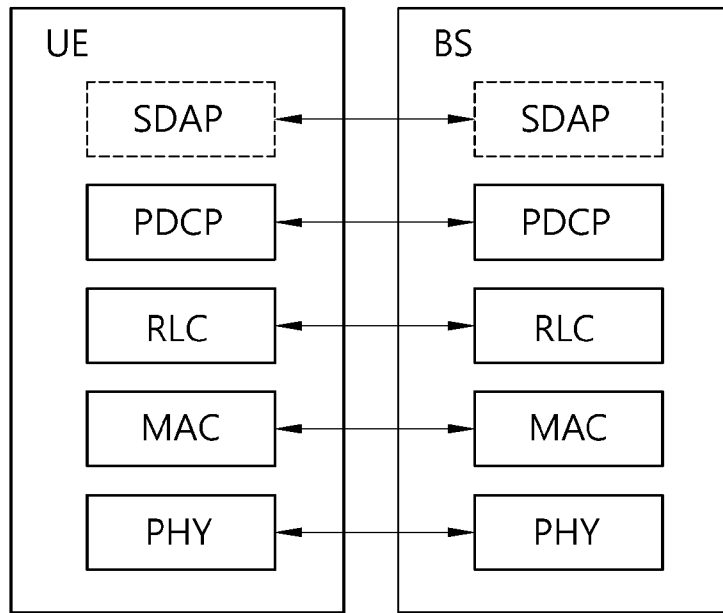
[Fig. 4]



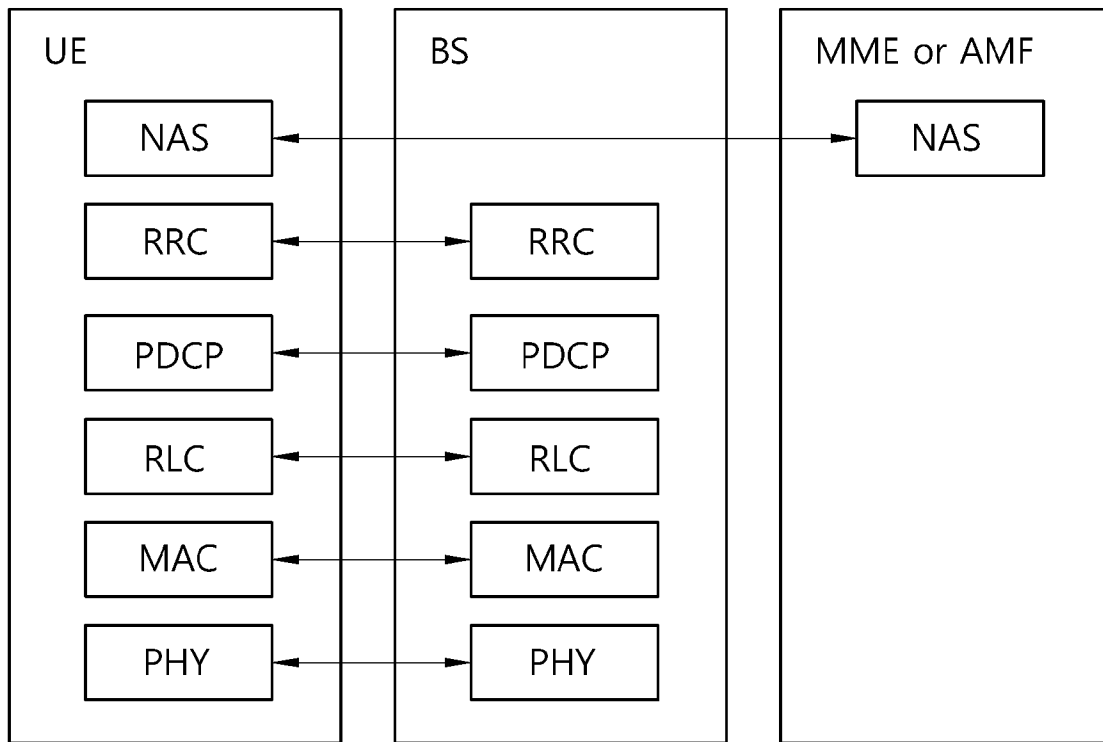
[Fig. 5]



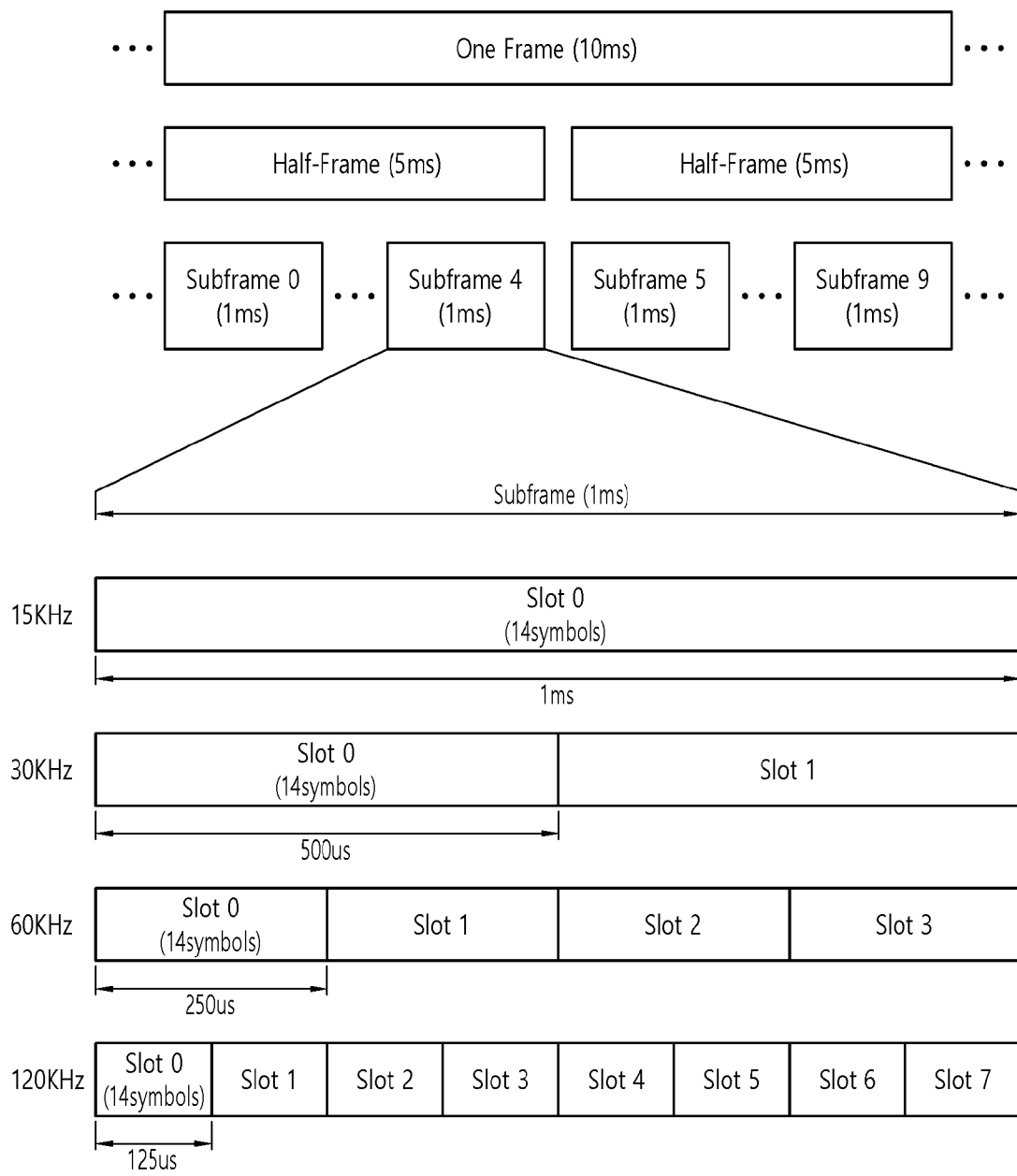
[Fig. 6]



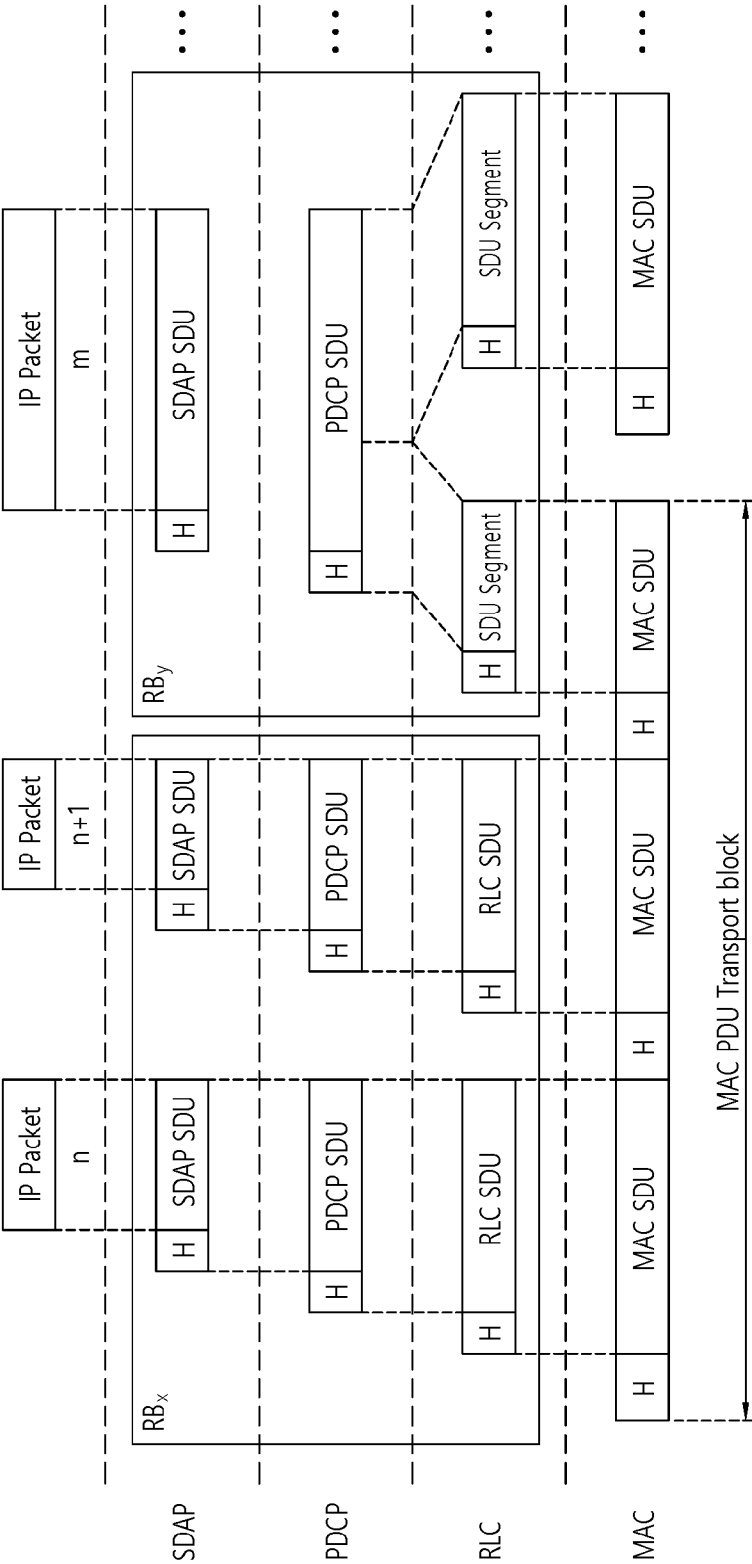
[Fig. 7]



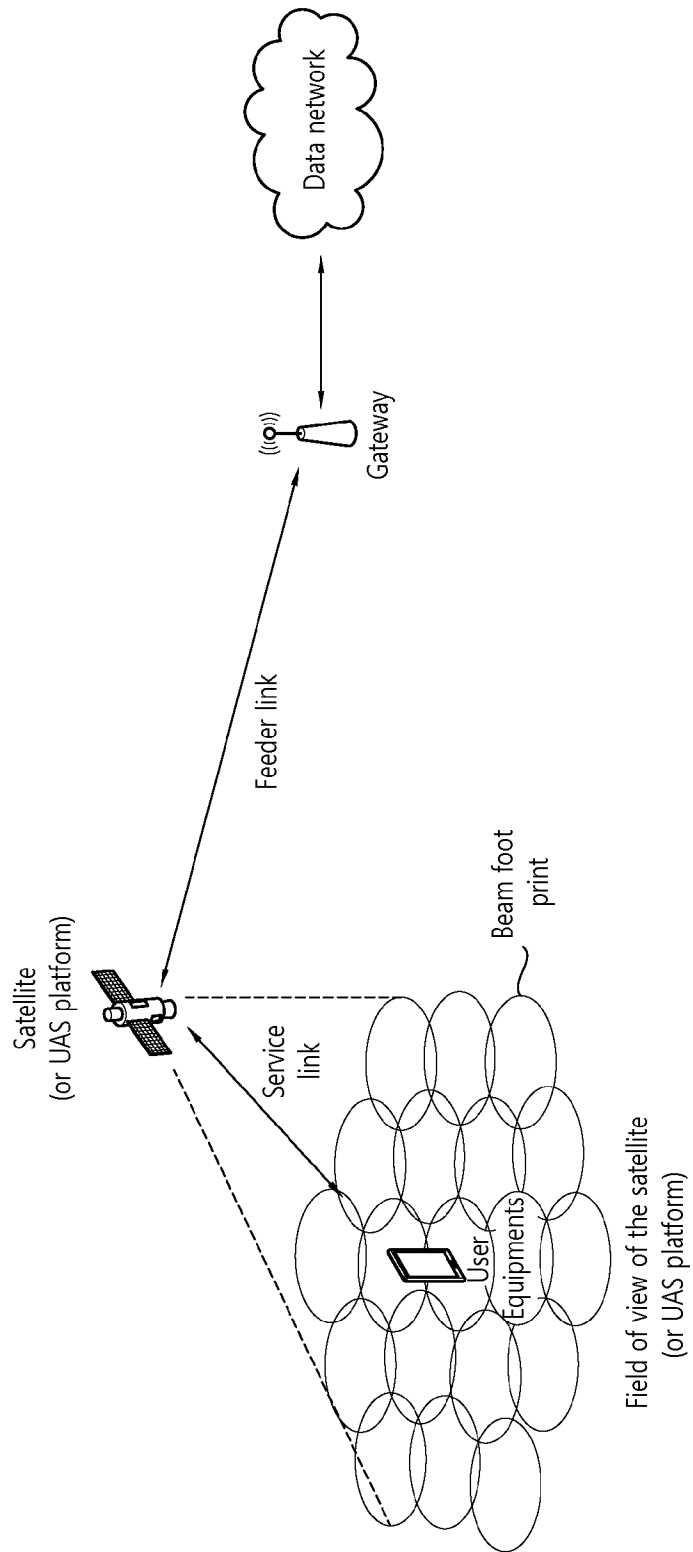
[Fig. 8]



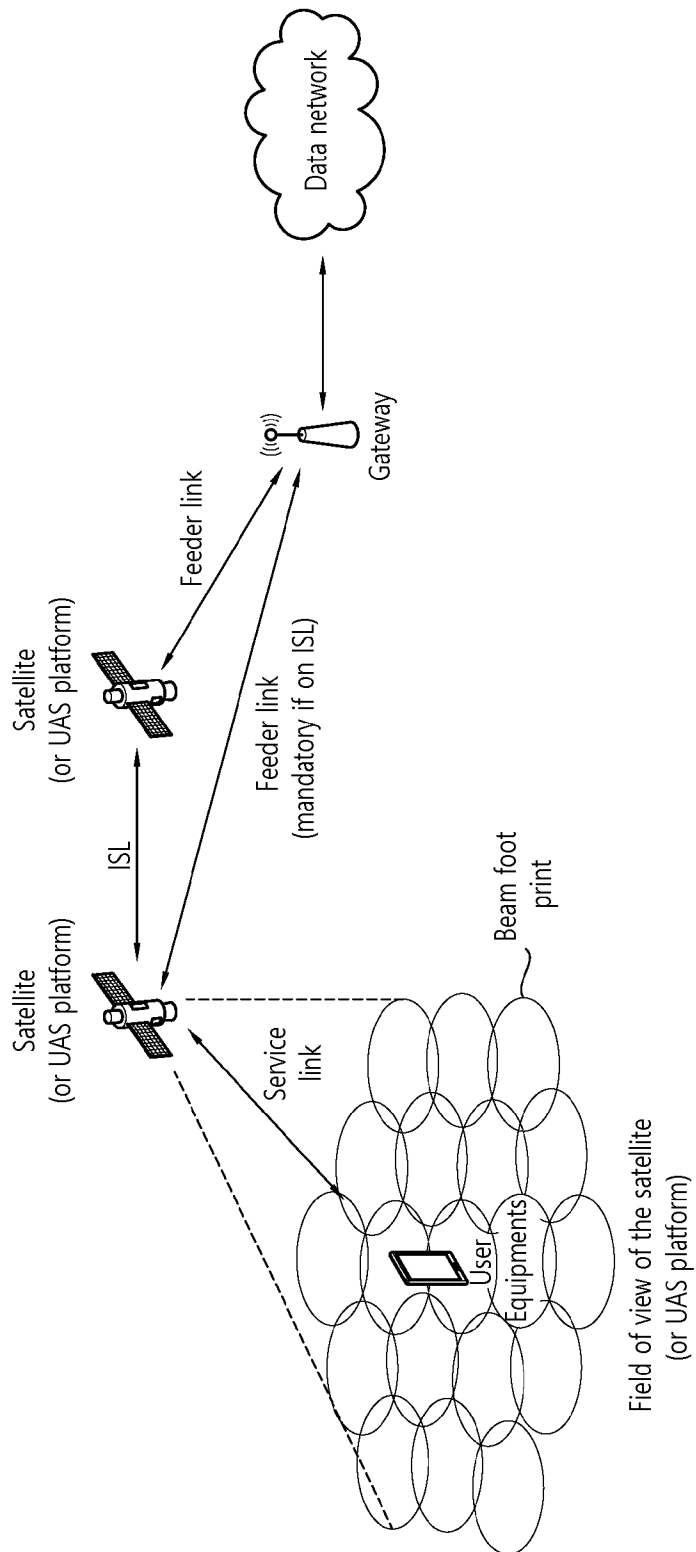
[Fig. 9]



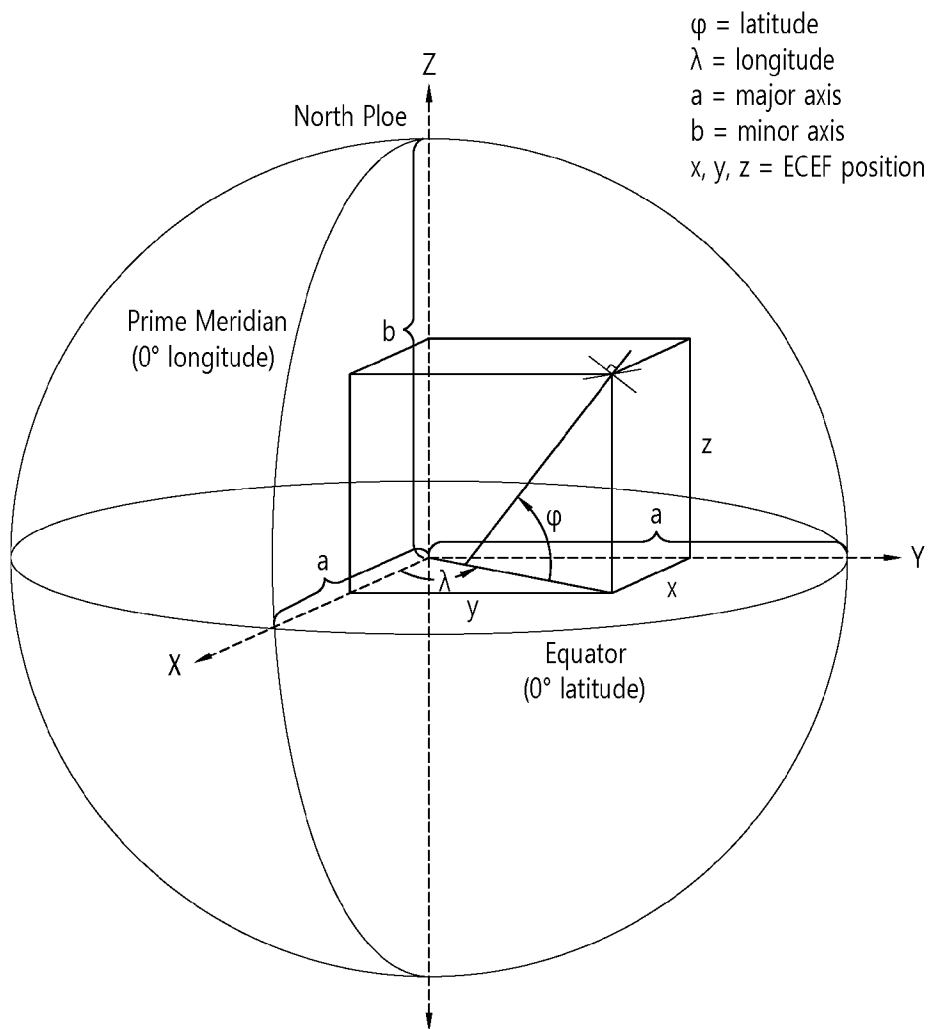
[Fig. 10]



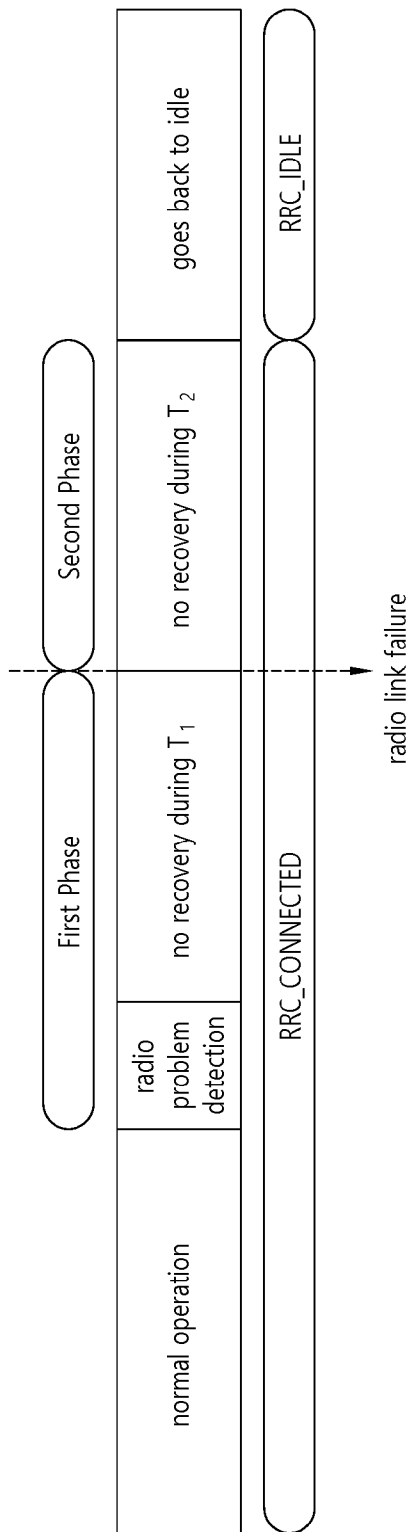
[Fig. 11]



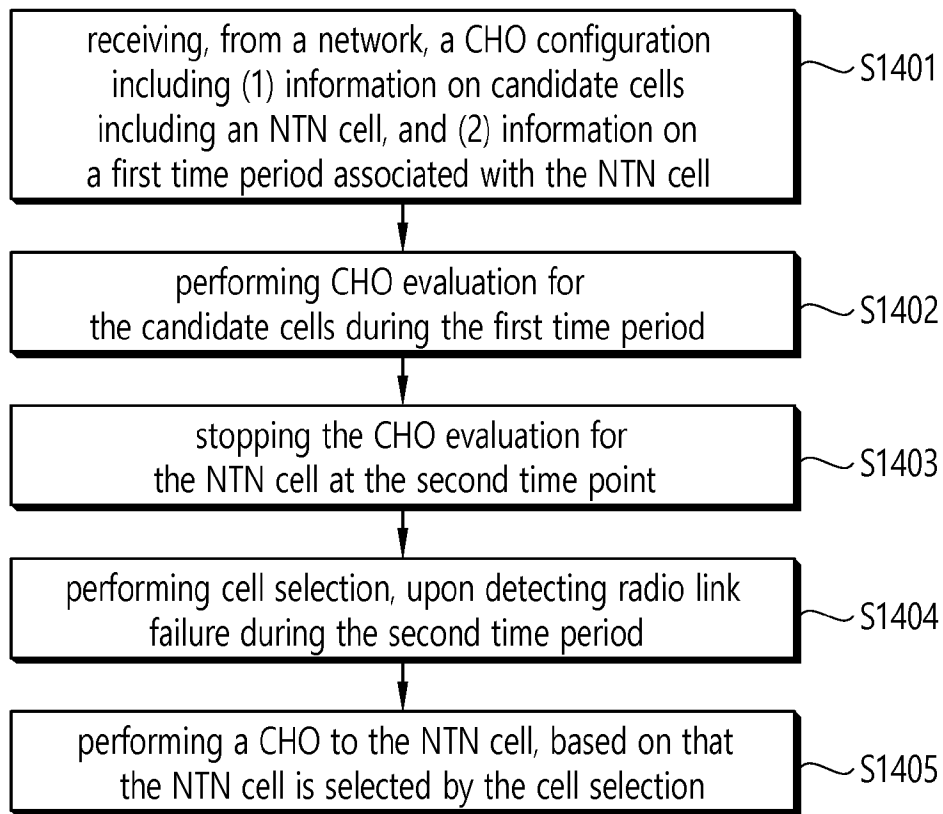
[Fig. 12]



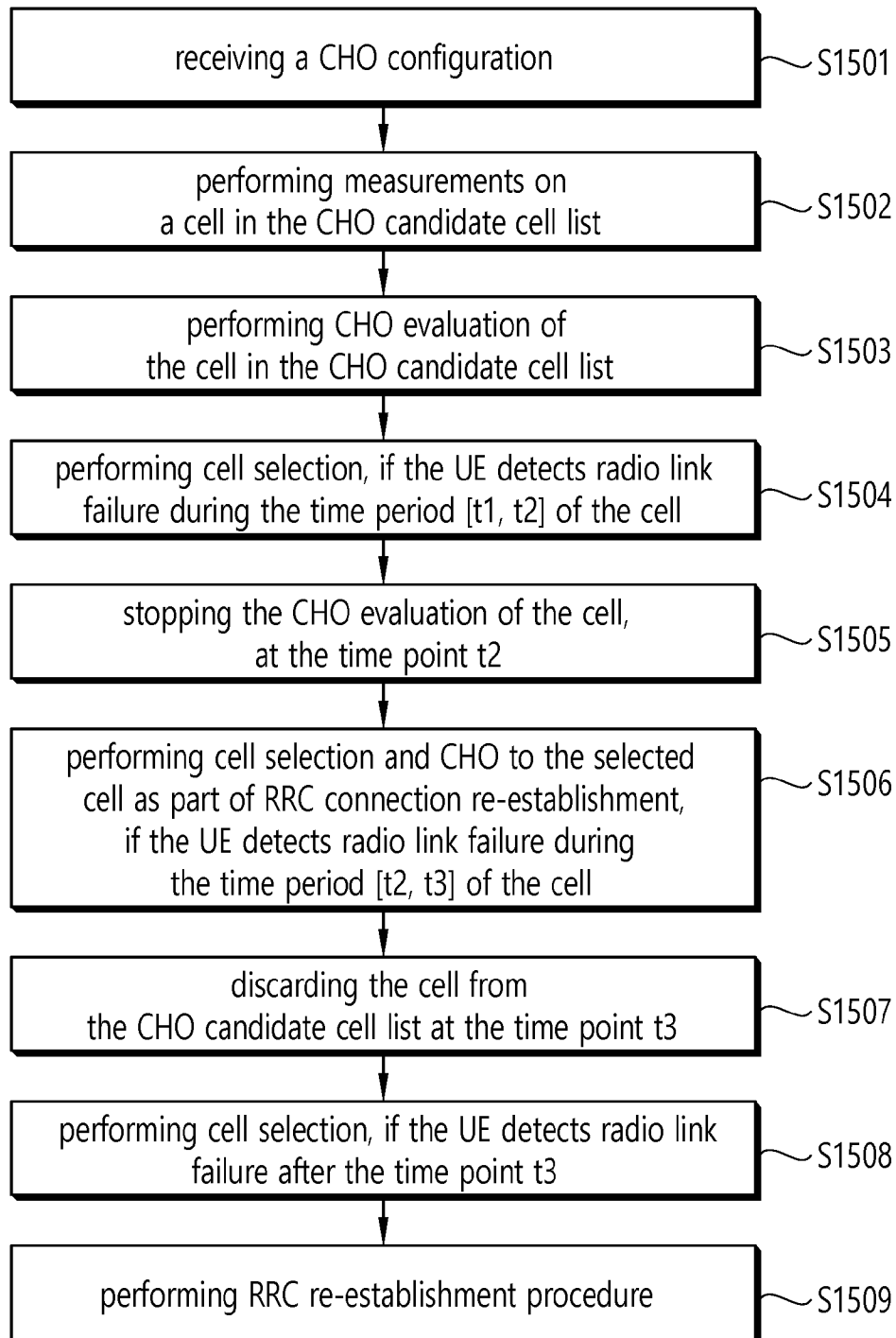
[Fig. 13]



[Fig. 14]



[Fig. 15]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2022/002998

A. CLASSIFICATION OF SUBJECT MATTER H04W 36/30(2009.01)i; H04W 36/00(2009.01)i; H04W 84/06(2009.01)i According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H04W 36/30(2009.01) Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean utility models and applications for utility models Japanese utility models and applications for utility models Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) eKOMPASS(KIPO internal) & Keywords: conditional handover (CHO), Non-Terrestrial Networks (NTN), time period, radio link failure, evaluation, discard		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	LG ELECTRONICS INC., 'Further considerations on NTN CHO', R2-2105787, 3GPP TSG-RAN WG2 Meeting #114-e, Online, 11 May 2021 sections 2.1-2.3	1-30
Y	ERICSSON, '[AT115-e][103][NTN] CHO and NTN -TN mobility aspects (Ericsson)', R2-2109056, 3GPP TSG-RAN WG2 Meeting #115, Electronic, 30 August 2021 pages 13-19	1-30
A	SONY, 'Signaling storm during HO and Timer based trigger details', R2-2108065, 3GPP TSG-RAN WG2 Meeting #115, electronic, Online, 05 August 2021 section 2.2	1-30
A	LENOVO et al., 'Execution condition for CHO in NTN', R2-2107912, 3GPP TSG-RAN WG2 Meeting #115e, Online, 06 August 2021 section 2	1-30
A	WO 2020-145558 A2 (KT CORPORATION) 16 July 2020 (2020-07-16) claims 1-6	1-30
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "D" document cited by the applicant in the international application "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 08 July 2022		Date of mailing of the international search report 12 July 2022
Name and mailing address of the ISA/KR Korean Intellectual Property Office 189 Cheongsu-ro, Seo-gu, Daejeon 35208, Republic of Korea Facsimile No. +82-42-481-8578		Authorized officer YANG, JEONG ROK Telephone No. +82-42-481-5709

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/KR2022/002998

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO	2020-145558	A2	16 July 2020	KR 10-2020-0086217 A	16 July 2020
				US 2022-0086715 A1	17 March 2022
				WO 2020-145558 A3	17 December 2020