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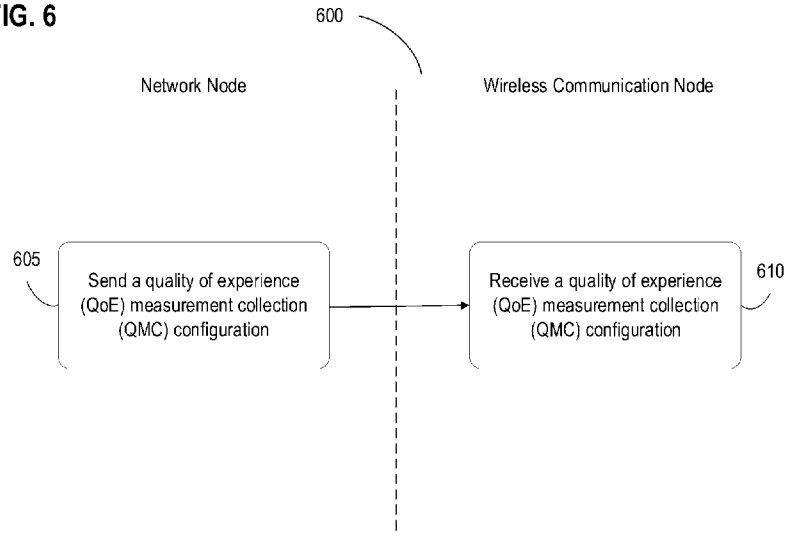
FIG. 6



(57) Abstract: Presented are systems and methods for quality of experience (QoE) support in a non-public network (NPN) scenario and/or a non-terrestrial network (NTN) scenario. A network node (e.g., a core network (CN), an administration and maintenance (OAM) node, or a next generation radio access network (NG-RAN) node) may send a quality of experience (QoE) measurement collection (QMC) configuration to a wireless communication node (e.g., a next generation radio access network (NG-RAN) node). The QMC configuration may comprise assistance information for QoE measurement in at least one of: a non-public network (NPN) or a non-terrestrial network (NTN).

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SYSTEMS AND METHODS FOR QUALITY OF EXPERIENCE SUPPORT

TECHNICAL FIELD

The disclosure relates generally to wireless communications, including but not limited to systems and methods for quality of experience (QoE) support in a non-public network (NPN) scenario and/or a non-terrestrial network (NTN) scenario.

BACKGROUND

The standardization organization Third Generation Partnership Project (3GPP) is currently in the process of specifying a new Radio Interface called 5G New Radio (5G NR) as well as a Next Generation Packet Core Network (NG-CN or NGC). The 5G NR will have three main components: a 5G Access Network (5G-AN), a 5G Core Network (5GC), and a User Equipment (UE). In order to facilitate the enablement of different data services and requirements, the elements of the 5GC, also called Network Functions, have been simplified with some of them being software based, and some being hardware based, so that they could be adapted according to need.

SUMMARY

The example embodiments disclosed herein are directed to solving the issues relating to one or more of the problems presented in the prior art, as well as providing additional features that will become readily apparent by reference to the following detailed description when taken in conjunction with the accompany drawings. In accordance with various embodiments, example systems, methods, devices and computer program products are disclosed herein. It is understood, however, that these embodiments are presented by way of example and are not limiting, and it will be apparent to those of ordinary skill in the art who read the present disclosure that various modifications to the disclosed embodiments can be made while remaining within the scope of this disclosure.

At least one aspect is directed to a system, method, apparatus, or a computer-readable medium of the following. A network node (e.g., a core network (CN), an administration and maintenance (OAM) node, or a next generation radio access network (NG-RAN) node) may send a quality of experience (QoE) measurement collection (QMC) configuration to a wireless communication node (e.g., a next generation radio access network (NG-RAN) node). The QMC configuration may comprise assistance information for QoE measurement in at least one of: a non-public network (NPN) or a non-terrestrial network (NTN). Traditionally, the QoE configuration may not include any information related to the NPN or the NTN. The network node may not be able to collect the QoE measurement for UEs in certain scenarios such as NPN/NTN. The present disclosure introduces assistance information for the NPN/NTN scenarios in QMC configuration, so that the QoE measurement can be collected when UEs are connected to NPN/NTN networks as indicated. The network node may comprise: a node of a core network (CN), an operations, administration and maintenance (OAM) node, or a next generation radio access network (NG-RAN) node. The three kinds of network nodes here denotes three different cases for the QoE measurement collection. For a node of a core network (CN), this can be the case for

the initial configuration of signaling-based QoE. The AMF may receive the QMC configuration from the OAM and may forward the QMC configuration to a specific UE. For an OAM node, this can be the case for the initial configuration of management-based QoE. The OAM may send the QMC configuration directly to the NG-RAN node. For a NG-RAN node, this can be for the case of mobility scenarios, e.g., handover. The source NG-RAN node may forward the QMC configuration to the target NG-RAN node to ensure the continuity of QoE measurement collection.

In some embodiments, the assistance information may include at least one of: non-public network (NPN) assistance information; or non-terrestrial network (NTN) assistance information. The present disclosure specifies the type or purpose of the assistance information in the QMC configuration. One can be for NPN network, to allow the OAM to indicate to the NG-RAN about the purpose of collecting QoE measurements for UEs in a certain NPN network. The other one can be for NTN network, to allow the OAM to indicate the NG-RAN about the purpose of collecting QoE measurements for UEs in a certain NTN network.

In some embodiments, the NPN assistance information may include at least one of: an indication to collect QoE measurement for at least one user equipment (UE) in the NPN; one or more choices for Area Scope of QMC in QoE configuration to be extended for the NPN; or a single information element (IE) to define an area scope of the NPN for QMC. The present disclosure defines three possible options of specific assistance information for the NPN.

In some embodiments, the one or more choices for the Area Scope of QMC in the QoE configuration to be extended for the NPN may include at least one of: a public network integrated NPN (PNI-NPN) based choice; a standalone non-public network (SNPN) cell based choice; a SNPN tracking area identity (TAI) based choice; or a SNPN based choice. The PNI-NPN based choice may include a closed access group (CAG) list. The SNPN cell based choice may include a SNPN cell identifier (ID) list. The SNPN TAI based choice may include a SNPN TAI list. The SNPN based choice may include a SNPN list. The present disclosure provides more details about the area scope defined for the NPN network. Specifically, the CAG list can be used to identify the PNI-NPN network. The cell-based/SNPN TAI based/SNPN based lists may define the area scope of SNPN in at least three different scales, e.g., a cell, a TAI, and/or a PLMN. This kind of classification can be more flexible and could allow the network to collect the QoE measurement in different granularity of area.

In some embodiments, the single/separate IE to define the area scope of the NPN for QMC may include at least one of: an IE to define an area scope of a public network integrated NPN (PNI-NPN); or an IE to define an area scope of a standalone non-public network (SNPN), or a SNPN list. The IE to define the area scope of the PNI-NPN may include a closed access group (CAG) list. The IE to define the area scope of the SNPN may include at least one of: a SNPN cell ID list, a SNPN tracking area identity (TAI) list. The present disclosure defines a single/separate IE that has no impact on the existing Area Scope of QMC IE. Similarly, this information included in this IE can be a network identifier of the PNI-NPN or the SNPN. The CAG list may include at least one of: a public land mobile network (PLMN) ID or a CAG ID. The SNPN cell ID list may include at least one of: a new radio cell global identity (NR-CGI) or a network identification (NID). The SNPN TAI list may include at least one of: a TAI or a NID. The SNPN list may include at least one of: a PLMN ID or a NID. The present disclosure provides more details about the information about the identifier of the NPN

network. Specifically, the PLMN ID and CAG ID can be used to identify an PNI-NPN. The PLMN ID and NID can be used to identify an SNPN (note that the NR-CGI and TAI both include an PLMN ID).

In some embodiments, the NTN assistance information may include at least one of: an indication to collect QoE measurement for at least one user equipment (UE) in the NTN; a connection type of the NTN; or frequency band information corresponding to an access network. The present disclosure defines three possible/example options of specific assistance information for the NTN.

The connection type of the NTN may include at least one of: a new radio-low earth orbit (NR-LEO); a new radio-medium earth orbit (NR-MEO); a new radio-geostationary earth orbit (NR-GEO); or a NR-OTHERSAT. The present disclosure provides more detailed information about the connection type of NTN, which can be used for the network to decide in which type of collection the QoE measurement can be performed.

The frequency band information may include at least one of: a range of absolute frequency; or a specific number that is allocated for a frequency band. The present disclosure provides more information about how the frequency information can be specified. One example can be to simply define the range of absolute frequency. The other example can be to use the allocated number for the frequency band and can also be easily translated by the network.

In some embodiments, the wireless communication node may send a QoE configuration to a wireless communication device via a radio resource control (RRC) message. The assistance information can be mainly used by the network but may also be of use to the user equipment. For example, the UE may sometimes move from a public network to a non-public network, or from a terrestrial network to a non-terrestrial network. Without the assistance information over the RRC message, the UE may continue to collect QoE measurements even if the OAM is only concerned about the measurement(s) in the NPN/NTN. With the assistance information over the RRC message, the UE can collect QoE measurement when the UE is connected to the NPN/NTN network, and can reduce some load in the application layer and also the utilization of radio resources.

In some embodiments, the network node may send the assistance information for the QoE measurement in the NPN or NTN to the wireless communication node via a user equipment (UE) associated message. The present disclosure specifies NGAP procedures that can be used to transfer the assistance information. The NGAP messages can be reused for transferring the assistance information. In some embodiments, the UE associated message can be to establish an initial UE context. The UE associated message can be to modify a UE context. The UE associated message can be to pass configuration information during a handover procedure.

In some embodiments, a wireless communication node (e.g., a next generation radio access network (NG-RAN) node) may receive a quality of experience (QoE) measurement collection (QMC) configuration from a network node (e.g., a core network (CN), an administration and maintenance (OAM) node, or a next generation radio access network (NG-RAN) node). The QMC configuration may comprise assistance information for QoE measurement in at least one of: a non-public network (NPN) or a non-terrestrial network (NTN).

BRIEF DESCRIPTION OF THE DRAWINGS

Various example embodiments of the present solution are described in detail below with reference to the following figures or drawings. The drawings are provided for purposes of illustration only and merely depict example embodiments of the present solution to facilitate the reader's understanding of the present solution. Therefore, the drawings should not be considered limiting of the breadth, scope, or applicability of the present solution. It should be noted that for clarity and ease of illustration, these drawings are not necessarily drawn to scale.

FIG. 1 illustrates an example cellular communication network in which techniques disclosed herein may be implemented, in accordance with an embodiment of the present disclosure;

FIG. 2 illustrates a block diagram of an example base station and a user equipment device, in accordance with some embodiments of the present disclosure;

FIG. 3 illustrates a sequence diagram illustrating collection of quality of experience (QoE) measurement(s) in a non-public network (NPN), in accordance with some embodiments of the present disclosure;

FIG. 4 illustrates a sequence diagram illustrating collection of quality of experience (QoE) measurement(s) in a non-terrestrial network (NTN), in accordance with some embodiments of the present disclosure;

FIG. 5 illustrates a sequence diagram illustrating support for quality of experience (QoE), in accordance with some embodiments of the present disclosure; and

FIG. 6 illustrates a flow diagram of an example method for providing support for quality of experience (QoE), in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

1. Mobile Communication Technology and Environment

FIG. 1 illustrates an example wireless communication network, and/or system, 100 in which techniques disclosed herein may be implemented, in accordance with an embodiment of the present disclosure. In the following discussion, the wireless communication network 100 may be any wireless network, such as a cellular network or a narrowband Internet of things (NB-IoT) network, and is herein referred to as "network 100." Such an example network 100 includes a base station 102 (hereinafter "BS 102"; also referred to as wireless communication node) and a user equipment device 104 (hereinafter "UE 104"; also referred to as wireless communication device) that can communicate with each other via a communication link 110 (e.g., a wireless communication channel), and a cluster of cells 126, 130, 132, 134, 136, 138 and 140 overlaying a geographical area 101. In FIG. 1, the BS 102 and UE 104 are contained within a respective geographic boundary of cell 126. Each of the other cells 130, 132, 134, 136, 138 and 140 may include at least one base station operating at its allocated bandwidth to provide adequate radio coverage to its intended users.

For example, the BS 102 may operate at an allocated channel transmission bandwidth to provide adequate coverage to the UE 104. The BS 102 and the UE 104 may communicate via a downlink radio frame

118, and an uplink radio frame 124 respectively. Each radio frame 118/124 may be further divided into sub-frames 120/127 which may include data symbols 122/128. In the present disclosure, the BS 102 and UE 104 are described herein as non-limiting examples of "communication nodes," generally, which can practice the methods disclosed herein. Such communication nodes may be capable of wireless and/or wired communications, in accordance with various embodiments of the present solution.

FIG. 2 illustrates a block diagram of an example wireless communication system 200 for transmitting and receiving wireless communication signals (e.g., OFDM/OFDMA signals) in accordance with some embodiments of the present solution. The system 200 may include components and elements configured to support known or conventional operating features that need not be described in detail herein. In one illustrative embodiment, system 200 can be used to communicate (e.g., transmit and receive) data symbols in a wireless communication environment such as the wireless communication environment 100 of FIG. 1, as described above.

System 200 generally includes a base station 202 (hereinafter "BS 202") and a user equipment device 204 (hereinafter "UE 204"). The BS 202 includes a BS (base station) transceiver module 210, a BS antenna 212, a BS processor module 214, a BS memory module 216, and a network communication module 218, each module being coupled and interconnected with one another as necessary via a data communication bus 220. The UE 204 includes a UE (user equipment) transceiver module 230, a UE antenna 232, a UE memory module 234, and a UE processor module 236, each module being coupled and interconnected with one another as necessary via a data communication bus 240. The BS 202 communicates with the UE 204 via a communication channel 250, which can be any wireless channel or other medium suitable for transmission of data as described herein.

As would be understood by persons of ordinary skill in the art, system 200 may further include any number of modules other than the modules shown in FIG. 2. Those skilled in the art will understand that the various illustrative blocks, modules, circuits, and processing logic described in connection with the embodiments disclosed herein may be implemented in hardware, computer-readable software, firmware, or any practical combination thereof. To clearly illustrate this interchangeability and compatibility of hardware, firmware, and software, various illustrative components, blocks, modules, circuits, and steps are described generally in terms of their functionality. Whether such functionality is implemented as hardware, firmware, or software can depend upon the particular application and design constraints imposed on the overall system. Those familiar with the concepts described herein may implement such functionality in a suitable manner for each particular application, but such implementation decisions should not be interpreted as limiting the scope of the present disclosure.

In accordance with some embodiments, the UE transceiver 230 may be referred to herein as an "uplink" transceiver 230 that includes a radio frequency (RF) transmitter and a RF receiver each comprising circuitry that is coupled to the antenna 232. A duplex switch (not shown) may alternatively couple the uplink transmitter or receiver to the uplink antenna in time duplex fashion. Similarly, in accordance with some embodiments, the BS transceiver 210 may be referred to herein as a "downlink" transceiver 210 that includes a RF transmitter and a RF receiver each comprising circuity that is coupled to the antenna 212. A downlink duplex switch may alternatively couple the downlink transmitter or receiver to the downlink antenna 212 in time duplex

fashion. The operations of the two transceiver modules 210 and 230 may be coordinated in time such that the uplink receiver circuitry is coupled to the uplink antenna 232 for reception of transmissions over the wireless transmission link 250 at the same time that the downlink transmitter is coupled to the downlink antenna 212. Conversely, the operations of the two transceivers 210 and 230 may be coordinated in time such that the downlink receiver is coupled to the downlink antenna 212 for reception of transmissions over the wireless transmission link 250 at the same time that the uplink transmitter is coupled to the uplink antenna 232. In some embodiments, there is close time synchronization with a minimal guard time between changes in duplex direction.

The UE transceiver 230 and the base station transceiver 210 are configured to communicate via the wireless data communication link 250, and cooperate with a suitably configured RF antenna arrangement 212/232 that can support a particular wireless communication protocol and modulation scheme. In some illustrative embodiments, the UE transceiver 210 and the base station transceiver 210 are configured to support industry standards such as the Long Term Evolution (LTE) and emerging 5G standards, and the like. It is understood, however, that the present disclosure is not necessarily limited in application to a particular standard and associated protocols. Rather, the UE transceiver 230 and the base station transceiver 210 may be configured to support alternate, or additional, wireless data communication protocols, including future standards or variations thereof.

In accordance with various embodiments, the BS 202 may be an evolved node B (eNB), a serving eNB, a target eNB, a femto station, or a pico station, for example. In some embodiments, the UE 204 may be embodied in various types of user devices such as a mobile phone, a smart phone, a personal digital assistant (PDA), tablet, laptop computer, wearable computing device, etc. The processor modules 214 and 236 may be implemented, or realized, with a general purpose processor, a content addressable memory, a digital signal processor, an application specific integrated circuit, a field programmable gate array, any suitable programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof, designed to perform the functions described herein. In this manner, a processor may be realized as a microprocessor, a controller, a microcontroller, a state machine, or the like. A processor may also be implemented as a combination of computing devices, e.g., a combination of a digital signal processor and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a digital signal processor core, or any other such configuration.

Furthermore, the steps of a method or algorithm described in connection with the embodiments disclosed herein may be embodied directly in hardware, in firmware, in a software module executed by processor modules 214 and 236, respectively, or in any practical combination thereof. The memory modules 216 and 234 may be realized as RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, a hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. In this regard, memory modules 216 and 234 may be coupled to the processor modules 210 and 230, respectively, such that the processors modules 210 and 230 can read information from, and write information to, memory modules 216 and 234, respectively. The memory modules 216 and 234 may also be integrated into their respective processor modules 210 and 230. In some embodiments, the memory modules 216 and 234 may each include a cache memory for storing temporary variables or other intermediate information during execution of

instructions to be executed by processor modules 210 and 230, respectively. Memory modules 216 and 234 may also each include non-volatile memory for storing instructions to be executed by the processor modules 210 and 230, respectively.

The network communication module 218 generally represents the hardware, software, firmware, processing logic, and/or other components of the base station 202 that enable bi-directional communication between base station transceiver 210 and other network components and communication nodes configured to communication with the base station 202. For example, network communication module 218 may be configured to support internet or WiMAX traffic. In a typical deployment, without limitation, network communication module 218 provides an 802.3 Ethernet interface such that base station transceiver 210 can communicate with a conventional Ethernet based computer network. In this manner, the network communication module 218 may include a physical interface for connection to the computer network (e.g., Mobile Switching Center (MSC)). The terms "configured for," "configured to" and conjugations thereof, as used herein with respect to a specified operation or function, refer to a device, component, circuit, structure, machine, signal, etc., that is physically constructed, programmed, formatted and/or arranged to perform the specified operation or function.

The Open Systems Interconnection (OSI) Model (referred to herein as, "open system interconnection model") is a conceptual and logical layout that defines network communication used by systems (e.g., wireless communication device, wireless communication node) open to interconnection and communication with other systems. The model is broken into seven subcomponents, or layers, each of which represents a conceptual collection of services provided to the layers above and below it. The OSI Model also defines a logical network and effectively describes computer packet transfer by using different layer protocols. The OSI Model may also be referred to as the seven-layer OSI Model or the seven-layer model. In some embodiments, a first layer may be a physical layer. In some embodiments, a second layer may be a Medium Access Control (MAC) layer. In some embodiments, a third layer may be a Radio Link Control (RLC) layer. In some embodiments, a fourth layer may be a Packet Data Convergence Protocol (PDCP) layer. In some embodiments, a fifth layer may be a Radio Resource Control (RRC) layer. In some embodiments, a sixth layer may be a Non Access Stratum (NAS) layer or an Internet Protocol (IP) layer, and the seventh layer being the other layer.

Various example embodiments of the present solution are described below with reference to the accompanying figures to enable a person of ordinary skill in the art to make and use the present solution. As would be apparent to those of ordinary skill in the art, after reading the present disclosure, various changes or modifications to the examples described herein can be made without departing from the scope of the present solution. Thus, the present solution is not limited to the example embodiments and applications described and illustrated herein. Additionally, the specific order or hierarchy of steps in the methods disclosed herein are merely example approaches. Based upon design preferences, the specific order or hierarchy of steps of the disclosed methods or processes can be re-arranged while remaining within the scope of the present solution. Thus, those of ordinary skill in the art will understand that the methods and techniques disclosed herein present various steps or acts in a sample order, and the present solution is not limited to the specific order or hierarchy presented unless expressly stated otherwise.

2. Systems and Methods for Supporting Quality of Experience (QoE) in a Non-Public Network (NPN) Scenario and/or a Non-Terrestrial Network (NTN) Scenario

Some basic procedures of quality of experience (QoE) measurement collection may have been established. However, how to collect measurements of QoE in specific scenarios (e.g., a non-terrestrial network (NTN) scenario and/or a non-public network (NPN) scenario) has not been addressed yet. The disclosure aims to provide solutions for supporting QoE measurement collection in NPN and NTN scenarios, covering aspects such as initial QoE measurement collection (QMC) configuration and ensuring QoE continuity during mobility.

New radio (NR) QoE measurement collection (QMC) function can be activated by an administration and maintenance (OAM) via a separate QMC framework. For signaling-based QoE, the QMC configuration for a specific UE can be sent from an OAM to a core network (CN), and then the CN may send the QMC configuration to a radio access network (RAN) node via a UE-associated signaling. For management-based QoE, an OAM may send the QMC configuration to a RAN node. The RAN node may select at least one UE which satisfies the condition for QoE measurement and may send the configuration to the at least one UE.

For QoE reporting in a standalone architecture, a UE application (APP) layer may collect QoE metrics and may send the collected data to a UE AS layer via an attention (AT) command. The UE AS layer may send the QoE report to the RAN node, after which the RAN node may transfer the received QoE reports to a measurement collection entity (MCE). The MCE can be an entity which collects QoE measurement reports and performs analysis for optimization. In some embodiments, the QoE reports can be transparent to the RAN node, which means the RAN may not read/inspect the content in the report.

For signaling-based QoE configuration, the OAM may send QoE configuration for a specific UE to the core network (CN). The CN may send the QMC configuration to the NG-RAN via a UE-associated signaling. The NG-RAN may send the configuration to the UE via a radio resource control (RRC) message.

For management-based QoE configuration, the OAM may send the QMC configuration directly to the NG-RAN node. The NG-RAN node may select suitable UE(s) based on configuration information, such as an area scope, or a slice list. The NG-RAN node may send the QoE configuration to the UE(s) via a RRC message.

The non-public network (NPN) can be classified to a standalone NPN (SNPN) network and a public network integrated NPN (PNI-NPN) network. An SNPN can be a network deployed for non-public use which does not rely on network functions provided by a public land mobile network (PLMN). An SNPN can be identified by a PLMN ID and a network identification (NID) broadcast in a System Information Block Type 1 (SIB1). A PNI-NPN can be a network deployed for non-public use which relies on network functions provided by a PLMN. In a PNI-NPN, a closed access groups (CAG) may identify a group of subscribers which are permitted to access one or more CAG cells associated to the CAG. A CAG can be identified by a CAG identifier broadcast in SIB1.

The non-terrestrial network may provide access to the UE by means of an NTN payload and an NTN gateway. There can be a service link between the NTN payload and a UE, and/or a feeder link between the NTN gateway and the NTN payload.

Implementation Example 1: QoE measurement collection in NPN

FIG. 3 illustrates a sequence diagram illustrating quality of experience (QoE) measurement collection in a non-public network (NPN), in accordance with some embodiments of the present disclosure. An OAM can be aware of which cells are configured to be NPN cell while which cells are public cells. When the OAM configures QoE measurement collection and plans to collect QoE measurement for NPN scenario, the OAM can also be aware of the NPN configuration information in the network and can provide assistance information for collecting QoE measurement result in a NPN.

Step 1: A network node may send a quality of experience (QoE) measurement collection (QMC) configuration to another network node. For example, an OAM may send QMC configuration to a CN. The QMC configuration may comprise assistance information for QoE measurement in at least one of: a non-public network (NPN) or a non-terrestrial network (NTN). For example, the assistance information includes at least one of: non-public network (NPN) assistance information; or non-terrestrial network (NTN) assistance information.

Step 2: The network node may send the QMC configuration to a wireless communication node. For example, the CN may send the QMC configuration to a NG-RAN or a UE via a UE-associated message. The UE-associated message can be an Initial Context Setup Request message, or a UE context modification request message. There can be for instance three kinds of purposes, depending on how the UE-associated message being used. For example, the purpose can be at least one of: to establish initial UE context (e.g., Initial Context Setup Request message), to modify the UE context (e.g., UE Context Modification Request message), or to pass the configuration information during handover (e.g., Handover Request message). To collect the QoE measurement in a NPN scenario, the QMC configuration in the step 1 and step 2 may include assistance information for the NPN. There can be three options of the assistance information for the NPN:

Option 1: An indication may indicate collect QoE measurement in an NPN. An example of the IE is shown below:

IE/Group Name	**Presence**	**Range**	**IE Type and Reference**
NPN assistance information	O		ENUERATED (true, ...)

Option 1 is a simple indication without specific network information and can be used directly to indicate the network about the purpose to collect QoE measurement in the NPN, without specifying any network information.

Option 2: The existing choice for Area Scope of QMC in QoE configuration can be extended to provide assistance information for collecting QoE in a NPN area. At least one of the following choices can be added into the area scope of QoE configuration:

- Public network integrated NPN (PNI-NPN) based choice: This choice may include at least a CAG list for QMC. The CAG list may include at least one of the following items: a public land mobile network

(PLMN) ID or a CAG ID. In some embodiments, the CAG ID, together with PLMN ID, can be used to identify a PNI-NPN network.

- Standalone non-public network (SNPN) cell based choice: This choice may include at least a SNPN cell ID list for QMC. The SNPN cell ID list may include at least one of the following items: a new radio cell global identity (NR-CGI) or a network identification (NID). The NR-CGI may comprise a PLMN ID and an NR cell identity.

- SNPN tracking area identity (TAI) based choice: This choice may include at least a SNPN TAI list for QMC. The SNPN TAI list may include at least one of the following items: a TAI or a NID. The TAI may comprise a PLMN ID and a tracking area code (TAC).

- SNPN based choice: This choice may include at least a SNPN list for QMC. The SNPN list may include at least one of the following items: a PLMN ID or a NID. In some embodiments, a NID, together with a PLMN ID, can be used to identify the SNPN network.

Option 2 can be used to extend the existing choice structure of Area Scope of QMC for the purpose of defining certain area scope for the NPN network. With the extension of the Area Scope of QMC, the network can be indicated about collecting QoE measurements for UE(s) in a certain SNPN or PNI-NPN.

Option 3: There can be a new separate/single information element (IE) to define the NPN area scope for QMC. The separate/single IE may include at least one of the following items:

- An IE to define an area scope of a public network integrated NPN (PNI-NPN) of QMC: This IE may include at least a closed access group (CAG) list for QMC. The CAG list for QMC may include at least one of the following items: a public land mobile network (PLMN) ID or a CAG ID.

- An IE to define an area scope of a standalone non-public network (SNPN) of QMC: This IE may include at least one of the following three choices: a SNPN cell based choice; a SNPN TAI based choice; or SNPN based choice.

    - The SNPN cell based choice may include at least a SNPN cell ID list for QMC. The SNPN cell ID list may include at least one of the following items: a new radio cell global identity (NR-CGI) or a network identification (NID).

    - The SNPN TAI based choice may include at least a SNPN TAI list for QMC. The SNPN TAI list may include at least one of the following items: a TAI or a NID.

    - The SNPN based choice may include at least a SNPN list for QMC. The SNPN list may include at least one of the following items: a PLMN ID or a NID.

Option 3 can be a single/separate IE, which can be similar to Option 2 but without any impact on the existing Area Scope of QMC IE.

For a PNI-NPN network, since the serving cell can be either a CAG cell or a public cell, the IEs in the above options may be present simultaneously in the QMC configuration. The following cases shows some examples for different presence of NPN assistance information:

- Case 1: If the Area Scope of QMC in the QMC configuration is set to the choice of "PNI-NPN Based" as in Option 2, and there is no separate NPN area scope for QMC as defined in Option 3, the QoE measurement can be only to be collected for UEs in PNI-NPN area as denoted by the CAG list in the Area scope of QMC.

- Case 2: If the Area Scope of QMC in the QMC configuration is not set to "PNI-NPN Based", and there is no separate NPN area scope for QMC, the QoE measurement can be collected for UEs in either public or CAG cells, e.g., there is no restriction on collecting QoE measurement only in public or CAG area.

- Case 3: If the Area Scope of QMC in the QMC configuration is not set to "PNI-NPN Based", and there is a separate NPN area scope for QMC as defined in Option 3 above, the QoE measurement can be collected for UE(s) in the public area (denoted by the Area Scope of QMC) or in the CAG area (denoted by the separate NPN area scope for QMC).

- Case 4: If the Area Scope of QMC in the QMC configuration is set to "PNI-NPN Based", and there is a separate NPN area scope for QMC as defined in Option 3 above, this case can be treated as an abnormal case. The actions of the NG-RAN node can be at least one of the following:

    - The NG-RAN node can ignore the separate NPN area scope for QMC, and only collect QoE measurement results for UEs in the PNI-NPN area as denoted by the Area Scope of QMC, e.g., the same as case 1.

    - The NG-RAN node can ignore the PNI-NPN based CAG list in the Area Scope of QMC, and use the separate NPN area scope for QMC, e.g., to collect QoE measurement results for UEs in the CAG list denoted by the NPN Area Scope for QMC.

    - The NG-RAN node can decide the final area scope for QMC, based on the PNI-NPN based CAG list in the Area Scope of QMC and the separate NPN area scope for QMC, e.g., by combining the two area scope included in the QMC configuration.

In some embodiments, for management-based QoE, the OAM may send QMC configuration directly to the NG-RAN node, without the CN forwarding the configuration. The configuration related to NPN can be the same as described above. After receiving the QMC configuration, the NG-RAN node may select the suitable UEs based on the configuration information, including the assistance information for NPN scenario.

Step 3: The NG-RAN node may send the QoE configuration to the UE via a RRC message, after which the UE may start QoE measurement collection in the application layer. The RRC message may also include some assistance information for NPN, to indicate the UE to collect QoE measurement results in the NPN scenario.

Step 4: The UE may send the QoE report(s) to the NG-RAN node.

Step 5: The NG-RAN node may forward the QoE report(s) to the corresponding measurement collection entity (MCE).

Implementation Example 2: QoE measurement collection in NTN scenario

FIG. 4 illustrates a sequence diagram illustrating quality of experience (QoE) measurement collection in a non-terrestrial network (NTN), in accordance with some embodiments of the present disclosure. An OAM may collect QoE measurement results for UEs that are connected to a non-terrestrial network (NTN) network. In order to collect QoE measurements for the NTN, when the OAM configures QoE measurement collection, the OAM may provide some assistance information on the NTN network.

Step 1: A network node may send a quality of experience (QoE) measurement collection (QMC) configuration to another network node. For example, an OAM may send QMC configuration to a CN. The QMC configuration may comprise assistance information for QoE measurement in at least one of: a non-public network (NPN) or a non-terrestrial network (NTN). For example, the assistance information includes at least one of: non-public network (NPN) assistance information; or non-terrestrial network (NTN) assistance information.

Step 2: The network node may send the QMC configuration to a wireless communication node. For example, the CN may send the QMC configuration to a NG-RAN or a UE via a UE-associated message. The UE-associated message can be an Initial Context Setup Request message, or a UE Context Modification Request message. There can be three kinds of purposes depended on how the UE-associated message being used. For example, the purpose can be at least one of: to establish initial UE context (e.g., Initial Context Setup Request message), to modify the UE context (e.g., UE Context Modification Request message), or to pass the configuration information during handover (e.g., Handover Request message).

For management-based QoE, the OAM may send QMC configuration directly to the NG-RAN node, without the CN forwarding the configuration. The configuration related to a NTN can be the same as described above. After receiving the QMC configuration, the NG-RAN node may select suitable UEs based on the configuration information, including the assistance information for a NTN scenario.

To collect the QoE measurement in a NTN scenario, the QMC configuration in the step 1 and step 2 may include assistance information for the NTN. There can be three options of the assistance information for the NTN:

Option 1: A non-terrestrial network indication may indicate to collect QoE measurement results in a NTN network. An example of the IE is shown below:

IE/Group Name	**Presence**	**Range**	**IE Type and Reference**
NTN assistance information	O		ENUERATED (true, ...)

Option 1 can be a simple indication without specific network information and can be used directly to indicate the network about the purpose to collect QoE measurement in NTN, without specifying any network information.

Option 2: A NTN QMC scope may indicate a NTN connection type that is to be collected for QoE measurement. The connection type of the NTN may include at least one of: a new radio-low earth orbit (NR-LEO); a new radio-medium earth orbit (NR-MEO); a new radio-geostationary earth orbit (NR-GEO); or a NR-OTHERSAT. The IE can be a bit string, or an ENMERATED type. For example, at least one of the following

codepoints may be used: nR-LEO, nR-MEO, nR-GEO, or nR-OTHERSAT. Option 2 provides more information about the NTN network, which can be to indicate the certain type NTN network where the QMC can be performed.

Option 3: The QMC configuration can include frequency band information corresponding to the NTN. If the frequency band information provided in the QMC configuration is associated with the frequency band allocated for NTN network, the OAM may collect the QoE measurement results for UEs in the NTN network. Some examples of the frequency information are provided below:

Example 1:

IE/Group Name	Presence	Range	IE Type and Reference
Minimum Frequency	O		INTEGER (0.. maxNRARFCN)
Maximum Frequency	O		INTEGER (0.. maxNRARFCN)

Range bound	Explanation
maxNRARFCN	Maximum value of NRARFCNs. Value can be 3279165.

The minimum frequency and maximum frequency may comprise the frequency scope of the UEs that the OAM can collect QoE measurement results. The frequency provided can be used to identify the absolute frequency position of the reference resource block (Common RB 0) of the carrier.

Example 2:

IE/Group Name	Presence	Range	IE Type and Reference
Frequency Band	O		INTEGER (1, .. 1024, ...)

This IE may denote the QMC can be performed for UEs that operate at the specific operating band. The value 1 corresponds to n1, value 2 corresponds to NR operating band n2, etc. For example, the operating band allocated for NR NTN can be n255 and n256. Thus, if the frequency band is set to 255 or 256, it may indicate that the QoE measurement can be collected for those UEs connected to the NR NTN. Option 3 uses the frequency information for the NG-RAN to decide whether to collect the QoE measurements for UE(s) in the NTN or other types of access network.

Step 3: The NG-RAN node may send the QoE configuration to the UE via a RRC message, after which the UE may start QoE measurement collection in the application layer. The RRC message may also include some assistance information for NTN, to indicate the UE to collect QoE measurement results in the NTN scenario.

Step 4: The UE may send the QoE report(s) to the NG-RAN node. Due to the limited resources in a NTN band, the UE may store the QoE measurement reports in the NTN frequency band while sending the reports to the NG-RAN node when the UE connects to non-NTN frequency band.

Step 5: The NG-RAN node may forward the QoE report(s) to the corresponding measurement collection entity (MCE).

Implementation Example 3: QMC continuity during mobility in a NPN scenario and/or a NTN scenario

FIG. 5 illustrates a sequence diagram illustrating quality of experience (QoE) support, in accordance with some embodiments of the present disclosure. The purpose for the transmission of assistance information between NG-RAN nodes can be to pass the configuration information to ensure the continuity of QoE measurement collection during a handover procedure.

NPN scenario:

The QoE continuity during mobility can be supported over NG and Xn. In a NPN scenario, the UE may also handover to target gNBs, so that the continuity of QoE measurement collection can also be supported. For a SNPN, the UE can only handovers to a SNPN network. For a PNI-NPN, the UE may handover to a CAG-cell or public cell, which depends on whether the UE is configured to be only allowed to connect to CAG cells.

Step 1: A NG-RAN node 1 may send a Handover Request message to a NG-RAN node 2 for a specific UE, which may include the QMC configuration information. The QMC configuration may include the assistance information to support QoE measurement collection continuity in NPN, which is as described in Implementation Example 1.

Step 2: The NG-NAN node 2 may send a Handover Request Acknowledge message to the NG-RAN node 1. The target NG-RAN node can decide whether to keep the QoE measurement in the UE or to release the QoE measurement configuration for that UE, based on the assistance information for NPN received in the Handover Request message. For example, in PNI-NPN scenario, if the UE handovers from a CAG-cell into a public cell, and the NPN assistance information indicates that the QMC can only be collected for UEs that connect to the CAG-cell, the target gNB may decide to release the QMC configuration by its implementation. The source NG-RAN may also include an indication in the message to the target NG-RAN node, to indicate the target node whether to keep the QoE measurement collection or not.

NTN scenario:

A NTN network may reuse procedures for mobility, which can include the QMC configuration to support the continuity of QoE measurement collection.

Step 1: A NG-RAN node 1 may send a Handover Request message to a NG-RAN node 2 for a specific UE, which may include the QMC configuration information. The QMC configuration may include the assistance information to support QoE measurement collection continuity in NPN, which is as described in Implementation Example 2.

Step 2: The NG-NAN node 2 may send a Handover Request Acknowledge message to the NG-RAN node 1. The target NG-RAN node can decide/determine whether to keep the QoE measurement in the UE or to release the QoE measurement configuration for that UE, based on the assistance information for NTN received in the Handover Request message. For example, if the UE handovers from the NTN network to a TN network, and if the assistance information indicates that the QoE measurement can be collected when the UE is connected to an NTN network, the target gNB may decide to release the QMC configuration by its implementation. The source NG-RAN may also include an indication in the message to the target NG-RAN node, to indicate the target node whether to keep the QoE measurement collection or not.

To support the continuity of QoE measurement collection during NG-based handover, the NPN assistance information or the NTN assistance information can be transferred to the target node via the AMF, e.g., included in the QMC configuration of source to target transparent container, which can be passed in the Handover Required message from source NG-RAN node to the AMF, and can be sent to the target AMF in the Handover Request message. The present disclosure targets the case of mobility when the UE moves between NG-RAN nodes. If the assistance information is not passed from the source NG-RAN node to the target NG-RAN node, the target node may not be able to be aware that the QMC is only needed to be collected in certain scenarios, such that the network node may not make suitable decisions on whether to keep or to release the QoE configuration afterwards. The present disclosure provides a method to pass the assistance information of the NPN/NTN to the target node as a reference, for better decisions.

It should be understood that one or more features from the above/following implementation examples are not exclusive to the specific implementation examples, but can be combined in any manner (e.g., in any priority and/or order, concurrently or otherwise).

FIG. 6 illustrates a flow diagram of an example method for supporting quality of experience (QoE), in accordance with an embodiment of the present disclosure. The method 600 may be implemented using any one or more of the components and devices detailed herein in conjunction with FIGS. 1 to 5. In overview, the method 600 may be performed by a network node (e.g., a CN, an OAM, and/or a NG-RAN), in some embodiments. Additional, fewer, or different operations may be performed in the method 600 depending on the embodiment. At least one aspect of the operations is directed to a system, method, apparatus, or a computer-readable medium.

A network node (e.g., a core network (CN), an administration and maintenance (OAM) node, or a next generation radio access network (NG-RAN) node) may send a quality of experience (QoE) measurement collection (QMC) configuration to a wireless communication node (e.g., a next generation radio access network (NG-RAN) node). The QMC configuration may comprise assistance information for QoE measurement in at least one of: a non-public network (NPN) or a non-terrestrial network (NTN). Traditionally, the QoE configuration may not include any information related to the NPN or the NTN. The network node may not be able to collect the QoE measurement for UEs in certain scenarios such as NPN/NTN. The present disclosure introduces assistance information for the NPN/NTN scenarios in QMC configuration, so that the QoE measurement can be collected when UEs are connected to NPN/NTN networks as indicated. The network node may comprise: a node of a core network (CN), an operations, administration and maintenance (OAM) node, or

a next generation radio access network (NG-RAN) node. The three kinds of network nodes here denotes three different cases/scenarios for the QoE measurement collection. For a node of a core network (CN), this can be the case for the initial configuration of signaling-based QoE. The AMF may receive the QMC configuration from the OAM and may forward the QMC configuration to a specific UE. For an OAM node, this can be the case for the initial configuration of management-based QoE. The OAM may send the QMC configuration directly to the NG-RAN node. For a NG-RAN node, this can be for the case of mobility scenarios, e.g., handover. The source NG-RAN node may forward the QMC configuration to the target NG-RAN node to ensure the continuity of QoE measurement collection.

In some embodiments, the assistance information may include at least one of: non-public network (NPN) assistance information; or non-terrestrial network (NTN) assistance information. The present disclosure specifies the type or purpose of the assistance information in the QMC configuration. One can be for NPN network, to allow the OAM to indicate to the NG-RAN about the purpose of collecting QoE measurements for UEs in a certain NPN network. The other one can be for NTN network, to allow the OAM to indicate the NG-RAN about the purpose of collecting QoE measurements for UEs in a certain NTN network.

In some embodiments, the NPN assistance information may include at least one of: an indication to collect QoE measurement for at least one user equipment (UE) in the NPN; one or more choices for Area Scope of QMC in QoE configuration to be extended for the NPN; or a single information element (IE) to define an area scope of the NPN for QMC. The present disclosure defines several possible/example options of specific assistance information for the NPN.

In some embodiments, the one or more choices for the Area Scope of QMC in the QoE configuration to be extended for the NPN may include at least one of: a public network integrated NPN (PNI-NPN) based choice; a standalone non-public network (SNPN) cell based choice; a SNPN tracking area identity (TAI) based choice; or a SNPN based choice. The PNI-NPN based choice may include a closed access group (CAG) list. The SNPN cell based choice may include a SNPN cell identifier (ID) list. The SNPN TAI based choice may include a SNPN TAI list. The SNPN based choice may include a SNPN list. The present disclosure provides more details about the area scope defined for the NPN network. Specifically, the CAG list can be used to identify the PNI-NPN network. The cell-based/SNPN TAI based/SNPN based lists may define the area scope of SNPN in at least three different scales, e.g., a cell, a TAI, and/or a PLMN. This kind of classification can be more flexible and could allow the network to collect the QoE measurement for different granularity/scope of area.

In some embodiments, the single/separate IE to define the area scope of the NPN for QMC may include at least one of: an IE to define an area scope of a public network integrated NPN (PNI-NPN); or an IE to define an area scope of a standalone non-public network (SNPN), or a SNPN list. The IE to define the area scope of the PNI-NPN may include a closed access group (CAG) list. The IE to define the area scope of the SNPN may include at least one of: a SNPN cell ID list, a SNPN tracking area identity (TAI) list. The present disclosure defines a single/separate IE that has no impact on the existing Area Scope of QMC IE. Similarly, this information included in this IE can be a network identifier of the PNI-NPN or the SNPN. The CAG list may include at least one of: a public land mobile network (PLMN) ID or a CAG ID. The SNPN cell ID list may

include at least one of: a new radio cell global identity (NR-CGI) or a network identification (NID). The SNPN TAI list may include at least one of: a TAI or a NID. The SNPN list may include at least one of: a PLMN ID or a NID. The present disclosure provides more details about the information about the identifier of the NPN network. Specifically, the PLMN ID and CAG ID can be used to identify an PNI-NPN. The PLMN ID and NID can be used to identify an SNPN (note that the NR-CGI and TAI both includes an PLMN ID).

In some embodiments, the NTN assistance information may include at least one of: an indication to collect QoE measurement for at least one user equipment (UE) in the NTN; a connection type of the NTN; or frequency band information corresponding to an access network. The present disclosure defines for example three options of specific assistance information for the NTN.

The connection type of the NTN may include at least one of: a new radio-low earth orbit (NR-LEO); a new radio-medium earth orbit (NR-MEO); a new radio-geostationary earth orbit (NR-GEO); or a NR-OTHERSAT. The present disclosure provides more detailed information about the connection type of NTN, which can be used for the network to decide in which type of collection the QoE measurement can be performed.

The frequency band information may include at least one of: a range of absolute frequency; or a specific number that is allocated for a frequency band. The present disclosure provides more information about how the frequency information can be specified. One example can be to simply define the range of absolute frequency. The other example can be to use the allocated number for the frequency band and can also be easily translated by the network.

In some embodiments, the wireless communication node may send a QoE configuration to a wireless communication device via a radio resource control (RRC) message. The assistance information can be mainly used by the network but may also be of use to the user equipment. For example, the UE may sometimes move/transition from a public network to a non-public network, or from a terrestrial network to a non-terrestrial network. Without the assistance information over the RRC message, the UE may continue to collect QoE measurements even if the OAM is only concerned about the measurement in the NPN/NTN. With the assistance information over the RRC message, the UE can only collect QoE measurement when the UE is connected to the NPN/NTN network, and can reduce load in the application layer and also utilization of radio resources.

In some embodiments, the network node may send the assistance information for the QoE measurement in the NPN or NTN to the wireless communication node via a user equipment (UE) associated message. The present disclosure specifies NGAP procedures that are used to transfer the assistance information. The NGAP messages can be reused for transferring the assistance information. In some embodiments, the UE associated message can be to establish an initial UE context. The UE associated message can be to modify a UE context. The UE associated message can be to pass configuration information during a handover procedure.

In some embodiments, a wireless communication node (e.g., a next generation radio access network (NG-RAN) node) may receive a quality of experience (QoE) measurement collection (QMC) configuration from a network node (e.g., a core network (CN), an administration and maintenance (OAM) node, or a next generation radio access network (NG-RAN) node). The QMC configuration may comprise assistance information for QoE measurement in at least one of: a non-public network (NPN) or a non-terrestrial network (NTN).

While various embodiments of the present solution have been described above, it should be understood that they have been presented by way of example only, and not by way of limitation. Likewise, the various diagrams may depict an example architectural or configuration, which are provided to enable persons of ordinary skill in the art to understand example features and functions of the present solution. Such persons would understand, however, that the solution is not restricted to the illustrated example architectures or configurations, but can be implemented using a variety of alternative architectures and configurations. Additionally, as would be understood by persons of ordinary skill in the art, one or more features of one embodiment can be combined with one or more features of another embodiment described herein. Thus, the breadth and scope of the present disclosure should not be limited by any of the above-described illustrative embodiments.

It is also understood that any reference to an element herein using a designation such as "first," "second," and so forth does not generally limit the quantity or order of those elements. Rather, these designations can be used herein as a convenient means of distinguishing between two or more elements or instances of an element. Thus, a reference to first and second elements does not mean that only two elements can be employed, or that the first element must precede the second element in some manner.

Additionally, a person having ordinary skill in the art would understand that information and signals can be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits and symbols, for example, which may be referenced in the above description can be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

A person of ordinary skill in the art would further appreciate that any of the various illustrative logical blocks, modules, processors, means, circuits, methods and functions described in connection with the aspects disclosed herein can be implemented by electronic hardware (e.g., a digital implementation, an analog implementation, or a combination of the two), firmware, various forms of program or design code incorporating instructions (which can be referred to herein, for convenience, as "software" or a "software module), or any combination of these techniques. To clearly illustrate this interchangeability of hardware, firmware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware, firmware or software, or a combination of these techniques, depends upon the particular application and design constraints imposed on the overall system. Skilled artisans can implement the described functionality in various ways for each particular application, but such implementation decisions do not cause a departure from the scope of the present disclosure.

Furthermore, a person of ordinary skill in the art would understand that various illustrative logical blocks, modules, devices, components and circuits described herein can be implemented within or performed by an integrated circuit (IC) that can include a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, or any combination thereof. The logical blocks, modules, and circuits can further include antennas and/or transceivers to communicate with various components within the network or within the device. A general purpose processor can be a microprocessor, but in the alternative, the processor can be any conventional

processor, controller, or state machine. A processor can also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other suitable configuration to perform the functions described herein.

If implemented in software, the functions can be stored as one or more instructions or code on a computer-readable medium. Thus, the steps of a method or algorithm disclosed herein can be implemented as software stored on a computer-readable medium. Computer-readable media includes both computer storage media and communication media including any medium that can be enabled to transfer a computer program or code from one place to another. A storage media can be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can include RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to store desired program code in the form of instructions or data structures and that can be accessed by a computer.

In this document, the term "module" as used herein, refers to software, firmware, hardware, and any combination of these elements for performing the associated functions described herein. Additionally, for purpose of discussion, the various modules are described as discrete modules; however, as would be apparent to one of ordinary skill in the art, two or more modules may be combined to form a single module that performs the associated functions according embodiments of the present solution.

Additionally, memory or other storage, as well as communication components, may be employed in embodiments of the present solution. It will be appreciated that, for clarity purposes, the above description has described embodiments of the present solution with reference to different functional units and processors. However, it will be apparent that any suitable distribution of functionality between different functional units, processing logic elements or domains may be used without detracting from the present solution. For example, functionality illustrated to be performed by separate processing logic elements, or controllers, may be performed by the same processing logic element, or controller. Hence, references to specific functional units are only references to a suitable means for providing the described functionality, rather than indicative of a strict logical or physical structure or organization.

Various modifications to the embodiments described in this disclosure will be readily apparent to those skilled in the art, and the general principles defined herein can be applied to other embodiments without departing from the scope of this disclosure. Thus, the disclosure is not intended to be limited to the embodiments shown herein, but is to be accorded the widest scope consistent with the novel features and principles disclosed herein, as recited in the claims below.

CLAIMS

1. A method comprising:

sending, by a network node to a wireless communication node, a quality of experience (QoE) measurement collection (QMC) configuration,

wherein the QMC configuration comprises assistance information for QoE measurement in at least one of: a non-public network (NPN) or a non-terrestrial network (NTN).

2. The method of claim 1, wherein the network node comprises: a node of a core network (CN), an operations, administration and maintenance (OAM) node, or a next generation radio access network (NG-RAN) node.

3. The method of claim 1, wherein the assistance information includes at least one of:

non-public network (NPN) assistance information; or

non-terrestrial network (NTN) assistance information.

4. The method of claim 3, wherein the NPN assistance information includes at least one of:

an indication to collect QoE measurement for at least one user equipment (UE) in the NPN;

one or more choices for Area Scope of QMC in QoE configuration to be extended for the NPN; or

a single information element (IE) to define an area scope of the NPN for QMC.

5. The method of claim 4, wherein the one or more choices for the Area Scope of QMC in the QoE configuration to be extended for the NPN includes at least one of:

a public network integrated NPN (PNI-NPN) based choice, wherein the PNI-NPN based choice includes a closed access group (CAG) list;

a standalone non-public network (SNPN) cell based choice, wherein the SNPN cell based choice includes a SNPN cell identifier (ID) list;

a SNPN tracking area identity (TAI) based choice, wherein the SNPN TAI based choice includes a SNPN TAI list; or

a SNPN based choice, wherein the SNPN based choice includes a SNPN list.

6. The method of claim 4, wherein the single IE to define the area scope of the NPN for QMC includes at least one of:

an IE to define an area scope of a public network integrated NPN (PNI-NPN), wherein the IE to define the area scope of the PNI-NPN includes a closed access group (CAG) list; or

an IE to define an area scope of a standalone non-public network (SNPN), wherein the IE to define the area scope of the SNPN includes at least one of: a SNPN cell ID list, a SNPN tracking area identity (TAI) list, or a SNPN list.

7. The method of claim 5 or 6, wherein at least one of:

the CAG list includes at least one of: a public land mobile network (PLMN) ID or a CAG ID;

the SNPN cell ID list includes at least one of: a new radio cell global identity (NR-CGI) or a

network identification (NID);

the SNPN TAI list includes at least one of: a TAI or a NID; or

the SNPN list includes at least one of: a PLMN ID or a NID.

8. The method of claim 3, wherein the NTN assistance information includes at least one of:

an indication to collect QoE measurement for at least one user equipment (UE) in the NTN;

a connection type of the NTN; or

frequency band information corresponding to an access network.

9. The method of claim 8, wherein the connection type of the NTN includes at least one of:

a new radio-low earth orbit (NR-LEO);

a new radio-medium earth orbit (NR-MEO);

a new radio-geostationary earth orbit (NR-GEO); or

a NR-OTHERSAT.

10. The method of claim 8, wherein the frequency band information includes at least one of:

a range of absolute frequency; or

a specific number that is allocated for a frequency band.

11. The method of claim 1, wherein the wireless communication node sends a QoE configuration to a wireless communication device via a radio resource control (RRC) message.

12. The method of claim 1, wherein the network node sends the assistance information for the QoE measurement in the NPN or NTN to the wireless communication node via a user equipment (UE) associated message.

13. The method of claim 12, wherein at least one of:

the UE associated message is to establish an initial UE context;

the UE associated message is to modify a UE context; or

the UE associated message is to pass configuration information during a handover procedure.

14. A method comprising:

receiving, by a wireless communication node from a network node, a quality of experience (QoE) measurement collection (QMC) configuration,

wherein the QMC configuration comprises assistance information for QoE measurement in at least one of: a non-public network (NPN) or a non-terrestrial network (NTN).

15. A non-transitory computer readable medium storing instructions, which when executed by at least one processor, cause the at least one processor to perform the method of any one of claims 1 to 14.

16. An apparatus comprising:

at least one processor configured to implement the method of any one of claims 1 to 14.

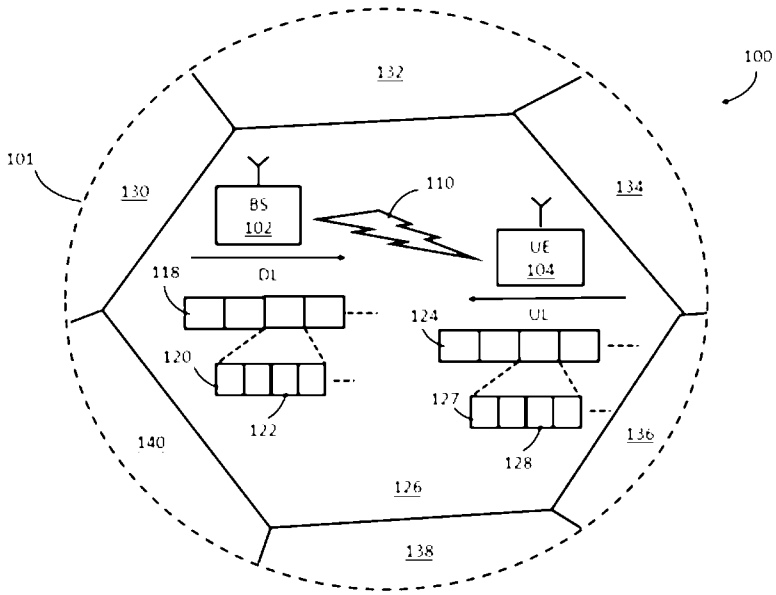
100
101
132
130
134
BS
102
110
UE
104
DL
UL
118
124
120
122
127
128
136
140
126
138

FIG. 1

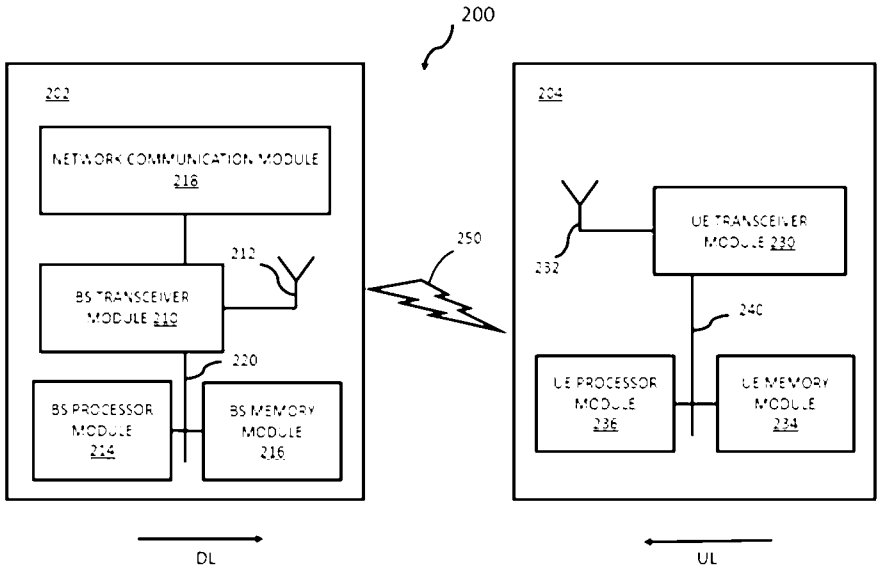
200
202
NETWORK COMMUNICATION MODULE
216
212
BS TRANSCEIVER
MODULE 210
220
BS PROCESSOR
MODULE
224
BS MEMORY
MODULE
226
250
204
UE TRANSCEIVER
MODULE 230
232
240
UE PROCESSOR
MODULE
236
UE MEMORY
MODULE
234
DL
UL

FIG. 2

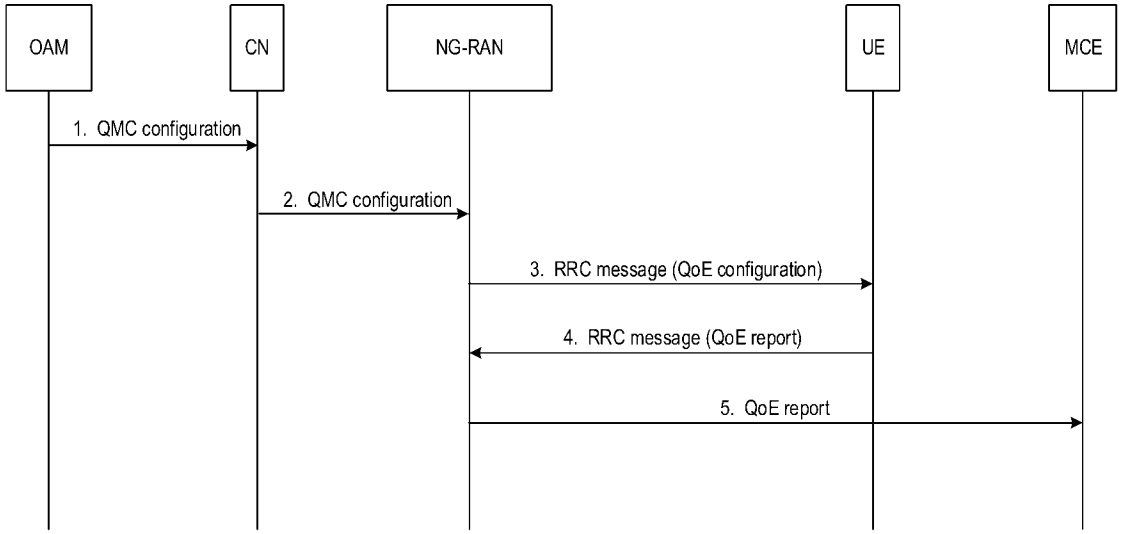
OAM
CN
NG-RAN
UE
MCE
1. QMC configuration
2. QMC configuration
3. RRC message (QoE configuration)
4. RRC message (QoE report)
5. QoE report

FIG. 3

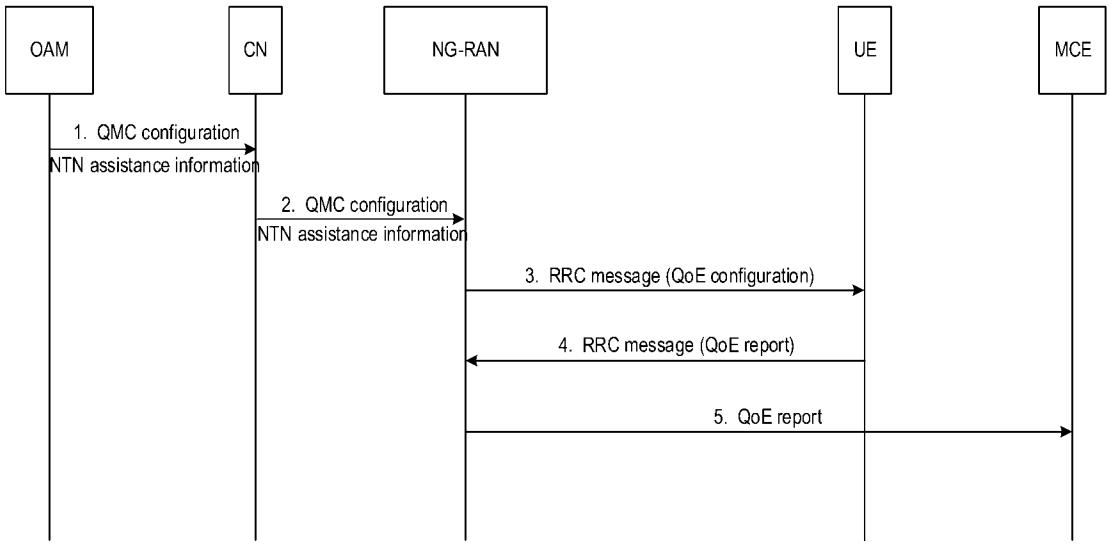
OAM
CN
NG-RAN
UE
MCE
1. QMC configuration
NTN assistance information
2. QMC configuration
NTN assistance information
3. RRC message (QoE configuration)
4. RRC message (QoE report)
5. QoE report

FIG. 4

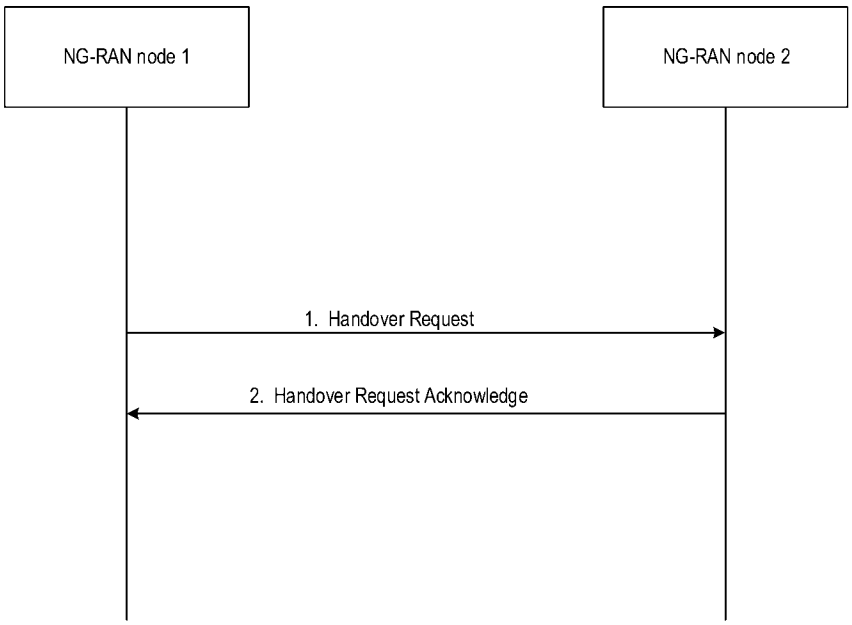
NG-RAN node 1
NG-RAN node 2
1. Handover Request
2. Handover Request Acknowledge

FIG. 5

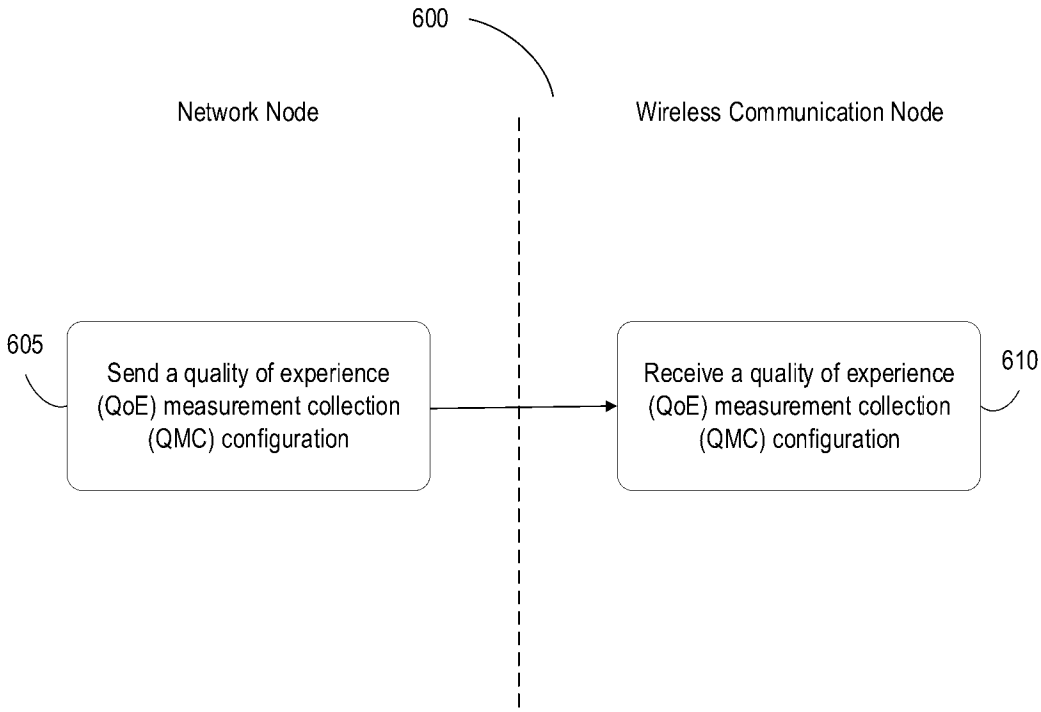
600
Network Node
Wireless Communication Node
605
Send a quality of experience (QoE) measurement collection (QMC) configuration
Receive a quality of experience (QoE) measurement collection (QMC) configuration
610

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2024/070904

A. CLASSIFICATION OF SUBJECT MATTER

H04L 5/00(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:H04W,H04L

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

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

CNKI,VEN,EXTXTC,WPABS,CNTXT,3GPP:quality,experience,QoE,measur+,collect+,QMC,configurat+,non-public network,NPN,non-terrestrial network,NTN

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2022075903 A1 (TELEFONAKTIEBOLAGET LM ERICSSON(PUBL)) 14 April 2022 (2022-04-14) description, paragraphs 37-68,153-396, claims 1-40	1-16
X	CN 116235528 A (ZTE CORPORATION) 06 June 2023 (2023-06-06) description, paragraphs 20-40	1-16
X	WO 2022150004 A1 (TELEFONAKTIEBOLAGET LM ERICSSON(PUBL)) 14 July 2022 (2022-07-14) description, paragraphs 100-135	1-16
A	CN 111918308 A (ZTE CORPORATION) 10 November 2020 (2020-11-10) the whole document	1-16

☐ 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
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"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	Date of mailing of the international search report
20 September 2024	**25 September 2024**

Name and mailing address of the ISA/CN	Authorized officer
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2024/070904

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2022075903 A1	14 April 2022	None	
CN 116235528 A	06 June 2023	WO 2022217477 A1	20 October 2022
		US 2023199543 A1	22 June 2023
		KR 20230170683 A1	19 December 2023
		EP 4305868 A1	17 January 2024
WO 2022150004 A1	14 July 2022	None	
CN 111918308 A	10 November 2020	WO 2022028345 A1	10 February 2022
		EP 4142342 A1	01 March 2023
		US 2023199892 A1	22 June 2023