US 20250267562A1

(19) United States
(12) Patent Application Publication
LJUNG

(10) Pub. No.: US 2025/0267562 A1
(43) Pub. Date: Aug. 21, 2025

(54) **COMMUNICATION DEVICE ASSISTANCE FOR NETWORK CONFIGURATION OPTIMIZATION**

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(21) Appl. No.: **18/858,449**

(22) PCT Filed: **May 25, 2022**

(86) PCT No.: **PCT/EP2023/064017**

§ 371 (c)(1),
(2) Date: **Oct. 21, 2024**

Related U.S. Application Data

(60) Provisional application No. 63/345,577, filed on May 25, 2022.

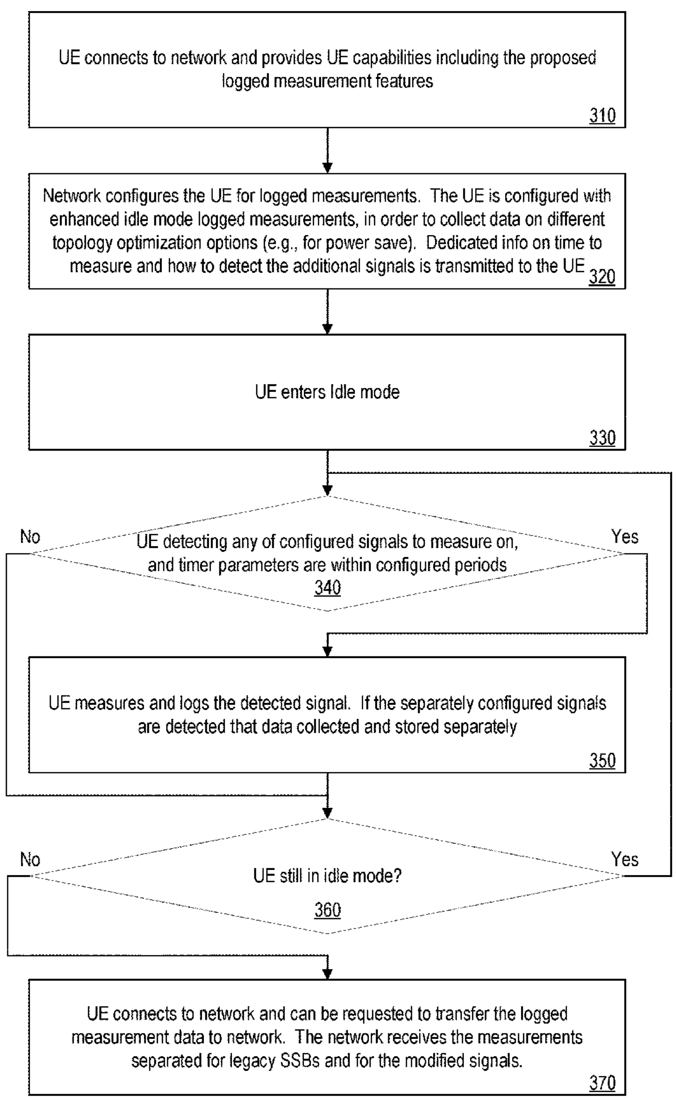
Publication Classification

(51) **Int. Cl.**
H04W 48/16 (2009.01)
H04W 52/02 (2009.01)

(52) **U.S. Cl.**
CPC ***H04W 48/16*** (2013.01); ***H04W 52/0216*** (2013.01); ***H04W 52/0229*** (2013.01)

(57) **ABSTRACT**

A communication device in a communications network can receive configuration information from the network node using a first topology configuration while the communication device is in an active state. The configuration information can indicate a request for the communication device to perform an action associated with a second topology configuration that is different than the first topology configuration while the communication device is in an idle state. The communication device can transition to an idle state. The communication device can perform the action associated with the second topology configuration.



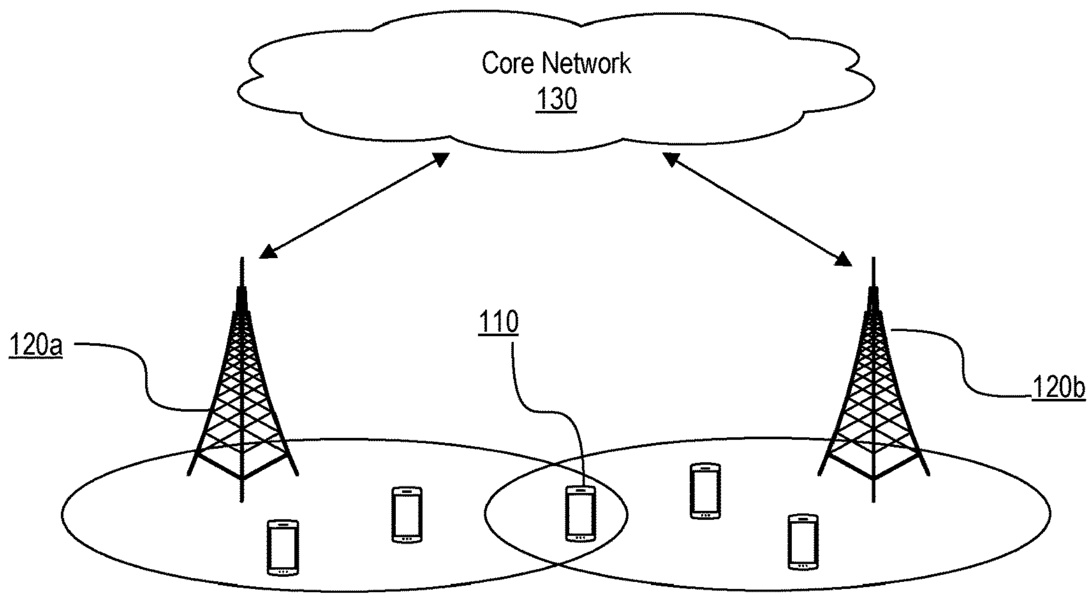


FIG. 1

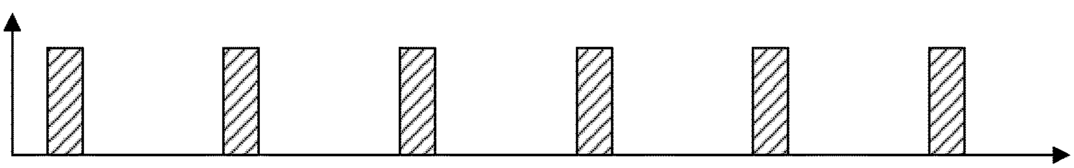


FIG. 2A

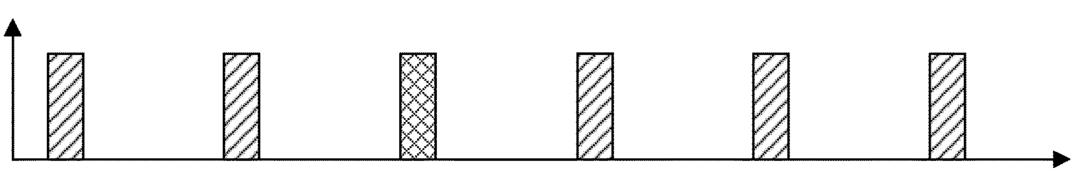


FIG. 2B

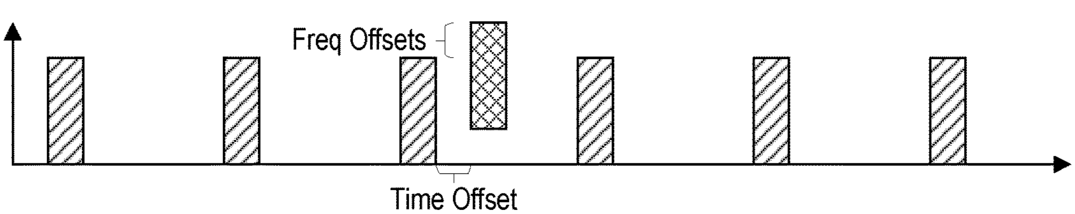
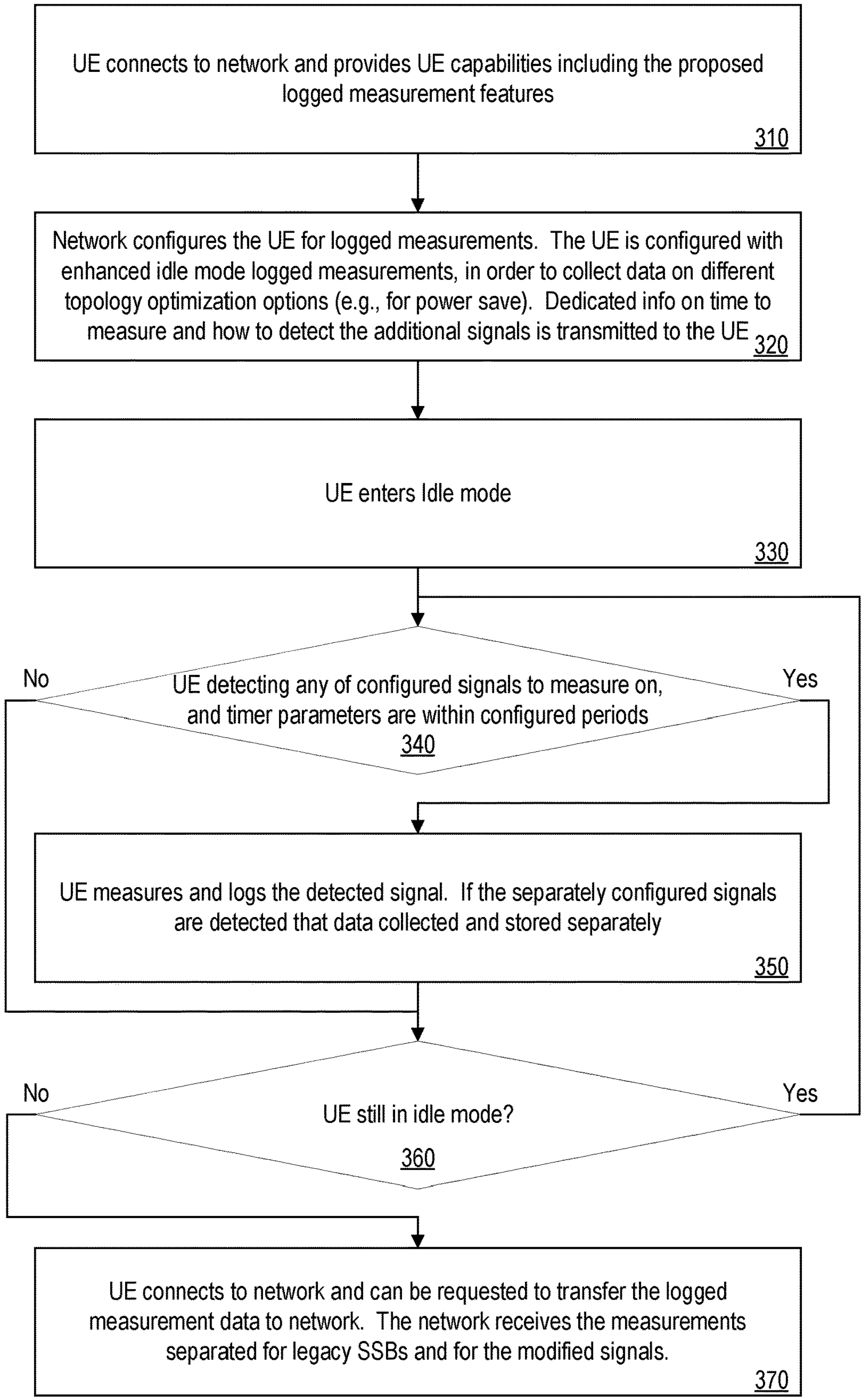


FIG. 2C



UE connects to network and provides UE capabilities including the proposed logged measurement features
310
Network configures the UE for logged measurements. The UE is configured with enhanced idle mode logged measurements, in order to collect data on different topology optimization options (e.g., for power save). Dedicated info on time to measure and how to detect the additional signals is transmitted to the UE
320
UE enters Idle mode
330
No
UE detecting any of configured signals to measure on, and timer parameters are within configured periods
340
Yes
UE measures and logs the detected signal. If the separately configured signals are detected that data collected and stored separately
350
No
UE still in idle mode?
360
Yes
UE connects to network and can be requested to transfer the logged measurement data to network. The network receives the measurements separated for legacy SSBs and for the modified signals.
370

FIG. 3

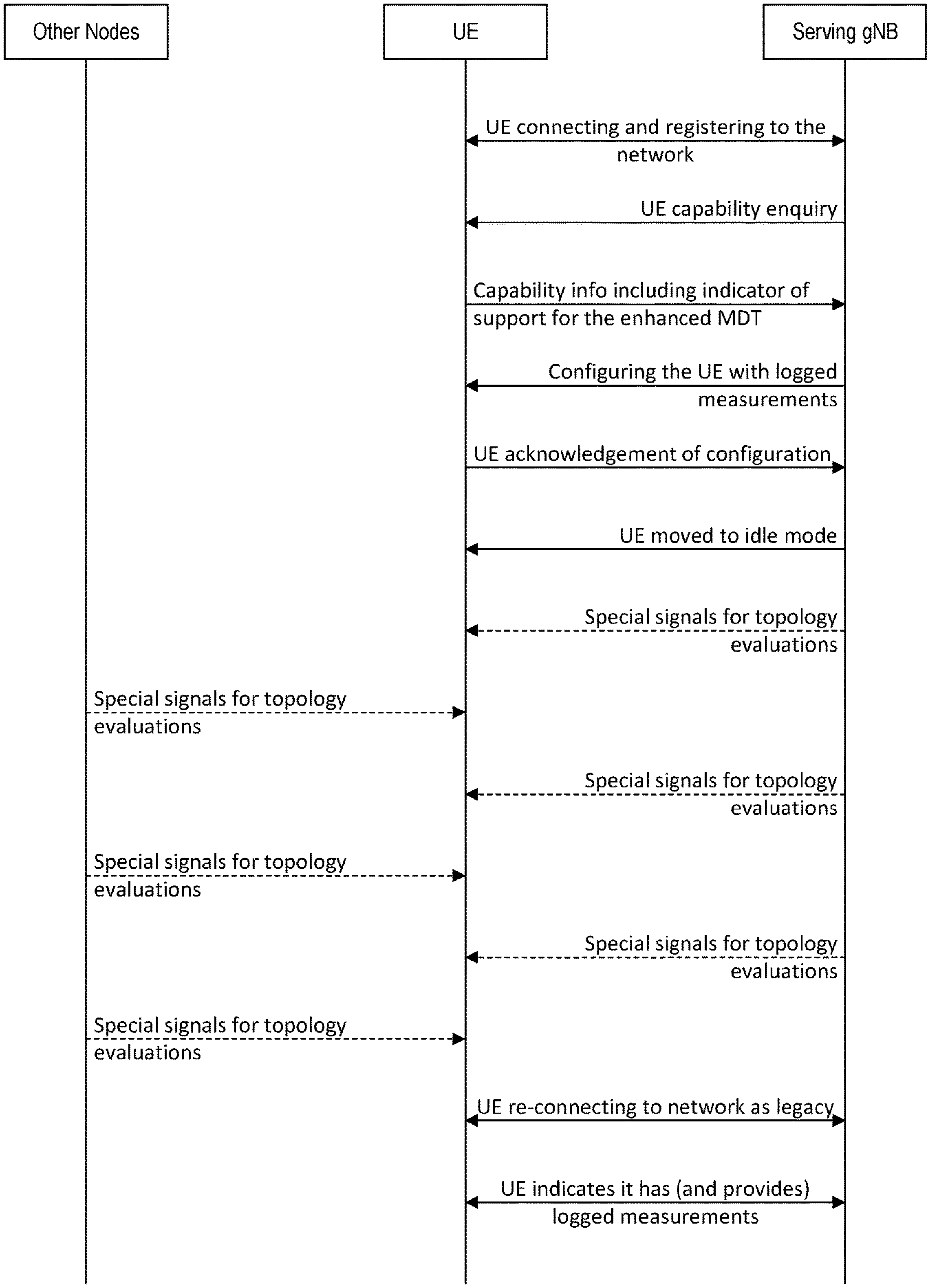

Other Nodes
UE
Serving gNB
UE connecting and registering to the network
UE capability enquiry
Capability info including indicator of support for the enhanced MDT
Configuring the UE with logged measurements
UE acknowledgement of configuration
UE moved to idle mode
Special signals for topology evaluations
Special signals for topology evaluations
Special signals for topology evaluations
Special signals for topology evaluations
Special signals for topology evaluations
Special signals for topology evaluations
UE re-connecting to network as legacy
UE indicates it has (and provides) logged measurements

FIG. 4

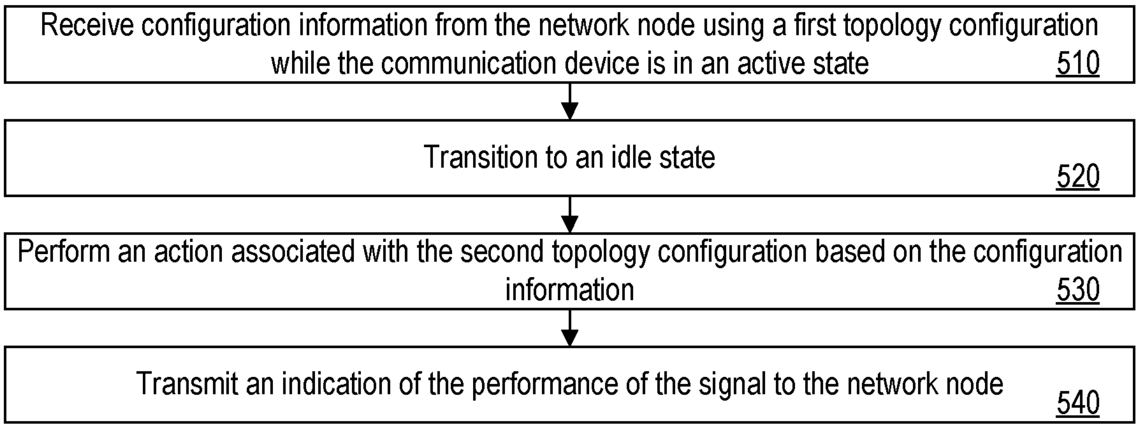

Receive configuration information from the network node using a first topology configuration while the communication device is in an active state 510
Transition to an idle state 520
Perform an action associated with the second topology configuration based on the configuration information 530
Transmit an indication of the performance of the signal to the network node 540

FIG. 5

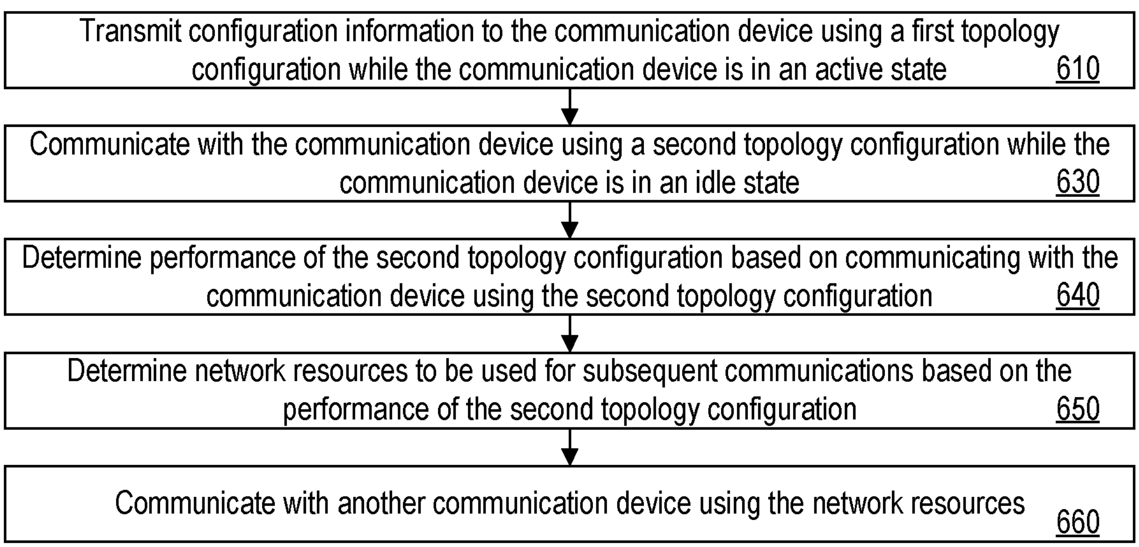

Transmit configuration information to the communication device using a first topology configuration while the communication device is in an active state 610
Communicate with the communication device using a second topology configuration while the communication device is in an idle state 630
Determine performance of the second topology configuration based on communicating with the communication device using the second topology configuration 640
Determine network resources to be used for subsequent communications based on the performance of the second topology configuration 650
Communicate with another communication device using the network resources 660

FIG. 6

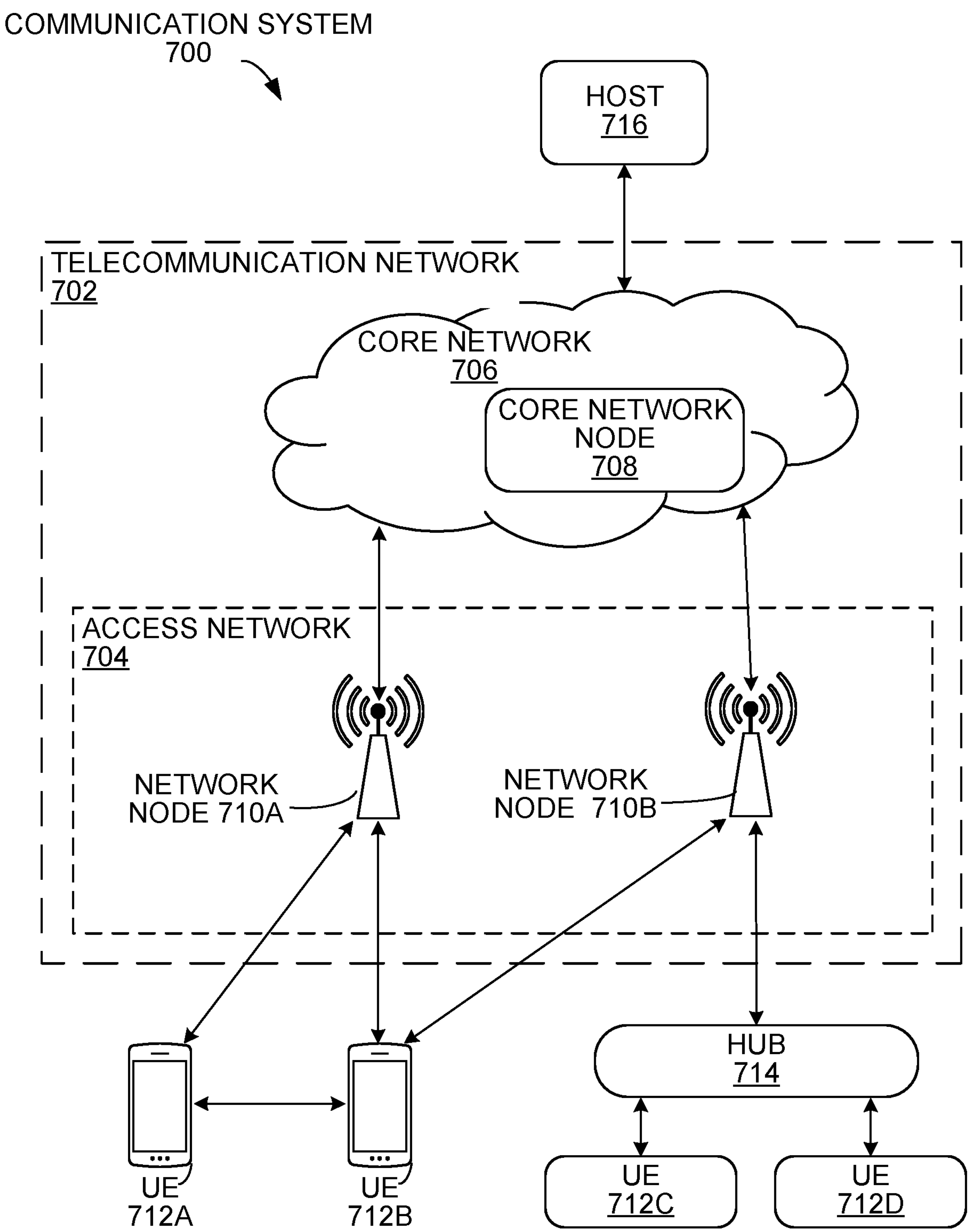

COMMUNICATION SYSTEM
700
HOST
716
TELECOMMUNICATION NETWORK
702
CORE NETWORK
706
CORE NETWORK
NODE
708
ACCESS NETWORK
704
NETWORK
NODE 710A
NETWORK
NODE 710B
HUB
714
UE
712A
UE
712B
UE
712C
UE
712D

FIG. 7

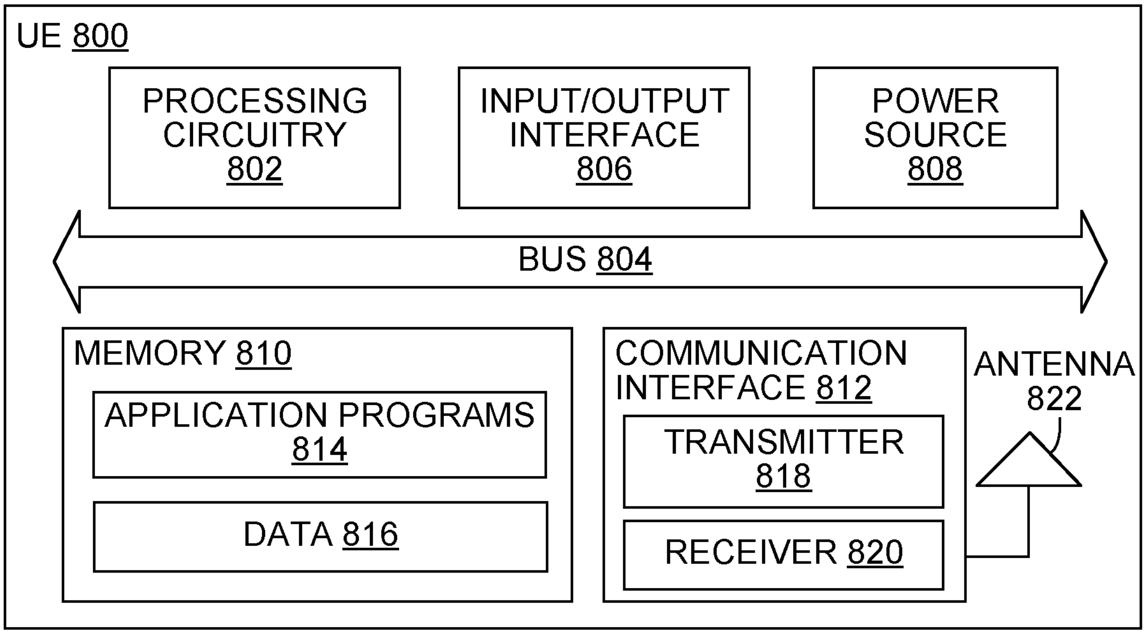

UE 800
PROCESSING CIRCUITRY 802
INPUT/OUTPUT INTERFACE 806
POWER SOURCE 808
BUS 804
MEMORY 810
APPLICATION PROGRAMS 814
DATA 816
COMMUNICATION INTERFACE 812
TRANSMITTER 818
RECEIVER 820
ANTENNA 822

FIG. 8

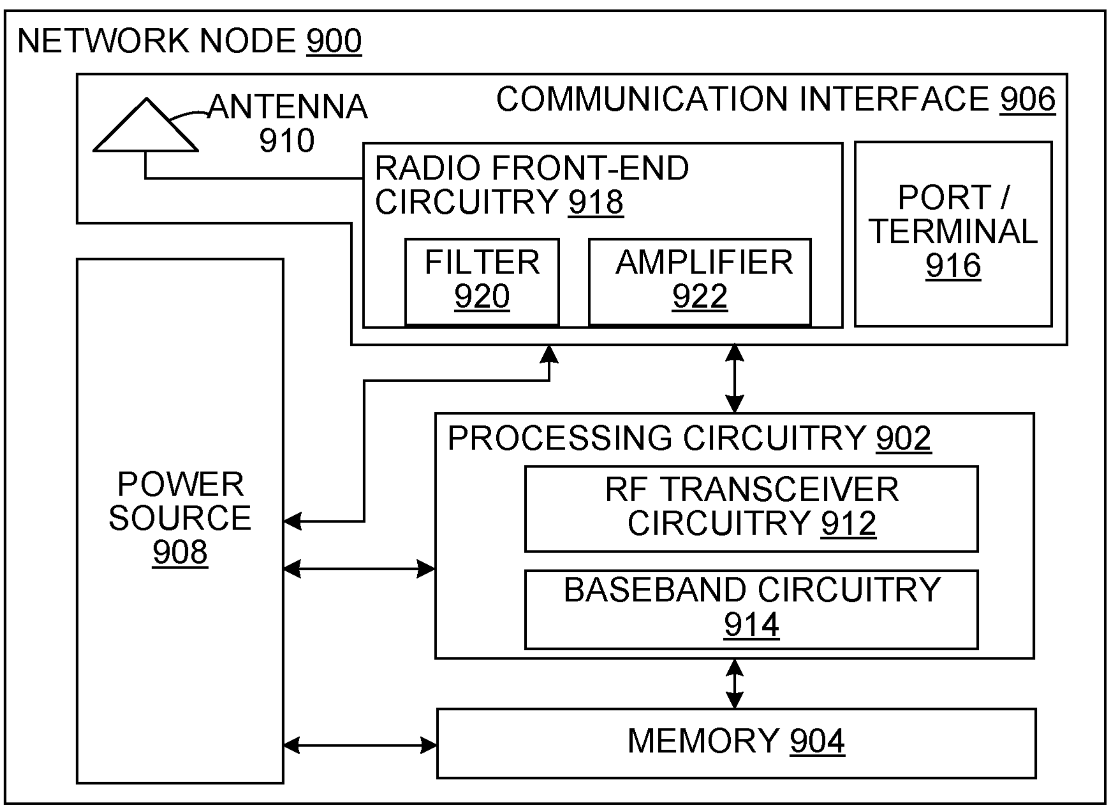

NETWORK NODE 900
COMMUNICATION INTERFACE 906
ANTENNA 910
RADIO FRONT-END CIRCUITRY 918
FILTER 920
AMPLIFIER 922
PORT / TERMINAL 916
POWER SOURCE 908
PROCESSING CIRCUITRY 902
RF TRANSCEIVER CIRCUITRY 912
BASEBAND CIRCUITRY 914
MEMORY 904

FIG. 9

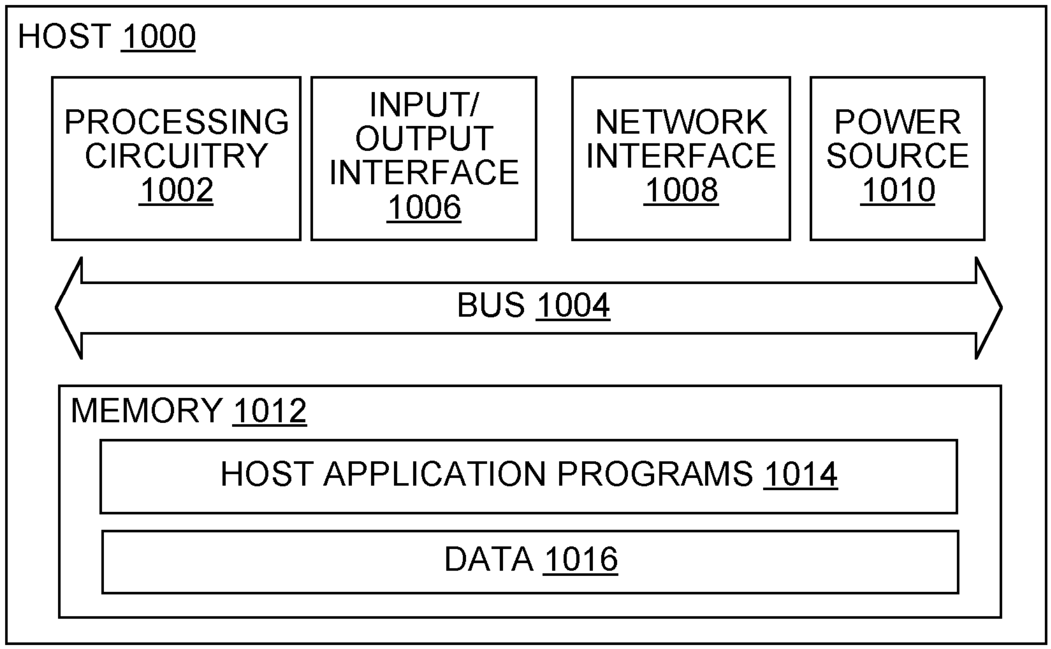

HOST 1000
PROCESSING CIRCUITRY 1002
INPUT/ OUTPUT INTERFACE 1006
NETWORK INTERFACE 1008
POWER SOURCE 1010
BUS 1004
MEMORY 1012
HOST APPLICATION PROGRAMS 1014
DATA 1016

FIG. 10

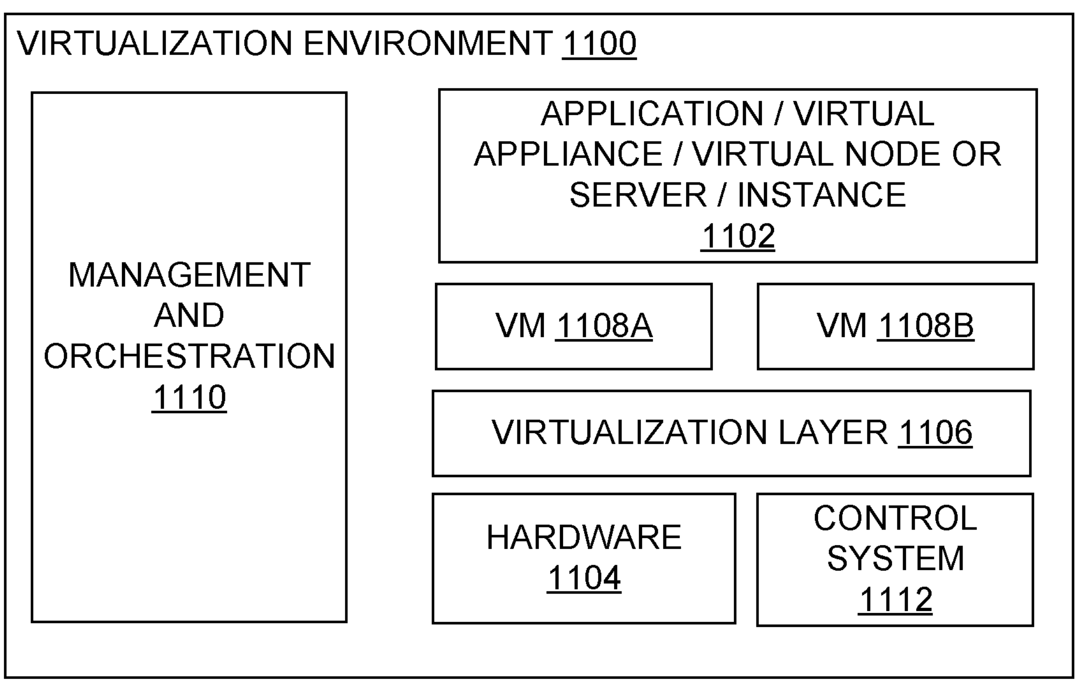

VIRTUALIZATION ENVIRONMENT 1100
MANAGEMENT AND ORCHESTRATION 1110
APPLICATION / VIRTUAL APPLIANCE / VIRTUAL NODE OR SERVER / INSTANCE 1102
VM 1108A
VM 1108B
VIRTUALIZATION LAYER 1106
HARDWARE 1104
CONTROL SYSTEM 1112

FIG. 11

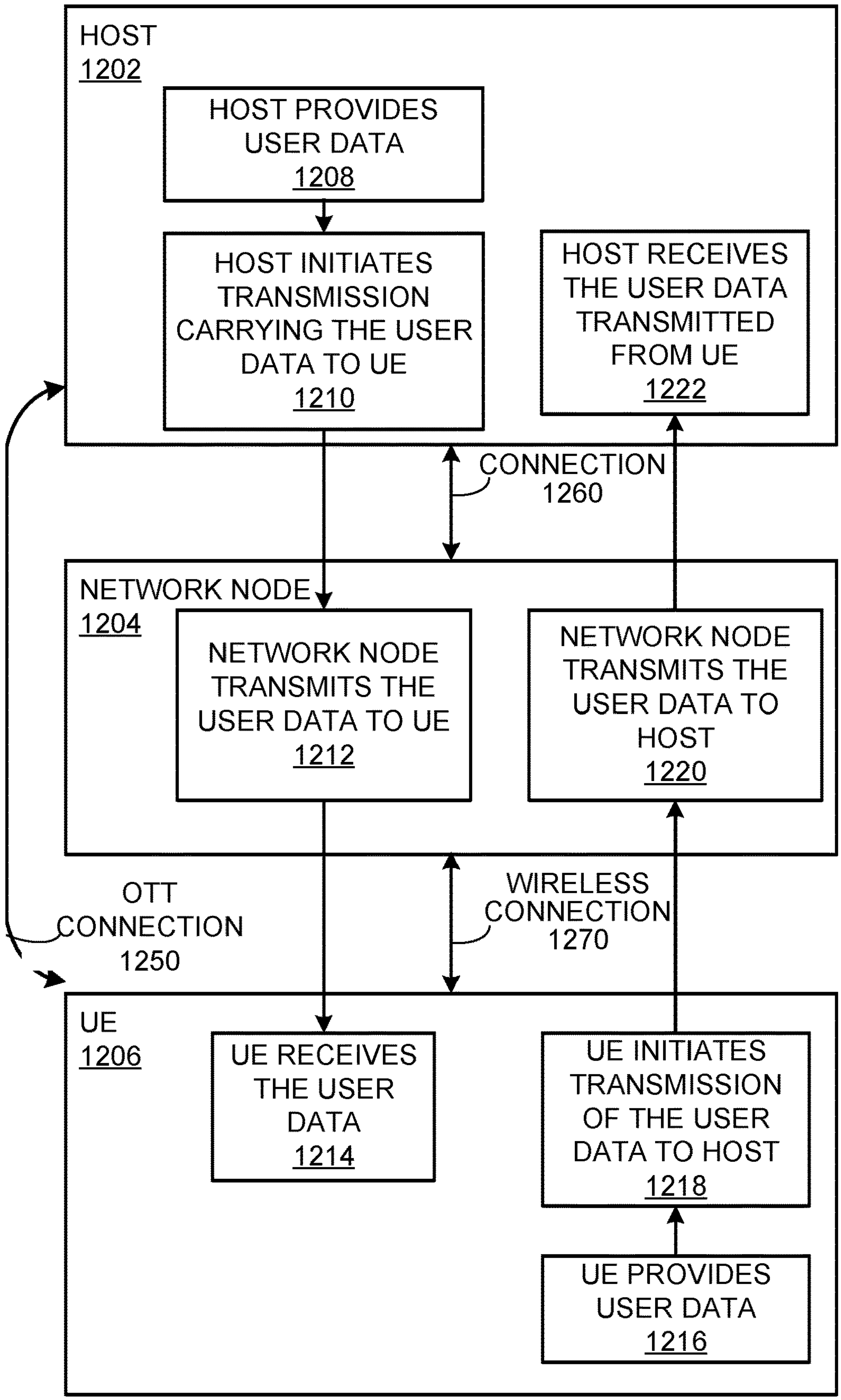

HOST
1202
HOST PROVIDES USER DATA
1208
HOST INITIATES TRANSMISSION CARRYING THE USER DATA TO UE
1210
HOST RECEIVES THE USER DATA TRANSMITTED FROM UE
1222
CONNECTION
1260
NETWORK NODE
1204
NETWORK NODE TRANSMITS THE USER DATA TO UE
1212
NETWORK NODE TRANSMITS THE USER DATA TO HOST
1220
OTT CONNECTION
1250
WIRELESS CONNECTION
1270
UE
1206
UE RECEIVES THE USER DATA
1214
UE INITIATES TRANSMISSION OF THE USER DATA TO HOST
1218
UE PROVIDES USER DATA
1216

FIG. 12

COMMUNICATION DEVICE ASSISTANCE FOR NETWORK CONFIGURATION OPTIMIZATION

TECHNICAL FIELD

[0001] The present disclosure is related to wireless communication systems and more particularly to communication device assistance for network configuration optimization.

BACKGROUND

[0002] FIG. **1** illustrates an example of a new radio ("NR") network (e.g., a 5th Generation ("5G") network) including a 5G core ("5GC") network **130**, network nodes **120**_a-b_ (e.g., 5G base station ("gNB")), multiple communication devices **110** (also referred to as user equipment ("UE")).

[0003] For the purpose of idle mode measurements, a network can request a UE while the UE is in connected mode to perform logged measurements after a transition to idle mode, as part of a "minimization of drive test" feature. This allows the network to gather information from UEs while they are idle and camping within the network. The measured and logged information may thereafter be transmitted to the network after the UE again has entered a connected mode. In some examples, a UE can be configured to measure the performance of the camped cell (e.g., a signal strength) as well as the best beam and the number of good beams of a sync signal burst ("SSB") transmission. In additional or alternative examples, this feature is a powerful mechanism for the network to learn about the UE experience of the network coverage for the currently used (camped) network and cells.

[0004] Evolution of wireless standards may include new or enhanced features for network optimizations, e.g. energy savings coverage enhancements, capacity and/or data rate enhancements. Such features may be included for future networks to be more environmentally friendly or in general improve its performance. One procedure within the area of network energy savings is to introduce transmission limitations when possible. As an example, a dense network deployment may be required to handle high load scenarios (e.g., during periods of high traffic loads and/or during a busy hour), but would be unnecessary during low load scenarios.

SUMMARY

[0005] According to some embodiments, a method of operating a communication device in a communications network that includes a network node is provided. The method includes receiving configuration information from the network node using a first topology configuration while the communication device is in an active state. The configuration information can indicate a request for the communication device to perform an action associated with a second topology configuration that is different than the first topology configuration while the communication device is in an idle state. The method can further include transitioning to an idle state. The method can further include performing the action associated with the second topology configuration.

[0006] According to other embodiments, a method of operating a network node in a communications network that includes a communication device is provided. The method includes transmitting configuration information to a communication device using a first topology configuration. The configuration information can indicate a request for the communication device to perform an action associated with a second topology configuration that is different than the first topology configuration. The method further incudes communicating with the communication device using the second topology configuration. The method further includes determining performance of the second topology configuration based on communicating with the communication device using the second topology configuration.

[0007] According to other embodiments, a communication device, network node, computer program, computer program product, non-transitory computer readable medium, system, or host is provided to perform one of the above methods.

[0008] Certain embodiments may provide one or more of the following technical advantages. In some embodiments, multiple new procedures for devices (e.g., UEs within the network) are introduced to support optimizing and tuning the network. In some examples, these procedures add opportunities for the network to try different operation modes (sometimes referred to herein as topology configurations). In additional or alternative examples, this may imply that the network tries how UEs would experience if certain gNBs are switched off or would be using different lower layer parameter or transmission settings (e.g., with lower output power, less transmission antennas, lower antenna gain settings, different tilting, or wider beams of transmission). In additional or alternative examples, these procedures also include a possibility to require a UE to log random access initiation statistics while in idle mode. The network may, as example, require a UE to perform test-preamble-transmissions to mimic an UL random access initiation, in order for a network to evaluate the UL reception possibility in an alternative topology.

[0009] In additional or alternative embodiments, this enables the network to evaluate these multiple alternative topologies while in ordinary operation. For example, for the purpose of collecting data to form statistics over the network performance for different settings.

[0010] In additional or alternative embodiments, UEs within active mode can be required to perform many different measurements, as configured measurement objects in RRC signaling. However, this proposed monitoring within idle mode has a separate technical effect. By configuring UEs to measure the broadcasted signals while in idle mode, the network assures that the evaluation can be made independent of whether the UEs are connected to the network or not in order to not bias the data to only be valid for UEs in acceptable coverage for the currently used topology. In other words, by configuring UEs to measure the broadcasted signals while in idle mode the UE may measure and store information of measurements independent on whether the UE is camping in a certain network or a part of a network such a specific cell.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The accompanying drawings, which are included to provide a further understanding of the disclosure and are incorporated in and constitute a part of this application, illustrate certain non-limiting embodiments of inventive concepts. In the drawings:

[0012] FIG. **1** is a schematic diagram illustrating an example of a 5^{th} generation ("5G") network;

[0013] FIGS. **2**A-C are schematic diagrams illustrating examples of SSB being transmit to an idle UE in accordance with some embodiments;

[0014] FIG. **3** is a flow chart illustrating an example of operations for UE assisted network configuration optimization in accordance with some embodiments;

[0015] FIG. **4** is a signal flow diagram illustrating an example of signals communicated during the operations of FIG. **3** in accordance with some embodiments;

[0016] FIG. **5** is a flow chart illustrating an example of operations performed by a communication device in accordance with some embodiments;

[0017] FIG. **6** is a flow chart illustrating an example of operations performed by a network node in accordance with some embodiments;

[0018] FIG. **7** is a block diagram of a communication system in accordance with some embodiments;

[0019] FIG. **8** is a block diagram of a user equipment in accordance with some embodiments;

[0020] FIG. **9** is a block diagram of a network node in accordance with some embodiments;

[0021] FIG. **10** is a block diagram of a host computer communicating with a user equipment in accordance with some embodiments;

[0022] FIG. **11** is a block diagram of a virtualization environment in accordance with some embodiments; and

[0023] FIG. **12** is a block diagram of a host computer communicating via a base station with a user equipment over a partially wireless connection in accordance with some embodiments in accordance with some embodiments.

DETAILED DESCRIPTION

[0024] Some of the embodiments contemplated herein will now be described more fully with reference to the accompanying drawings. Embodiments are provided by way of example to convey the scope of the subject matter to those skilled in the art, in which examples of embodiments of inventive concepts are shown. Inventive concepts may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of present inventive concepts to those skilled in the art. It should also be noted that these embodiments are not mutually exclusive. Components from one embodiment may be tacitly assumed to be present/used in another embodiment.

[0025] There currently exist certain challenges. The current procedures for logged UE measurements to assist in understanding the UE experience of the network are constructed to provide information on the current network as it is deployed while the UE is camping on it. But it is not suitable for evaluating how deployment would possibly impact the UE and/or network nodes if the network would be deployed differently. And further it is not suitable for configuring the UE to perform time specific measurements at certain time of day.

[0026] The evolution of machine learning ("ML") and artificial intelligence ("AI") technologies enhance the possibilities for a network to learn and adapt the topology to meet the needs of capacity as well as energy savings. However, the tools for ML and AI require data collection. The current procedures for data collection by UEs in idle mode are limited, and improvements in order to provide data for modeling and learning should be introduced in the wireless networks.

[0027] Certain aspects of the disclosure and their embodiments may provide solutions to these or other challenges. Various embodiments modify the concept of logged UE measurements (e.g., from the network features sometimes referred to as "Minimization of Drive Tests—MTD") into a new 5G evolution or 6G concept for evaluating multiple different network configurations for energy saving. Since a network may operate in different configurations for power saving (e.g., while the network load is limited) it is of importance from a system perspective to understand and even to optimize the UE experience of that such different configurations prior to activating them.

[0028] In some embodiments, the communication protocol is evolved to also cover the case of requesting UEs to measure some specific signals transmitted by the network in which these specific signals are indicative of how a UE would experience one or more different operating modes.

[0029] In additional or alternative embodiments, the network benefits from the feature by receiving information from UEs in idle mode. In some examples, this has the specific technical effect of not limiting any measurements to UEs within coverage, but gives a broader selection of measurements. The UE may benefit from supporting network to optimize the system coverage and operation.

[0030] In additional or alternative embodiments, new types of measurement configurations are introduced for idle mode logged measurements into the wireless standards of 3GPP systems.

[0031] In some examples, the new types of measurement configurations include introduction of separated measurements on specifically indicated broadcasted signals such as SSBs among the SSBs transmitted by an ordinary camped cell. This feature can give the network an opportunity to modify the transmit characteristics of certain repeated signal such as SSBs (e.g., adjust one or more transmit characteristics of every 10th or 100th SSB) and let the configured UEs measure and report separately the performance of these. This UE behavior can be in contrast to a legacy UE which would measure and report on all SSBs which the UE is expected to detect (e.g., during its DRX-on periods in idle mode) as usual.

[0032] In additional or alternative examples, the new types of measurement configurations include introduction of separated measurements on additional test reference signals or SSBs, in which the additional test signals are transmitted in a relation to a given set of resources such as the resources of transmitted SSBs within an ordinary camped cell. This feature can give the network an opportunity to modify downlink ("DL") transmissions such as SSBs and test the reception possibility of these, specifically for UEs which are detecting and possibly camping in the original cell.

[0033] In additional or alternative examples, the new types of measurement configurations include introduction of separated measurements and or uplink ("UL") transmissions on non-camped cells or subset within cells such as a specific bandwidth part ("BWP"), where network indicates the cell identifier ("ID") to measure and transmit on. In practice this can mean that such cell or BWP in a cell may only consist of "test ID" broadcasted cell information. This feature gives the network an opportunity to transmit SSBs and receive test-preambles in UL for a separate test-cell, wherein the purpose of the SSB transmissions is to evaluate the coverage of a possible energy saving mode of operation.

[0034] In additional or alternative embodiments, a single UE may be configured to multiple of above configurations, and the different procedures may be combined.

[0035] In additional or alternative embodiments, a UE can be configured to separately, while in idle mode, measure and report radio characteristics of one or more repeated patterns of separate reference signals transmitted by a network, wherein the separate reference signals may be expected to be detected by the UE only with this specific configuration and may be indicative of radio performance of a different operating mode of a base station transmitter.

[0036] In additional or alternative embodiments, a wireless device in a mobile communication network receives, while in a connected mode, a control signaling from a radio network node of the network. The control signaling can be indicative of a request to the wireless device while in idle mode to communicate and store/log radio characteristics of one or more repeated patterns of separate reference signals transmitted to or from a network. The separate reference signals can be used to evaluate radio performance of an operating configuration of a base station different than the operation configuration currently used for communication in the network.

[0037] In additional or alternative embodiments, the control signaling is broadcasted to the wireless device.

[0038] In additional or alternative embodiments, the control signaling is transmitted in a dedicated control channel to the wireless device (which could be 3rd generation partnership project ("3GPP") radio resource control ("RRC") signaling, a physical downlink control channel ("PDCCH"), or similar).

[0039] In additional or alternative embodiments, the separate reference signals are transmitted using different time and/or frequency resources than reference signals used for communication in the network.

[0040] In additional or alternative embodiments, the separate reference signals are transmitted using same time and frequency resources as one or more of reference signals used for communication in the network.

[0041] In additional or alternative embodiments, the separate reference signals constitute of one or more of signals included in a 3GPP SS burst.

[0042] In additional or alternative embodiments, a different operation configuration relates to one or more of a variation in transmit antenna configuration, transmit beam configuration, output power, transmit node.

[0043] In additional or alternative embodiments, the wireless device is configured to transmit one or more reference signals while in idle mode, using indicated resources.

[0044] In additional or alternative embodiments, the wireless device is further configured to transmit all or parts of the stored information to the network upon being in connected mode.

[0045] FIGS. **2**A-C illustrate some embodiments in which communication devices (also referred to herein as user equipments ("UEs")) that have been connected to the network but currently are in any idle mode can support the network to evaluate alternative network topologies. In some examples, this is done by configuring UEs to measure broadcasted signals from the network in a separated manner, meaning on signals in addition to the signals a UE may expect being transmitted by a network such as regular sync signal burst ("SSB"). Hence, the UE may perform evaluations on additional signals than the ones used for idle mode camping and cell reselection.

[0046] Such broadcasted signals may be introduced in various ways, as shown in FIGS. **2**A-C. Examples include, but are not limited to, appointed synchronization signals, positioning reference signals, demodulation reference signal, channel state information reference signals, bandwidth part specific signals, SSB transmissions among the regular SSBs, additional sync signals at different resources than within SSBs, or additional signals such as SSBs representing a parallel not campable network.

[0047] FIG. **2**A illustrates an example in which a UE may be configured to report quality and strength of SSBs while in an idle state.

[0048] FIGS. **2**B-C illustrates an example in which a UE may be configured to report quality and strength of the ordinary SSBs and perform measurements (and report the measurements) of the modified SSBs. In FIG. **2**B, the modified SSB replaces one of the original SSBs. In FIG. **2**C, the modified SSB is at a time and/or frequency offset from an original SSB.

[0049] In some embodiments, the UE can combine the reporting with location and time stamps in a similar manner as in legacy minimization of drivetest ("MDT") functionality.

[0050] In additional or alternative embodiments, the UE can support the network to evaluate topology options and the network can collect detection probabilities (e.g., for data collection) within the network. In additional or alternative embodiments, for the case of configuring the UE to

[0051] monitor the performance of separately transmitted SSBs, the UE can be configured to perform one or more transmissions such as random access preamble transmissions for the purpose of assisting the network to measure uplink performance in different topologies. In other words, such transmissions may be performed for the purpose of enabling the network to evaluate uplink signal detection/reception performance on signals transmitted at appointed resources by the UE, while the UE remains in idle mode. In some examples, the UE is not expected to receive any response to such preamble transmission. The network can configure a UE to transmit one or more uplink ("UL") random access channel ("RACH") preambles at configured time and/or frequency occasions. Since the network is aware of the expected transmission but may not need to respond to the transmission, the network may use this functionality for uplink evaluations of various network settings or configurations. In other words, the network can use such preambles to evaluate different network settings for uplink transmission detection and decoding.

[0052] FIG. **3** illustrates an example of a flow chart for UE assisted network configuration optimization.

[0053] At block **310**, similar to legacy MDT functionality, a UE is connected to the network and provides an indication of its capability to perform logged topology evaluation measurements to the network. At block **320**, the network may determine to configure one or more such measurements for the UE. At block **330**, when an UE enters idle mode, the measurement configurations are activated, and the UE follows the configurations along with triggers or constraints to perform the configured measurements.

[0054] In some examples, a UE within an idle mode may be separately measuring and logging the performance of a selection of the detected SSB occasions within a cell it is camped on. The network may within the configuration provide a SSB transmission pattern, e.g. every 100th SSB is to be separately measured and logged. This function does not require the UE to be camping within the configured network, but it is likely that the UE will be so since it assumes that the UE at least is in sync and can detect SSBs from the configured network.

[0055] In additional or alternative examples, a UE within idle mode may be separately measuring and logging the performance of separately transmitted sync signals or reference signals or similar, wherein these separately transmitted signals are resource wise coupled to the ordinary cell SSBs. As example, the network may configure a frequency and/or time offset to ordinary SSBs and request the UE to measure and separately log the detected performance of these. Again, this function does not require the UE to be camping within the configured network, but it is likely that the UE will be since it assumes that the UE is at least in sync with the configured network.

[0056] In additional or alternative examples, a UE within idle mode may be separately measuring and logging the performance of a separate test-SSB transmission set. The network may have configured the UE with a separate cell ID which the UE should measure and report the SSB performance of. This SSB may not be required to constitute a valid cell for communication, but instead just represents the information required for detectability such as a primary and secondary sync signal and cell identifier ("ID") part of a physical block channel ("PBCH"). When not being complete, a UE will not attempt to camp on it. The broadcasted information may indicate a functional but barred cell.

[0057] At block **340**, the UE may determine if any of the configured signals to measure on and timer parameters are within configured periods. The UE may be configured at specific timing and/or frequency occasions to log the performance of or to perform a specified transmission such as a random access preamble (msg1) transmission upon detecting such test-SSB transmissions. This can be utilized by the network for measuring the uplink performance of an alternative network topology or configuration and to store statistics of such uplink receptions at the network side.

[0058] Signaling wise, this concept would be possible to introduce as an addition of signaling parameters on the existing concept for logged UE measurements/MDT signaling.

[0059] In response to the configured signals and/or time parameters being within the configured periods, at block **350**, the UE measures and logs the detected signals and if separately configured signals are detected that data is collected and stored separately.

[0060] At block **360**, in response to the UE still being in the idle mode, the procedure can return to block **340**. Otherwise, the UE can connect to the network and be requested to transfer the logged measurement data to the network (at block **370**).

[0061] Within legacy, the network can provide the UE with a logged measurement configuration. In current standards this includes configuration on the network timing, area to be activated within, public land mobile networks ("PLMNs") to be activated within and the logging interval (e.g., log periodicity).

[0062] In some embodiments, the logged measurement configuration can include a new information element of the separate logging, which, for example, could be signaled with a set of bits. In some examples, the one bit/flag for indicating that certain SSBs should be separately logged. If this flag is set, there could be other parameters following where a set of different options are captures, for example, every 10th or every 100 SSB being separately logged. In additional or alternative examples, the one bit/flag for indicating that separate SSBs or channel state information reference signals ("CSI-RS") are transmitted and should be measured. A time and/or frequency offset indication may be given as additional parameters.

[0063] In additional or alternative embodiments, the logged measurement configuration can include a new information element for the timing in order to limit the usage of this logging to certain time interval (e.g., only measure between 1 am to 3 am at night). This could be signaled in several ways, for example, as an absolute time delay for activation such as X number of minutes.

[0064] In additional or alternative embodiments, the logged measurement configuration can include a new information element for configuration of UL msg 1 preamble transmissions. A transmission burst configuration may be given as indicating one from multiple pre-determined standardized burst configurations and timing information can be indicated.

[0065] FIG. **4** illustrates an example of signals communicated to configure the UE. In some embodiments, the UE capability signaling may be adapted to capture signaling of the UE support of the proposed feature. Therefore the UE capability specification may be updated to capture the description of the proposed feature, and the signaling of UE capability and may include the relevant additional information as an additional indicator.

[0066] In additional or alternative embodiments, the configuration signaling to the UE for the logged measurement request to cover UE assisted topology measurements needs to be included into the 3GPP specifications. In additional or alternative embodiments, RRC signaling for the "LoggedMeasurementConfiguration" signaling can be extended. Within this information element an addition can be added, for example, a "logged measurement configuration release 18 element" or similar that indicates the required information on which signals to measure on and how to detect them. This could therefore include specific information fields such as time, frequency information, and signal type (e.g., if it's an SSB or other information required to detect the signal).

[0067] In FIG. **4**, a UE response to acknowledge the signaling is added. This is not mandatory to be included and the current RRC Specification does not include such information.

[0068] In this example, one or more specific signals for topology evaluations are transmitted by one or more transmitters of signals in the network. Such transmitters may be different gNBs, but it may also include one or more different transmit units connected to a gNB or similar. In additional or alternative examples, such transmitter may be an auxiliary transmit unit connected to a gNB.

[0069] In some embodiments, the network configuring the UE to transmit signals for uplink evaluations during the logged measurement activity. This example is not illustrated in FIG. **4**, but could be captured by one or more transmissions from the UE during the period of idle mode wherein one or more nodes in the network could evaluate its receiving configuration of a power saving topology.

[0070] In additional or alternative embodiments, when (re-)connecting to the network the UE can provide any stored/logged measurements according to 3GPP specification.

[0071] In the description that follows, while the communication device may be any of wireless device **712**A, **712**B, wired or wireless devices UE **712**C, UE **712**D, UE **800**, virtualization hardware **1104**, virtual machines **1108**A, **1108**B, or UE **1206**, the UE **800** (also referred to herein as communication device **800**) shall be used to describe the functionality of the operations of the communication device. Operations of the communication device **800** (implemented using the structure of the block diagram of FIG. **8**) will now be discussed with reference to the flow chart of FIG. **5** according to some embodiments of inventive concepts. For example, modules may be stored in memory **810** of FIG. **8**, and these modules may provide instructions so that when the instructions of a module are executed by respective communication device processing circuitry **802**, processing circuitry **802** performs respective operations of the flow chart.

[0072] FIG. **5** illustrates an example of operations performed by a communication device in a communications network that includes a network node.

[0073] At block **510**, processing circuitry **802** receives, via communication interface **812**, configuration information from the network node using a first topology configuration (e.g., while the communication device is in an active state). In some embodiments, the configuration information indicates a request for the communication device to perform an action associated with a second topology configuration that is different than the first topology configuration (e.g., while the communication device is in an idle state). In some examples, a difference between the first topology configuration and the second topology configuration includes a variation in at least one of: a transmit antenna configuration; a transmit beam configuration; an output power; a transmit node; a receive antenna configuration; a receive beam configuration; and a receive node.

[0074] In additional or alternative embodiments, the configuration information includes an indication of when a signal will be transmitted by the network node using the second topology configuration; a request that the communication device measure performance of the signal; and a request that the communication device provide an indication of the performance of the signal to the network node. In some examples, the indication of when the signal will be transmitted includes an indication that the signal will be transmitted using different time and/or frequency resources than signals being communicated using the first topology configuration. In additional or alternative examples, the indication of when the signal will be transmitted includes an indication that the signal will be transmitted using time and frequency resources used for communication of signals transmitted using the first topology configuration.

[0075] In additional or alternative embodiments, receiving the configuration information includes receiving a broadcast signal including an indication of the configuration information from the network node.

[0076] In additional or alternative embodiments, receiving the configuration information includes receiving a RRC signal including an indication of the configuration information from the network node via a dedicated control channel.

[0077] At block **520**, processing circuitry **802** transitions to an idle state.

[0078] At block **530**, processing circuitry **802** performs an action associated with the second topology configuration based on the configuration information. In some embodiments, performing the action includes measuring the performance of the signal. In additional or alternative embodiments, the signal includes a SSB.

[0079] In additional or alternative embodiments, the configuration information includes a request that the communication device transmit a signal to the network node while the network node uses the second topology configuration. Performing the action includes transmitting the signal based on the configuration information.

[0080] At block **540**, processing circuitry **802** transmits, via communication interface **812**, an indication of the performance of the signal to the network node.

[0081] Various operations of FIG. **5** may be optional.

[0082] In the description that follows, while the network node may be any of the network node **710**A, **710**B, core network node **708**, network node **900**, virtualization hardware **1104**, virtual machines **1108**A, **1108**B, or network node **1204**, the network node **900** shall be used to describe the functionality of the operations of the network node. Operations of the network node **900** (implemented using the structure of the block diagram of FIG. **9**) will now be discussed with reference to the flow charts of FIG. **6** according to some embodiments of inventive concepts. For example, modules may be stored in memory **904** of FIG. **9**, and these modules may provide instructions so that when the instructions of a module are executed by respective network node processing circuitry **902**, processing circuitry **902** performs respective operations of the flow chart.

[0083] FIG. **6** illustrates an example of operations performed by a network node in a communications network that includes a communication device.

[0084] At block **610**, processing circuitry **902** transmits, via communication interface **906**, configuration information to the communication device using a first topology configuration (e.g., while the communication device is in an active state). In some embodiments, the configuration information indicates a request for the communication device to perform an action associated with a second topology configuration that is different than the first topology configuration while the communication device is in an idle state. In some examples, a difference between the first topology configuration and the second topology configuration includes a variation in at least one of: a transmit antenna configuration; a transmit beam configuration; an output power; a transmit node; a receive antenna configuration; a receive beam configuration; and a receive node.

[0085] In additional or alternative embodiments, the configuration information includes an indication of when a signal will be transmitted by the network node using the second topology configuration; a request that the communication device measure performance of the signal; and a request that the communication device provide an indication of the performance of the signal to the network node. In some examples, the indication of when the signal will be transmitted includes an indication that the signal will be transmitted using different time and/or frequency resources than signals being communicated using the first topology configuration. In additional or alternative examples, the indication of when the signal will be transmitted includes an indication that the signal will be transmitted using time and frequency resources used for communication of signals transmitted using the first topology configuration.

[0086] In additional or alternative embodiments, transmitting the configuration information includes transmitting a broadcast signal including an indication of the configuration information to the communication device.

[0087] In additional or alternative embodiments, transmitting the configuration information includes transmitting a RRC signal including an indication of the configuration information to the communication device via a dedicated control channel.

[0088] At block **630**, processing circuitry **902** communicates with the communication device using a second topology configuration (e.g., while the communication device is in an idle state). In some embodiments, communicating with the communication device includes transmitting a signal to the communication device using the second topology configuration. In some examples, the signal includes a SSB.

[0089] In additional or alternative embodiments, communicating with the communication devices includes receiving the signal using the second topology configuration.

[0090] At block **640**, processing circuitry **902** determines performance of the second topology configuration based on communicating with the communication device using the second topology configuration. In some embodiments, determining the performance includes receiving an indication of the performance of a signal transmitted using the second topology configuration from the communication device.

[0091] At block **650**, processing circuitry **902** determines network resources to be used for subsequent communications based on the performance of the second topology configuration.

[0092] At block **660**, processing circuitry **902** communicates, via communication interface **906**, with another communication device using the network resources.

[0093] Various operations of FIG. **6** may be optional.

[0094] FIG. **7** shows an example of a communication system **700** in accordance with some embodiments.

[0095] In the example, the communication system **700** includes a telecommunication network **702** that includes an access network **704**, such as a radio access network (RAN), and a core network **706**, which includes one or more core network nodes **708**. The access network **704** includes one or more access network nodes, such as network nodes **710***a* and **710***b* (one or more of which may be generally referred to as network nodes **710**), or any other similar 3^{rd} Generation Partnership Project (3GPP) access node or non-3GPP access point. Moreover, as will be appreciated by those of skill in the art, the network nodes **710** are not necessarily limited to an implementation in which a radio portion and a baseband portion are supplied and integrated by a single vendor. Thus, it will be understood that the network nodes **710** may include disaggregated implementations or portions thereof. For example, in some embodiments, the telecommunication network **702** includes one or more Open-RAN (ORAN) network nodes. An ORAN network node is a node in the telecommunication network **702** that supports an ORAN specification (e.g., a specification published by the O-RAN Alliance, or any similar organization) and may operate alone or together with other nodes to implement one or more functionalities of any node in the telecommunication network **702**, including one or more network nodes **710** and/or core network nodes **708**.

[0096] Examples of an ORAN network node include an open radio unit (O-RU), an open distributed unit (O-DU), an open central unit (O-CU), including an O-CU control plane (O-CU-CP) or an O-CU user plane (O-CU-UP), a RAN intelligent controller (near-real time or non-real time) hosting software or software plug-ins, such as a near-real time RAN control application (e.g., xApp) or a non-real time RAN automation application (e.g., rApp), or any combination thereof (the adjective "open" designating support of an ORAN specification). The network node may support a specification by, for example, supporting an interface defined by the ORAN specification, such as an A1, F1, W1, E1, E2, X2, Xn interface, an open fronthaul user plane interface, or an open fronthaul management plane interface. Intents and content-aware notifications described herein may be communicated from a 3GPP network node or an ORAN network node over 3GPP-defined interfaces (e.g., N2, N3) and/or ORAN Alliance-defined interfaces (e.g., A1, O1). Moreover, an ORAN network node may be a logical node in a physical node. Furthermore, an ORAN network node may be implemented in a virtualization environment (described further below) in which one or more network functions are virtualized. For example, the virtualization environment may include an O-Cloud computing platform orchestrated by a Service Management and Orchestration Framework via an O-2 interface defined by the O-RAN Alliance. The network nodes **710** facilitate direct or indirect connection of user equipment (UE), such as by connecting wireless devices **712***a*, **712***b*, **712***c*, and **712***d* (one or more of which may be generally referred to as UEs **712**) to the core network **706** over one or more wireless connections. The network nodes **710** facilitate direct or indirect connection of user equipment (UE), such as by connecting UEs **712***a*, **712***b*, **712***c*, and **712***d* (one or more of which may be generally referred to as UEs **712**) to the core network **706** over one or more wireless connections.

[0097] Example wireless communications over a wireless connection include transmitting and/or receiving wireless signals using electromagnetic waves, radio waves, infrared waves, and/or other types of signals suitable for conveying information without the use of wires, cables, or other material conductors. Moreover, in different embodiments, the communication system **700** may include any number of wired or wireless networks, network nodes, UEs, and/or any other components or systems that may facilitate or participate in the communication of data and/or signals whether via wired or wireless connections. The communication system **700** may include and/or interface with any type of communication, telecommunication, data, cellular, radio network, and/or other similar type of system.

[0098] The UEs **712** may be any of a wide variety of communication devices, including wireless devices arranged, configured, and/or operable to communicate wirelessly with the network nodes **710** and other communication devices. Similarly, the network nodes **710** are arranged, capable, configured, and/or operable to communicate directly or indirectly with the UEs **712** and/or with other network nodes or equipment in the telecommunication network **702** to enable and/or provide network access, such as wireless network access, and/or to perform other functions, such as administration in the telecommunication network **702**.

[0099] In the depicted example, the core network **706** connects the network nodes **710** to one or more hosts, such as host **716**. These connections may be direct or indirect via one or more intermediary networks or devices. In other examples, network nodes may be directly coupled to hosts. The core network **706** includes one more core network nodes (e.g., core network node **708**) that are structured with hardware and software components. Features of these components may be substantially similar to those described with respect to the UEs, network nodes, and/or hosts, such that the descriptions thereof are generally applicable to the corresponding components of the core network node **708**. Example core network nodes include functions of one or more of a Mobile Switching Center (MSC), Mobility Management Entity (MME), Home Subscriber Server (HSS), Access and Mobility Management Function (AMF), Session Management Function (SMF), Authentication Server Function (AUSF), Subscription Identifier De-concealing function (SIDF), Unified Data Management (UDM), Security Edge Protection Proxy (SEPP), Network Exposure Function (NEF), and/or a User Plane Function (UPF).

[0100] The host **716** may be under the ownership or control of a service provider other than an operator or provider of the access network **704** and/or the telecommunication network **702**, and may be operated by the service provider or on behalf of the service provider. The host **716** may host a variety of applications to provide one or more service. Examples of such applications include live and pre-recorded audio/video content, data collection services such as retrieving and compiling data on various ambient conditions detected by a plurality of UEs, analytics functionality, social media, functions for controlling or otherwise interacting with remote devices, functions for an alarm and surveillance center, or any other such function performed by a server.

[0101] As a whole, the communication system **700** of FIG. **7** enables connectivity between the UEs, network nodes, and hosts. In that sense, the communication system may be configured to operate according to predefined rules or procedures, such as specific standards that include, but are not limited to: Global System for Mobile Communications (GSM); Universal Mobile Telecommunications System (UMTS); Long Term Evolution (LTE), and/or other suitable 2G, 3G, 4G, 5G standards, or any applicable future generation standard (e.g., 6G); wireless local area network (WLAN) standards, such as the Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards (WiFi); and/or any other appropriate wireless communication standard, such as the Worldwide Interoperability for Microwave Access (WiMax), Bluetooth, Z-Wave, Near Field Communication (NFC) ZigBee, LiFi, and/or any low-power wide-area network (LPWAN) standards such as LoRa and Sigfox.

[0102] In some examples, the telecommunication network **702** is a cellular network that implements 3GPP standardized features. Accordingly, the telecommunications network **702** may support network slicing to provide different logical networks to different devices that are connected to the telecommunication network **702**. For example, the telecommunications network **702** may provide Ultra Reliable Low Latency Communication (URLLC) services to some UEs, while providing Enhanced Mobile Broadband (eMBB) services to other UEs, and/or Massive Machine Type Communication (mMTC)/Massive IoT services to yet further UEs.

[0103] In some examples, the UEs **712** are configured to transmit and/or receive information without direct human interaction. For instance, a UE may be designed to transmit information to the access network **704** on a predetermined schedule, when triggered by an internal or external event, or in response to requests from the access network **704**. Additionally, a UE may be configured for operating in single- or multi-RAT or multi-standard mode. For example, a UE may operate with any one or combination of Wi-Fi, NR (New Radio) and LTE, i.e. being configured for multi-radio dual connectivity (MR-DC), such as E-UTRAN (Evolved-UMTS Terrestrial Radio Access Network) New Radio-Dual Connectivity (EN-DC).

[0104] In the example, the hub **714** communicates with the access network **704** to facilitate indirect communication between one or more UEs (e.g., UE **712***c* and/or **712***d*) and network nodes (e.g., network node **710***b*). In some examples, the hub **714** may be a controller, router, content source and analytics, or any of the other communication devices described herein regarding UEs. For example, the hub **714** may be a broadband router enabling access to the core network **706** for the UEs. As another example, the hub **714** may be a controller that sends commands or instructions to one or more actuators in the UEs. Commands or instructions may be received from the UEs, network nodes **710**, or by executable code, script, process, or other instructions in the hub **714**. As another example, the hub **714** may be a data collector that acts as temporary storage for UE data and, in some embodiments, may perform analysis or other processing of the data. As another example, the hub **714** may be a content source. For example, for a UE that is a VR headset, display, loudspeaker or other media delivery device, the hub **714** may retrieve VR assets, video, audio, or other media or data related to sensory information via a network node, which the hub **714** then provides to the UE either directly, after performing local processing, and/or after adding additional local content. In still another example, the hub **714** acts as a proxy server or orchestrator for the UEs, in particular in if one or more of the UEs are low energy IoT devices.

[0105] The hub **714** may have a constant/persistent or intermittent connection to the network node **710***b*. The hub **714** may also allow for a different communication scheme and/or schedule between the hub **714** and UEs (e.g., UE **712***c* and/or **712***d*), and between the hub **714** and the core network **706**. In other examples, the hub **714** is connected to the core network **706** and/or one or more UEs via a wired connection. Moreover, the hub **714** may be configured to connect to an M2M service provider over the access network **704** and/or to another UE over a direct connection. In some scenarios, UEs may establish a wireless connection with the network nodes **710** while still connected via the hub **714** via a wired or wireless connection. In some embodiments, the hub **714** may be a dedicated hub—that is, a hub whose primary function is to route communications to/from the UEs from/to the network node **710***b*. In other embodiments, the hub **714** may be a non-dedicated hub—that is, a device which is capable of operating to route communications between the UEs and network node **710***b*, but which is additionally capable of operating as a communication start and/or end point for certain data channels.

[0106] FIG. **8** shows a UE **800** in accordance with some embodiments. As used herein, a UE refers to a device capable, configured, arranged and/or operable to communicate wirelessly with network nodes and/or other UEs. Examples of a UE include, but are not limited to, a smart phone, mobile phone, cell phone, voice over IP (VoIP) phone, wireless local loop phone, desktop computer, personal digital assistant (PDA), wireless cameras, gaming console or device, music storage device, playback appliance, wearable terminal device, wireless endpoint, mobile station, tablet, laptop, laptop-embedded equipment (LEE), laptop-mounted equipment (LME), smart device, wireless customer-premise equipment (CPE), vehicle-mounted or vehicle embedded/integrated wireless device, etc. Other examples include any UE identified by the 3rd Generation Partnership Project (3GPP), including a narrow band internet of things (NB-IoT) UE, a machine type communication (MTC) UE, and/or an enhanced MTC (eMTC) UE.

[0107] A UE may support device-to-device (D2D) communication, for example by implementing a 3GPP standard for sidelink communication, Dedicated Short-Range Communication (DSRC), vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), or vehicle-to-everything (V2X). In other examples, a UE may not necessarily have a user in the sense of a human user who owns and/or operates the relevant device. Instead, a UE may represent a device that is intended for sale to, or operation by, a human user but which may not, or which may not initially, be associated with a specific human user (e.g., a smart sprinkler controller). Alternatively, a UE may represent a device that is not intended for sale to, or operation by, an end user but which may be associated with or operated for the benefit of a user (e.g., a smart power meter).

[0108] The UE **800** includes processing circuitry **802** that is operatively coupled via a bus **804** to an input/output interface **806**, a power source **808**, a memory **810**, a communication interface **812**, and/or any other component, or any combination thereof. Certain UEs may utilize all or a subset of the components shown in FIG. **8**. The level of integration between the components may vary from one UE to another UE. Further, certain UEs may contain multiple instances of a component, such as multiple processors, memories, transceivers, transmitters, receivers, etc.

[0109] The processing circuitry **802** is configured to process instructions and data and may be configured to implement any sequential state machine operative to execute instructions stored as machine-readable computer programs in the memory **810**. The processing circuitry **802** may be implemented as one or more hardware-implemented state machines (e.g., in discrete logic, field-programmable gate arrays (FPGAs), application specific integrated circuits (ASICs), etc.); programmable logic together with appropriate firmware; one or more stored computer programs, general-purpose processors, such as a microprocessor or digital signal processor (DSP), together with appropriate software; or any combination of the above. For example, the processing circuitry **802** may include multiple central processing units (CPUs).

[0110] In the example, the input/output interface **806** may be configured to provide an interface or interfaces to an input device, output device, or one or more input and/or output devices. Examples of an output device include a speaker, a sound card, a video card, a display, a monitor, a printer, an actuator, an emitter, a smartcard, another output device, or any combination thereof. An input device may allow a user to capture information into the UE **800**. Examples of an input device include a touch-sensitive or presence-sensitive display, a camera (e.g., a digital camera, a digital video camera, a web camera, etc.), a microphone, a sensor, a mouse, a trackball, a directional pad, a trackpad, a scroll wheel, a smartcard, and the like. The presence-sensitive display may include a capacitive or resistive touch sensor to sense input from a user. A sensor may be, for instance, an accelerometer, a gyroscope, a tilt sensor, a force sensor, a magnetometer, an optical sensor, a proximity sensor, a biometric sensor, etc., or any combination thereof. An output device may use the same type of interface port as an input device. For example, a Universal Serial Bus (USB) port may be used to provide an input device and an output device.

[0111] In some embodiments, the power source **808** is structured as a battery or battery pack. Other types of power sources, such as an external power source (e.g., an electricity outlet), photovoltaic device, or power cell, may be used. The power source **808** may further include power circuitry for delivering power from the power source **808** itself, and/or an external power source, to the various parts of the UE **800** via input circuitry or an interface such as an electrical power cable. Delivering power may be, for example, for charging of the power source **808**. Power circuitry may perform any formatting, converting, or other modification to the power from the power source **808** to make the power suitable for the respective components of the UE **800** to which power is supplied.

[0112] The memory **810** may be or be configured to include memory such as random access memory (RAM), read-only memory (ROM), programmable read-only memory (PROM), erasable programmable read-only memory (EPROM), electrically erasable programmable read-only memory (EEPROM), magnetic disks, optical disks, hard disks, removable cartridges, flash drives, and so forth. In one example, the memory **810** includes one or more application programs **814**, such as an operating system, web browser application, a widget, gadget engine, or other application, and corresponding data **816**. The memory **810** may store, for use by the UE **800**, any of a variety of various operating systems or combinations of operating systems.

[0113] The memory **810** may be configured to include a number of physical drive units, such as redundant array of independent disks (RAID), flash memory, USB flash drive, external hard disk drive, thumb drive, pen drive, key drive, high-density digital versatile disc (HD-DVD) optical disc drive, internal hard disk drive, Blu-Ray optical disc drive, holographic digital data storage (HDDS) optical disc drive, external mini-dual in-line memory module (DIMM), synchronous dynamic random access memory (SDRAM), external micro-DIMM SDRAM, smartcard memory such as tamper resistant module in the form of a universal integrated circuit card (UICC) including one or more subscriber identity modules (SIMs), such as a USIM and/or ISIM, other memory, or any combination thereof. The UICC may for example be an embedded UICC (eUICC), integrated UICC (iUICC) or a removable UICC commonly known as 'SIM card.' The memory **810** may allow the UE **800** to access instructions, application programs and the like, stored on transitory or non-transitory memory media, to off-load data, or to upload data. An article of manufacture, such as one utilizing a communication system may be tangibly embodied as or in the memory **810**, which may be or comprise a device-readable storage medium.

[0114] The processing circuitry **802** may be configured to communicate with an access network or other network using the communication interface **812**. The communication interface **812** may comprise one or more communication subsystems and may include or be communicatively coupled to an antenna **822**. The communication interface **812** may include one or more transceivers used to communicate, such as by communicating with one or more remote transceivers of another device capable of wireless communication (e.g., another UE or a network node in an access network). Each transceiver may include a transmitter **818** and/or a receiver **820** appropriate to provide network communications (e.g., optical, electrical, frequency allocations, and so forth). Moreover, the transmitter **818** and receiver **820** may be coupled to one or more antennas (e.g., antenna **822**) and may share circuit components, software or firmware, or alternatively be implemented separately.

[0115] In the illustrated embodiment, communication functions of the communication interface **812** may include cellular communication, Wi-Fi communication, LPWAN communication, data communication, voice communication, multimedia communication, short-range communications such as Bluetooth, near-field communication, location-based communication such as the use of the global positioning system (GPS) to determine a location, another like communication function, or any combination thereof. Communications may be implemented in according to one or more communication protocols and/or standards, such as IEEE 802.11, Code Division Multiplexing Access (CDMA), Wideband Code Division Multiple Access (WCDMA), GSM, LTE, New Radio (NR), UMTS, WiMax, Ethernet, transmission control protocol/internet protocol (TCP/IP), synchronous optical networking (SONET), Asynchronous Transfer Mode (ATM), QUIC, Hypertext Transfer Protocol (HTTP), and so forth.

[0116] Regardless of the type of sensor, a UE may provide an output of data captured by its sensors, through its communication interface **812**, via a wireless connection to a network node. Data captured by sensors of a UE can be communicated through a wireless connection to a network node via another UE. The output may be periodic (e.g., once every 15 minutes if it reports the sensed temperature), random (e.g., to even out the load from reporting from several sensors), in response to a triggering event (e.g., when moisture is detected an alert is sent), in response to a request (e.g., a user initiated request), or a continuous stream (e.g., a live video feed of a patient).

[0117] As another example, a UE comprises an actuator, a motor, or a switch, related to a communication interface configured to receive wireless input from a network node via a wireless connection. In response to the received wireless input the states of the actuator, the motor, or the switch may change. For example, the UE may comprise a motor that adjusts the control surfaces or rotors of a drone in flight according to the received input or to a robotic arm performing a medical procedure according to the received input.

[0118] A UE, when in the form of an Internet of Things (IoT) device, may be a device for use in one or more application domains, these domains comprising, but not limited to, city wearable technology, extended industrial application and healthcare. Non-limiting examples of such an IoT device are a device which is or which is embedded in: a connected refrigerator or freezer, a TV, a connected lighting device, an electricity meter, a robot vacuum cleaner, a voice controlled smart speaker, a home security camera, a motion detector, a thermostat, a smoke detector, a door/window sensor, a flood/moisture sensor, an electrical door lock, a connected doorbell, an air conditioning system like a heat pump, an autonomous vehicle, a surveillance system, a weather monitoring device, a vehicle parking monitoring device, an electric vehicle charging station, a smart watch, a fitness tracker, a head-mounted display for Augmented Reality (AR) or Virtual Reality (VR), a wearable for tactile augmentation or sensory enhancement, a water sprinkler, an animal- or item-tracking device, a sensor for monitoring a plant or animal, an industrial robot, an Unmanned Aerial Vehicle (UAV), and any kind of medical device, like a heart rate monitor or a remote controlled surgical robot. A UE in the form of an IoT device comprises circuitry and/or software in dependence of the intended application of the IoT device in addition to other components as described in relation to the UE **800** shown in FIG. **8**.

[0119] As yet another specific example, in an IoT scenario, a UE may represent a machine or other device that performs monitoring and/or measurements, and transmits the results of such monitoring and/or measurements to another UE and/or a network node. The UE may in this case be an M2M device, which may in a 3GPP context be referred to as an MTC device. As one particular example, the UE may implement the 3GPP NB-IoT standard. In other scenarios, a UE may represent a vehicle, such as a car, a bus, a truck, a ship and an airplane, or other equipment that is capable of monitoring and/or reporting on its operational status or other functions associated with its operation.

[0120] In practice, any number of UEs may be used together with respect to a single use case. For example, a first UE might be or be integrated in a drone and provide the drone's speed information (obtained through a speed sensor) to a second UE that is a remote controller operating the drone. When the user makes changes from the remote controller, the first UE may adjust the throttle on the drone (e.g. by controlling an actuator) to increase or decrease the drone's speed. The first and/or the second UE can also include more than one of the functionalities described above. For example, a UE might comprise the sensor and the actuator, and handle communication of data for both the speed sensor and the actuators.

[0121] FIG. **9** shows a network node **900** in accordance with some embodiments. As used herein, network node refers to equipment capable, configured, arranged and/or operable to communicate directly or indirectly with a UE and/or with other network nodes or equipment, in a telecommunication network. Examples of network nodes include, but are not limited to, access points (APs) (e.g., radio access points), base stations (BSs) (e.g., radio base stations, Node Bs, evolved Node Bs (eNBs), NR NodeBs (gNBs)), O-RAN nodes, or components of an O-RAN node (e.g., intelligent controller, O-RU, O-DU, O-CU).

[0122] Base stations may be categorized based on the amount of coverage they provide (or, stated differently, their transmit power level) and so, depending on the provided amount of coverage, may be referred to as femto base stations, pico base stations, micro base stations, or macro base stations. A base station may be a relay node or a relay donor node controlling a relay. A network node may also include one or more (or all) parts of a distributed radio base station such as centralized digital units and/or remote radio units (RRUs), sometimes referred to as Remote Radio Heads (RRHs). Such remote radio units may or may not be integrated with an antenna as an antenna integrated radio. Parts of a distributed radio base station may also be referred to as nodes in a distributed antenna system (DAS).

[0123] Other examples of network nodes include multiple transmission point (multi-TRP) 5G access nodes, multi-standard radio (MSR) equipment such as MSR BSs, network controllers such as radio network controllers (RNCs) or base station controllers (BSCs), base transceiver stations (BTSs), transmission points, transmission nodes, multi-cell/multicast coordination entities (MCEs), Operation and Maintenance (O&M) nodes, Operations Support System (OSS) nodes, Self-Organizing Network (SON) nodes, positioning nodes (e.g., Evolved Serving Mobile Location Centers (E-SMLCs)), and/or Minimization of Drive Tests (MDTs).

[0124] The network node **900** includes a processing circuitry **902**, a memory **904**, a communication interface **906**, and a power source **908**. The network node **900** may be composed of multiple physically separate components (e.g., a NodeB component and a RNC component, or a BTS component and a BSC component, etc.), which may each have their own respective components. In certain scenarios in which the network node **900** comprises multiple separate components (e.g., BTS and BSC components), one or more of the separate components may be shared among several network nodes. For example, a single RNC may control multiple NodeBs. In such a scenario, each unique NodeB and RNC pair, may in some instances be considered a single separate network node. In some embodiments, the network node **900** may be configured to support multiple radio access technologies (RATs). In such embodiments, some components may be duplicated (e.g., separate memory **904** for different RATs) and some components may be reused (e.g., a same antenna **910** may be shared by different RATs). The network node **900** may also include multiple sets of the various illustrated components for different wireless technologies integrated into network node **900**, for example GSM, WCDMA, LTE, NR, WiFi, Zigbee, Z-wave, LoRaWAN, Radio Frequency Identification (RFID) or Bluetooth wireless technologies. These wireless technologies may be integrated into the same or different chip or set of chips and other components within network node **900**.

[0125] The processing circuitry **902** may comprise a combination of one or more of a microprocessor, controller, microcontroller, central processing unit, digital signal processor, application-specific integrated circuit, field programmable gate array, or any other suitable computing device, resource, or combination of hardware, software and/or encoded logic operable to provide, either alone or in conjunction with other network node **900** components, such as the memory **904**, to provide network node **900** functionality.

[0126] In some embodiments, the processing circuitry **902** includes a system on a chip (SOC). In some embodiments, the processing circuitry **902** includes one or more of radio frequency (RF) transceiver circuitry **912** and baseband processing circuitry **914**. In some embodiments, the radio frequency (RF) transceiver circuitry **912** and the baseband processing circuitry **914** may be on separate chips (or sets of chips), boards, or units, such as radio units and digital units. In alternative embodiments, part or all of RF transceiver circuitry **912** and baseband processing circuitry **914** may be on the same chip or set of chips, boards, or units.

[0127] The memory **904** may comprise any form of volatile or non-volatile computer-readable memory including, without limitation, persistent storage, solid-state memory, remotely mounted memory, magnetic media, optical media, random access memory (RAM), read-only memory (ROM), mass storage media (for example, a hard disk), removable storage media (for example, a flash drive, a Compact Disk (CD) or a Digital Video Disk (DVD)), and/or any other volatile or non-volatile, non-transitory device-readable and/or computer-executable memory devices that store information, data, and/or instructions that may be used by the processing circuitry **902**. The memory **904** may store any suitable instructions, data, or information, including a computer program, software, an application including one or more of logic, rules, code, tables, and/or other instructions capable of being executed by the processing circuitry **902** and utilized by the network node **900**. The memory **904** may be used to store any calculations made by the processing circuitry **902** and/or any data received via the communication interface **906**. In some embodiments, the processing circuitry **902** and memory **904** is integrated.

[0128] The communication interface **906** is used in wired or wireless communication of signaling and/or data between a network node, access network, and/or UE. As illustrated, the communication interface **906** comprises port(s)/terminal(s) **916** to send and receive data, for example to and from a network over a wired connection. The communication interface **906** also includes radio front-end circuitry **918** that may be coupled to, or in certain embodiments a part of, the antenna **910**. Radio front-end circuitry **918** comprises filters **920** and amplifiers **922**. The radio front-end circuitry **918** may be connected to an antenna **910** and processing circuitry **902**. The radio front-end circuitry may be configured to condition signals communicated between antenna **910** and processing circuitry **902**. The radio front-end circuitry **918** may receive digital data that is to be sent out to other network nodes or UEs via a wireless connection. The radio front-end circuitry **918** may convert the digital data into a radio signal having the appropriate channel and bandwidth parameters using a combination of filters **920** and/or amplifiers **922**. The radio signal may then be transmitted via the antenna **910**. Similarly, when receiving data, the antenna **910** may collect radio signals which are then converted into digital data by the radio front-end circuitry **918**. The digital data may be passed to the processing circuitry **902**. In other embodiments, the communication interface may comprise different components and/or different combinations of components.

[0129] In certain alternative embodiments, the network node **900** does not include separate radio front-end circuitry **918**, instead, the processing circuitry **902** includes radio front-end circuitry and is connected to the antenna **910**. Similarly, in some embodiments, all or some of the RF transceiver circuitry **912** is part of the communication interface **906**. In still other embodiments, the communication interface **906** includes one or more ports or terminals **916**, the radio front-end circuitry **918**, and the RF transceiver circuitry **912**, as part of a radio unit (not shown), and the communication interface **906** communicates with the baseband processing circuitry **914**, which is part of a digital unit (not shown).

[0130] The antenna **910** may include one or more antennas, or antenna arrays, configured to send and/or receive wireless signals. The antenna **910** may be coupled to the radio front-end circuitry **918** and may be any type of antenna capable of transmitting and receiving data and/or signals wirelessly. In certain embodiments, the antenna **910** is separate from the network node **900** and connectable to the network node **900** through an interface or port.

[0131] The antenna **910**, communication interface **906**, and/or the processing circuitry **902** may be configured to perform any receiving operations and/or certain obtaining operations described herein as being performed by the network node. Any information, data and/or signals may be received from a UE, another network node and/or any other network equipment. Similarly, the antenna **910**, the communication interface **906**, and/or the processing circuitry **902** may be configured to perform any transmitting operations described herein as being performed by the network node. Any information, data and/or signals may be transmitted to a UE, another network node and/or any other network equipment.

[0132] The power source **908** provides power to the various components of network node **900** in a form suitable for the respective components (e.g., at a voltage and current level needed for each respective component). The power source **908** may further comprise, or be coupled to, power management circuitry to supply the components of the network node **900** with power for performing the functionality described herein. For example, the network node **900** may be connectable to an external power source (e.g., the power grid, an electricity outlet) via an input circuitry or interface such as an electrical cable, whereby the external power source supplies power to power circuitry of the power source **908**. As a further example, the power source **908** may comprise a source of power in the form of a battery or battery pack which is connected to, or integrated in, power circuitry. The battery may provide backup power should the external power source fail.

[0133] Embodiments of the network node **900** may include additional components beyond those shown in FIG. **9** for providing certain aspects of the network node's functionality, including any of the functionality described herein and/or any functionality necessary to support the subject matter described herein. For example, the network node **900** may include user interface equipment to allow input of information into the network node **900** and to allow output of information from the network node **900**. This may allow a user to perform diagnostic, maintenance, repair, and other administrative functions for the network node **900**.

[0134] FIG. **10** is a block diagram of a host **1000**, which may be an embodiment of the host **716** of FIG. **7**, in accordance with various aspects described herein. As used herein, the host **1000** may be or comprise various combinations hardware and/or software, including a standalone server, a blade server, a cloud-implemented server, a distributed server, a virtual machine, container, or processing resources in a server farm. The host **1000** may provide one or more services to one or more UEs.

[0135] The host **1000** includes processing circuitry **1002** that is operatively coupled via a bus **1004** to an input/output interface **1006**, a network interface **1008**, a power source **1010**, and a memory **1012**. Other components may be included in other embodiments. Features of these components may be substantially similar to those described with respect to the devices of previous figures, such as FIGS. **8** and **9**, such that the descriptions thereof are generally applicable to the corresponding components of host **1000**.

[0136] The memory **1012** may include one or more computer programs including one or more host application programs **1014** and data **1016**, which may include user data, e.g., data generated by a UE for the host **1000** or data generated by the host **1000** for a UE. Embodiments of the host **1000** may utilize only a subset or all of the components shown. The host application programs **1014** may be implemented in a container-based architecture and may provide support for video codecs (e.g., Versatile Video Coding (VVC), High Efficiency Video Coding (HEVC), Advanced Video Coding (AVC), MPEG, VP9) and audio codecs (e.g., FLAC, Advanced Audio Coding (AAC), MPEG, G.711), including transcoding for multiple different classes, types, or implementations of UEs (e.g., handsets, desktop computers, wearable display systems, heads-up display systems). The host application programs **1014** may also provide for user authentication and licensing checks and may periodically report health, routes, and content availability to a central node, such as a device in or on the edge of a core network. Accordingly, the host **1000** may select and/or indicate a different host for over-the-top services for a UE. The host application programs **1014** may support various protocols, such as the HTTP Live Streaming (HLS) protocol, Real-Time Messaging Protocol (RTMP), Real-Time Streaming Protocol (RTSP), Dynamic Adaptive Streaming over HTTP (MPEG-DASH), etc.

[0137] FIG. **11** is a block diagram illustrating a virtualization environment **1100** in which functions implemented by some embodiments may be virtualized. In the present context, virtualizing means creating virtual versions of apparatuses or devices which may include virtualizing hardware platforms, storage devices and networking resources. As used herein, virtualization can be applied to any device described herein, or components thereof, and relates to an implementation in which at least a portion of the functionality is implemented as one or more virtual components. Some or all of the functions described herein may be implemented as virtual components executed by one or more virtual machines (VMs) implemented in one or more virtual environments **1100** hosted by one or more of hardware nodes, such as a hardware computing device that operates as a network node, UE, core network node, or host. Further, in embodiments in which the virtual node does not require radio connectivity (e.g., a core network node or host), then the node may be entirely virtualized. In some embodiments, the virtualization environment **1100** includes components defined by the O-RAN Alliance, such as an O-Cloud environment orchestrated by a Service Management and Orchestration Framework via an O-2 interface.

[0138] Applications **1102** (which may alternatively be called software instances, virtual appliances, network functions, virtual nodes, virtual network functions, etc.) are run in the virtualization environment Q400 to implement some of the features, functions, and/or benefits of some of the embodiments disclosed herein.

[0139] Hardware **1104** includes processing circuitry, memory that stores software and/or instructions executable by hardware processing circuitry, and/or other hardware devices as described herein, such as a network interface, input/output interface, and so forth. Software may be executed by the processing circuitry to instantiate one or more virtualization layers **1106** (also referred to as hypervisors or virtual machine monitors (VMMs)), provide VMs **1108***a* and **1108***b* (one or more of which may be generally referred to as VMs **1108**), and/or perform any of the functions, features and/or benefits described in relation with some embodiments described herein. The virtualization layer **1106** may present a virtual operating platform that appears like networking hardware to the VMs **1108**.

[0140] The VMs **1108** comprise virtual processing, virtual memory, virtual networking or interface and virtual storage, and may be run by a corresponding virtualization layer **1106**. Different embodiments of the instance of a virtual appliance **1102** may be implemented on one or more of VMs **1108**, and the implementations may be made in different ways. Virtualization of the hardware is in some contexts referred to as network function virtualization (NFV). NFV may be used to consolidate many network equipment types onto industry standard high volume server hardware, physical switches, and physical storage, which can be located in data centers, and customer premise equipment.

[0141] In the context of NFV, a VM **1108** may be a software implementation of a physical machine that runs programs as if they were executing on a physical, non-virtualized machine. Each of the VMs **1108**, and that part of hardware **1104** that executes that VM, be it hardware dedicated to that VM and/or hardware shared by that VM with others of the VMs, forms separate virtual network elements. Still in the context of NFV, a virtual network function is responsible for handling specific network functions that run in one or more VMs **1108** on top of the hardware **1104** and corresponds to the application **1102**.

[0142] Hardware **1104** may be implemented in a standalone network node with generic or specific components. Hardware **1104** may implement some functions via virtualization. Alternatively, hardware **1104** may be part of a larger cluster of hardware (e.g. such as in a data center or CPE) where many hardware nodes work together and are managed via management and orchestration **1110**, which, among others, oversees lifecycle management of applications **1102**. In some embodiments, hardware **1104** is coupled to one or more radio units that each include one or more transmitters and one or more receivers that may be coupled to one or more antennas. Radio units may communicate directly with other hardware nodes via one or more appropriate network interfaces and may be used in combination with the virtual components to provide a virtual node with radio capabilities, such as a radio access node or a base station. In some embodiments, some signaling can be provided with the use of a control system **1112** which may alternatively be used for communication between hardware nodes and radio units.

[0143] FIG. **12** shows a communication diagram of a host **1202** communicating via a network node **1204** with a UE **1206** over a partially wireless connection in accordance with some embodiments. Example implementations, in accordance with various embodiments, of the UE (such as a UE **712***a* of FIG. **7** and/or UE **800** of FIG. **8**), network node (such as network node **710***a* of FIG. **7** and/or network node **900** of FIG. **9**), and host (such as host **716** of FIG. **7** and/or host **1000** of FIG. **10**) discussed in the preceding paragraphs will now be described with reference to FIG. **12**.

[0144] Like host **1000**, embodiments of host **1202** include hardware, such as a communication interface, processing circuitry, and memory. The host **1202** also includes software, which is stored in or accessible by the host **1202** and executable by the processing circuitry. The software includes a host application that may be operable to provide a service to a remote user, such as the UE **1206** connecting via an over-the-top (OTT) connection **1250** extending between the UE **1206** and host **1202**. In providing the service to the remote user, a host application may provide user data which is transmitted using the OTT connection **1250**.

[0145] The network node **1204** includes hardware enabling it to communicate with the host **1202** and UE **1206**. The connection **1260** may be direct or pass through a core network (like core network **706** of FIG. **7**) and/or one or more other intermediate networks, such as one or more public, private, or hosted networks. For example, an intermediate network may be a backbone network or the Internet.

[0146] The UE **1206** includes hardware and software, which is stored in or accessible by UE **1206** and executable by the UE's processing circuitry. The software includes a client application, such as a web browser or operator-specific "app" that may be operable to provide a service to a human or non-human user via UE **1206** with the support of the host **1202**. In the host **1202**, an executing host application may communicate with the executing client application via the OTT connection **1250** terminating at the UE **1206** and host **1202**. In providing the service to the user, the UE's client application may receive request data from the host's host application and provide user data in response to the request data. The OTT connection **1250** may transfer both the request data and the user data. The UE's client application may interact with the user to generate the user data that it provides to the host application through the OTT connection **1250**.

[0147] The OTT connection **1250** may extend via a connection **1260** between the host **1202** and the network node **1204** and via a wireless connection **1270** between the network node **1204** and the UE **1206** to provide the connection between the host **1202** and the UE **1206**. The connection **1260** and wireless connection **1270**, over which the OTT connection **1250** may be provided, have been drawn abstractly to illustrate the communication between the host **1202** and the UE **1206** via the network node **1204**, without explicit reference to any intermediary devices and the precise routing of messages via these devices.

[0148] As an example of transmitting data via the OTT connection **1250**, in step **1208**, the host **1202** provides user data, which may be performed by executing a host application. In some embodiments, the user data is associated with a particular human user interacting with the UE **1206**. In other embodiments, the user data is associated with a UE **1206** that shares data with the host **1202** without explicit human interaction. In step **1210**, the host **1202** initiates a transmission carrying the user data towards the UE **1206**. The host **1202** may initiate the transmission responsive to a request transmitted by the UE **1206**. The request may be caused by human interaction with the UE **1206** or by operation of the client application executing on the UE **1206**. The transmission may pass via the network node **1204**, in accordance with the teachings of the embodiments described throughout this disclosure. Accordingly, in step **1212**, the network node **1204** transmits to the UE **1206** the user data that was carried in the transmission that the host **1202** initiated, in accordance with the teachings of the embodiments described throughout this disclosure. In step **1214**, the UE **1206** receives the user data carried in the transmission, which may be performed by a client application executed on the UE **1206** associated with the host application executed by the host **1202**.

[0149] In some examples, the UE **1206** executes a client application which provides user data to the host **1202**. The user data may be provided in reaction or response to the data received from the host **1202**. Accordingly, in step **1216**, the UE **1206** may provide user data, which may be performed by executing the client application. In providing the user data, the client application may further consider user input received from the user via an input/output interface of the UE **1206**. Regardless of the specific manner in which the user data was provided, the UE **1206** initiates, in step **1218**, transmission of the user data towards the host **1202** via the network node **1204**. In step **1220**, in accordance with the teachings of the embodiments described throughout this disclosure, the network node **1204** receives user data from the UE **1206** and initiates transmission of the received user data towards the host **1202**. In step **1222**, the host **1202** receives the user data carried in the transmission initiated by the UE **1206**.

[0150] One or more of the various embodiments improve the performance of OTT services provided to the UE **1206** using the OTT connection **1250**, in which the wireless connection **1270** forms the last segment. More precisely, the teachings of these embodiments may enable the network to evaluate multiple alternative topologies while in ordinary operation, for example, for the purpose of collecting data to form statistics over the network performance for different settings.

[0151] In an example scenario, factory status information may be collected and analyzed by the host **1202**. As another example, the host **1202** may process audio and video data which may have been retrieved from a UE for use in creating maps. As another example, the host **1202** may collect and analyze real-time data to assist in controlling vehicle congestion (e.g., controlling traffic lights). As another example, the host **1202** may store surveillance video uploaded by a UE. As another example, the host **1202** may store or control access to media content such as video, audio, VR or AR which it can broadcast, multicast or unicast to UEs. As other examples, the host **1202** may be used for energy pricing, remote control of non-time critical electrical load to balance power generation needs, location services, presentation services (such as compiling diagrams etc. from data collected from remote devices), or any other function of collecting, retrieving, storing, analyzing and/or transmitting data.

[0152] In some examples, a measurement procedure may be provided for the purpose of monitoring data rate, latency and other factors on which the one or more embodiments improve. There may further be an optional network functionality for reconfiguring the OTT connection **1250** between the host **1202** and UE **1206**, in response to variations in the measurement results. The measurement procedure and/or the network functionality for reconfiguring the OTT connection may be implemented in software and hardware of the host **1202** and/or UE **1206**. In some embodiments, sensors (not shown) may be deployed in or in association with other devices through which the OTT connection **1250** passes; the sensors may participate in the measurement procedure by supplying values of the monitored quantities exemplified above, or supplying values of other physical quantities from which software may compute or estimate the monitored quantities. The reconfiguring of the OTT connection **1250** may include message format, retransmission settings, preferred routing etc.; the reconfiguring need not directly alter the operation of the network node **1204**. Such procedures and functionalities may be known and practiced in the art. In certain embodiments, measurements may involve proprietary UE signaling that facilitates measurements of throughput, propagation times, latency and the like, by the host **1202**. The measurements may be implemented in that software causes messages to be transmitted, in particular empty or 'dummy' messages, using the OTT connection **1250** while monitoring propagation times, errors, etc.

[0153] Although the computing devices described herein (e.g., UEs, network nodes, hosts) may include the illustrated combination of hardware components, other embodiments may comprise computing devices with different combinations of components. It is to be understood that these computing devices may comprise any suitable combination of hardware and/or software needed to perform the tasks, features, functions and methods disclosed herein. Determining, calculating, obtaining or similar operations described herein may be performed by processing circuitry, which may process information by, for example, converting the obtained information into other information, comparing the obtained information or converted information to information stored in the network node, and/or performing one or more operations based on the obtained information or converted information, and as a result of said processing making a determination. Moreover, while components are depicted as single boxes located within a larger box, or nested within multiple boxes, in practice, computing devices may comprise multiple different physical components that make up a single illustrated component, and functionality may be partitioned between separate components. For example, a communication interface may be configured to include any of the components described herein, and/or the functionality of the components may be partitioned between the processing circuitry and the communication interface. In another example, non-computationally intensive functions of any of such components may be implemented in software or firmware and computationally intensive functions may be implemented in hardware.

[0154] In certain embodiments, some or all of the functionality described herein may be provided by processing circuitry executing instructions stored on in memory, which in certain embodiments may be a computer program product in the form of a non-transitory computer-readable storage medium. In alternative embodiments, some or all of the functionality may be provided by the processing circuitry without executing instructions stored on a separate or discrete device-readable storage medium, such as in a hard-wired manner. In any of those particular embodiments, whether executing instructions stored on a non-transitory computer-readable storage medium or not, the processing circuitry can be configured to perform the described functionality. The benefits provided by such functionality are not limited to the processing circuitry alone or to other components of the computing device, but are enjoyed by the computing device as a whole, and/or by end users and a wireless network generally.

1.-**33**. (canceled)

34. A method of operating a communication device in a communications network that includes a network node, the method comprising:

receiving configuration information from the network node using a first topology configuration while the communication device is in an active state, the configuration information indicating a request for the communication device to perform an action associated with a second topology configuration that is different than the first topology configuration while the communication device is in an idle state;

transitioning to an idle state; and

performing the action associated with the second topology configuration, the action being performed while the network node is using the second topology configuration.

35. The method of claim **34**, wherein the configuration information comprises:

an indication of a signal that will be transmitted by the network node using the second topology configuration;

a request that the communication device measure performance of the signal; and

a request that the communication device provide an indication of the performance of the signal to the network node.

36. The method of claim **35**, wherein performing the action comprises measuring the performance of the signal,

wherein the method further comprises:

transmitting an indication of the performance of the signal to the network node.

37. The method of claim **35**, wherein the signal comprises a synch signal burst, SSB.

38. The method of claim **35**, wherein the indication of when the signal will be transmitted comprises an indication that the signal will be transmitted using the same or different time and/or frequency resources as signals being communicated using the first topology configuration.

39. The method of claim **34**, wherein the configuration information comprises a request that the communication device transmit a signal to the network node while the network node uses the second topology configuration,

wherein performing the action comprises:

transmitting the signal based on the configuration information.

40. The method of claim **34**, wherein receiving the configuration information comprises any one of:

receiving a broadcast signal including an indication of the configuration information from the network node; and

receiving the configuration information from the network node via a dedicated control channel, optionally the configuration information being received via a radio resource control, RRC, signal.

41. The method of claim **34**, wherein a difference between the first topology configuration and the second topology configuration includes a variation in at least one of:

a transmit antenna configuration;

a transmit beam configuration;

an output power;

a transmit node;

a receive antenna configuration;

a receive beam configuration; and

a receive node.

42. The method of claim **34**, wherein transitioning to the idle state comprises transitioning to the idle state subsequent to receiving the configuration information, and

wherein performing the action comprises performing the action in response to transitioning to the idle state.

43. A method of operating a network node in a communications network that includes a communication device, the method comprising:

transmitting configuration information to a communication device using a first topology configuration while the communication device is in an active state, the configuration information indicating a request for the communication device to perform an action associated with a second topology configuration when the wireless device is in an idle state, the second topology being different than the first topology configuration;

communicating with the communication device using the second topology configuration while the communication device is in the idle state; and

determining performance of the second topology configuration based on communicating with the communication device using the second topology configuration while the communication device is in the idle state.

44. The method of claim **43**, wherein the configuration information comprises:

an indication of a signal that will be transmitted by the network node using the second topology configuration;

a request that the communication device measure performance of the signal; and

a request that the communication device provide an indication of the performance of the signal to the network node.

45. The method of claim **44**, wherein communicating with the communication device comprises transmitting the signal to the communication device using the second topology configuration, and

wherein determining the performance comprises receiving an indication of the performance of the signal from the communication device.

46. The method of claim **44**, wherein the signal comprises a synch signal burst, SSB.

47. The method of claim **44**, wherein the indication of when the signal will be transmitted comprises an indication that the signal will be transmitted using the same or different time and/or frequency resources as signals being communicated using the first topology configuration.

48. The method of claim **43**, wherein the configuration information comprises a request that the communication device transmit a signal to the network node while the network node uses the second topology configuration, and

wherein communicating with the communication devices comprises receiving the signal using the second topology configuration.

49. The method of claim **43**, wherein transmitting the configuration information comprises any one of:

transmitting a broadcast signal including an indication of the configuration information to the communication device;

transmitting the configuration information to the communication device via a dedicated control channel, optionally the configuration information being transmitted via a radio resource control, RRC, signal.

50. The method of claim **43**, wherein a difference between the first topology configuration and the second topology configuration includes a variation in at least one of:

a transmit antenna configuration;

a transmit beam configuration;

an output power;

a transmit node;

a receive antenna configuration;

a receive beam configuration; and

a receive node.

51. The method of claim **43**, further comprising:

determining network resources to be used for subsequent communications based on the performance of the second topology configuration; and subsequent to determining the network resources, communicating with another communication device using the network resources.

52. A communication device, the communication device comprising:

processing circuitry; and

memory coupled to the processing circuitry and having instructions stored therein that are executable by the processing circuitry to cause the communication device to perform operations to:

receive configuration information from the network node using a first topology configuration while the communication device is in an active state, the configuration information indicating a request for the communication device to perform an action associated with a second topology configuration that is different than the first topology configuration while the communication device is in an idle state;

transition to an idle state; and

perform the action associated with the second topology configuration, the action being performed while the network node is using the second topology configuration.

53. A network node, the node comprising:

processing circuitry; and

memory coupled to the processing circuitry and having instructions stored therein that are executable by the processing circuitry to cause the network node to perform operations to:

transmit configuration information to a communication device using a first topology configuration while the communication device is in an active state, the configuration information indicating a request for the communication device to perform an action associated with a second topology configuration when the wireless device is in an idle state, the second topology being different than the first topology configuration;

communicate with the communication device using the second topology configuration while the communication device is in the idle state; and

determine performance of the second topology configuration based on communicating with the communication device using the second topology configuration while the communication device is in the idle state.

* * * * *