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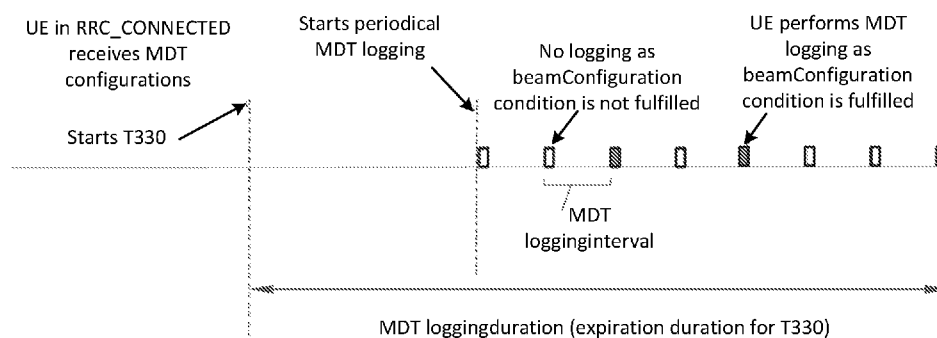


Figure 10

(57) **Abstract:** A method performed by a user equipment in a radio communication network is provided. The method includes receiving a minimization of drive tests (MDT) configuration comprising a beam configuration. The beam configuration comprises at least the identity of a beam and a cell identity of the beam. The method further includes detecting at least one beam of a cell proximate to the user equipment, determining from the beam configuration whether the at least one detected beam is included in the beam configuration, performing MDT measurements, performing logging of the MDT measurements at an interval of a periodic logging interval when the at least one detected beam is included in the beam configuration, and omitting logging of the MDT measurements at an interval of the periodic logging interval when the at least one detected beam is not included in the beam configuration.



MINIMIZATION OF DRIVE TESTS BASED ON CONFIGURED BEAMS

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of and priority to U.S. Provisional Patent Application No. 62/887,269 filed on August 15, 2019, the disclosure of which is hereby incorporated in its entirety by reference.

TECHNICAL FIELD

[0002] The present disclosure relates generally to wireless communications systems and, more particularly, to performing minimization of drive tests (MDT) based on configured beams in a radio communication network.

[0003]

BACKGROUND

[0004] MDT was studied by Radio Access Network group 2 (RAN2) in Rel-9 (3GPP TR 36.805) with a purpose to minimize the need of actual, manual drive tests. MDT has been introduced in Long Term Evolution (LTE) since Rel-10. MDT has not been specified for New Radio (NR) in the involved standards in RAN2, RAN3 and Services and Systems Aspects group 5 (SA5) groups.

[0005] Use cases for MDT in 3GPP TR 36.805, Rel-9 include:

- Coverage optimization
- Mobility optimization
- Capacity optimization
- Parameterization for common channels, and
- QoS verification

[0006] MDT types based on radio resource control (RRC) generally include two types of MDT measurement logging, referred to as Logged MDT and Immediate MDT.

[0007] Referring first to Logged MDT, a user equipment (UE) in RRC_IDLE state may be configured to perform periodical MDT logging after receiving the MDT configurations from the network. The UE may report the downlink (DL) pilot strength measurements (reference signal received power (RSRP)/reference signal received quality

(RSRQ) together with time information, detailed location information if available, and wireless local area network (WLAN), Bluetooth to the network using the UE information framework when it is in RRC_CONNECTED state. The DL pilot strength measurement of Logged MDT may be collected based on the existing measurements required for cell reselection purpose, without imposing the UE to perform additional measurements.

[0008] Figure 1 illustrates an example of measurement logging for Logged MDT.

[0009] In some approaches for logged MDT, a UE may receive MDT configurations including logginginterval and loggingduration in an RRC message, e.g., LoggedMeasurementConfiguration, from the network. A timer (e.g., T330) may be started at the UE upon receiving the configurations and set to a loggingduration (e.g., 10 min – 120 min). The UE may perform periodical MDT logging with the interval set to logginginterval (e.g., 1.28 s – 61.44 s) when the UE is in RRC_IDLE. An example of MDT logging is illustrated in Figure 2.

[0010] Referring next to Immediate MDT, in some approaches, measurements for Immediate MDT may be performed by a radio access node (RAN) and a UE. A number of measurements (M1-M9) may be included for RAN measurements and UE measurements. For UE measurements, a MDT configuration is based on existing RRC measurement procedures for configuration and reporting with some extensions for location information. An example of measurement quantities for Immediate MDT is shown in Figure 3.

[0011] Referring to Figure 3, reporting of Immediate MDT may include the following:

- For M1:
 - o Event-triggered measurement reports according to existing RRM configuration for events A1, A2, A3, A4, A5 A6, B1 or B2.
 - o Periodic, A2 event-triggered, or A2 event triggered periodic measurement report according to MDT specific measurement configuration.
- For M2: Reception of Power Headroom Report (PHR) according to existing RRM configuration.
- For M3 – M9: End of measurement collection period.

[0012] Note that terminology used here such as “network node”, “gNodeB”, “gNB”, “eNodeB”, “eNB” and user equipment (UE) is non-limiting and does not imply or otherwise constrain a certain hierarchical relation. The term “network node” can be any wireless communication device, including but not limited to cloud deployment, and the term “UE” can also be any wireless communication device, and these two devices communicate with each other over a radio channel. Although various embodiments are described in the example context of wireless transmissions in the uplink, these and other embodiments can be used for wireless transmissions in the downlink.

SUMMARY

[0013] According to some embodiments of the present disclosure, a method performed by a user equipment in a radio communication network is provided. The method includes receiving from the radio communication network a minimization of drive tests (MDT) configuration comprising a beam configuration. The beam configuration comprises at least the identity of a beam and a cell identity of the beam. The method further includes detecting at least one beam of a cell proximate to the user equipment. The method further includes determining from the beam configuration whether the at least one detected beam is included in the beam configuration. The method further includes performing MDT measurements; performing logging of the MDT measurements at an interval of a periodic logging interval when the at least one detected beam is included in the beam configuration; and omitting logging of the MDT measurements at an interval of the periodic logging interval when the at least one detected beam is not included in the beam configuration.

[0014] In some embodiments, the method further includes storing the MDT measurements when the at least one detected beam is included in the beam configuration, and reporting the MDT measurements to the radio communication network when the at least one detected beam is included in the beam configuration.

[0015] In some embodiments, the method further includes one of: receiving a configuration from a master node or a secondary node of the radio communication network for dual connectivity comprising a configuration for monitoring beams based on configured beams of a master cell group, a secondary cell group, or both a master cell

group and a secondary cell group provided in an MDT area configuration; receiving a configuration from a master node of the radio communication network for dual connectivity comprising a configuration for both a master cell group and a secondary cell group or providing a separate configuration for a master cell group and a secondary cell group; and receiving a configuration from the radio communication network for carrier aggregation comprising a configuration for monitoring beams based on configured beams provided in an MDT area configuration.

[0016] Corresponding embodiments of inventive concepts for a user equipment, a network node, computer products, and computer programs are also provided.

[0017] The following explanation of potential problems with existing solutions is a present realization as part of the present disclosure and is not to be construed as previously known by others. MDT has not been specified for NR in involved standards in RAN2, RAN3 and SA5 groups. MDT may provide value for coverage detection and QoS verification. Performing MDT, however, may incur costs including, e.g., UE memory use, traffic overhead, etc. While a more accurate area selected by Operations, Administration, and Maintenance (OAM) to perform MDT may lower costs that MDT may incur, existing approaches to MDT may not provide sufficient granularity to lower costs of MDT.

[0018] Operational advantages that may be provided by one or more embodiments of the present disclosure may include enabling a UE to perform measurements logging when a beam configuration condition is fulfilled. From the network perspective, the network may collect more data which is relevant to the found problems (e.g., beam coverage issue) for a given logged MDT duration, interval and fixed reserved UE memory. From UE perspective, a UE may not need to store all of the measurements at each configured logging interval; instead, a UE may only store the corresponding measurements when the beam configuration condition is met, which may save UE memory. As a consequence, costs of MDT may be lower.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] 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:

- [0020]** Figure 1 illustrates a measurement logging for Logged MDT;
- [0021]** Figure 2 illustrates an example of a Logged MDT procedure;
- [0022]** Figure 3 is a table illustrating measurement quantities for Immediate MDT;
- [0023]** Figure 4 illustrates an SSB-Index information element from 3GPP TS 38.331 (v15.6.0);
- [0024]** Figure 5 illustrates a SSB-MTC information element from 3GPP TS 38.331 (v15.6.0);
- [0025]** Figure 6 illustrates SSB-MTC field descriptions from 3GPP TS 38.331 (v15.6.0);
- [0026]** Figure 7 is a table illustrating choices of area scope in MDT configuration received by eNB as defined in 3GPP TS 36.413;
- [0027]** Figure 8 illustrates an AreaConfiguration information element that may be sent to a UE as described in 3GPP TS 36.331;
- [0028]** Figure 9 illustrates operations of a UE camping normally on a cell for checking if the serving cell is part of an Area Scope if configured as described in 3GPP TS 36.331;
- [0029]** Figure 10 illustrates a Logged MDT procedure, in accordance with some embodiments of the present disclosure;
- [0030]** Figure 11 illustrates UE beam detecting, in accordance with some embodiments of the present disclosure;
- [0031]** Figure 12 illustrates a LoggedMeasurementConfiguration message, in accordance with some embodiments of the present disclosure;
- [0032]** Figure 13 illustrates an AreaConfiguration information element included in a LoggedMeasurementConfiguration message;
- [0033]** Figure 14 illustrates a BeamConfiguration information element included in a LoggedMeasurementConfiguration message, in accordance with some embodiments of the present disclosure;

[0034] Figures 15-19 are flowcharts of operations that may be performed by a user equipment, in accordance with some embodiments of the present disclosure;

[0035] Figures 20-23 are flowcharts of operations that may be performed by a network node, in accordance with some embodiments of the present disclosure;

[0036] Figure 24 is a block diagram of elements of a user equipment that are configured according to some embodiments of the present disclosure;

[0037] Figure 25 is a block diagram of elements of a network node that are configured according to some embodiments of the present disclosure; and

[0038] Figure 26 is a block diagram of a wireless network in accordance with some embodiments of the present disclosure.

DETAILED DESCRIPTION

[0039] Inventive concepts will now be described more fully hereinafter with reference to the accompanying drawings, 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.

[0040] The following description presents various embodiments of the disclosed subject matter. These embodiments are presented as teaching examples and are not to be construed as limiting the scope of the disclosed subject matter. For example, certain details of the described embodiments may be modified, omitted, or expanded upon without departing from the scope of the described subject matter. The term "user equipment" is used in a non-limiting manner and, as explained below, can refer to any type of radio communication terminal/device. The term "UE" herein may be interchangeably replaced with the term "radio terminal," "radio communication terminal," "radio device," "mobile device", "device", or "user equipment".

[0041] A UE may perform cell selection and reselection based on measurements on downlink signals.

[0042] In NR, a Synchronization Signal (SS) block may include time-division multiplexed components each with the duration of one symbol as follows: (a) Primary Synchronization Signal (PSS), (b) Physical Broadcast Channel (PBCH), (c) Secondary Synchronization Signal (SSS) and finally (d) PBCH. PBCH may carry a small part of the system information, sometimes referred to as the Master Information Block (MIB). The PSS+PBCH+SSS+PBCH structure may be denoted SS Block (SSB).

[0043] Depending on the deployment, beamforming may be used to distribute the SSB over the coverage area of a cell. Each SSB instance may be beamformed in a certain direction, either to ensure coverage or to provide beam finding support for subsequent link establishment. For improving coverage (or beam finding), the SS Block may be transmitted using beam sweeping where SSB is transmitted sequentially through pre-determined beam patterns that together cover the desired area. Another approach for improving coverage may be repetition of wide (even omnidirectional) beam transmissions. Both beam sweeping and repetition may involve multiple transmissions.

[0044] It may have been agreed in 3GPP meetings that Secondary Synchronization Signal (SSS) and Demodulation Reference Signal (DMRS) of PBCH may be used for Downlink (DL) based radio resource management (RRM) measurement for a UE in RRC_IDLE or RRC_INACTIVE state. In other words, a UE in RRC_IDLE or RRC_INACTIVE state may perform cell selection and re-selection based on measurements on the SS Blocks associated to cells.

[0045] 3GPP TS 38.331 (v15.6.0) defines an SSB-Index, as illustrated in Figure 4.

[0046] An information element (IE), SSB-Index, may identify an SS-Block within an SS-Burst. See 3GPP TS 38.213, clause 4.1.

[0047] An IE SSB-MTC may be used to configure measurement timing configurations, i.e., timing occasions at which the UE measures SSBs. A SSB-MTC IE is illustrated in Figure 5.

[0048] Figure 6 illustrates SSB-MTC field descriptions.

[0049] In some approaches for management-based MDT, upon receiving the MDT configuration, a RAN node may select UEs and activate MDT functionality to the selected UEs. A UE which is outside of the area scope may not be selected by the RAN node.

[0050] Figure 7 illustrates choices of area scope in MDT configuration received by eNB as defined in 3GPP TS 36.413. Referring to Figure 7, in the case of tracking area (TA) based, the tracking area identity (TAI) is derived using the current public land mobile network (PLMN).

[0051] In some approaches, for Immediate MDT, a UE does not check the area scope since the MDT configuration is not sent to the UE. In some approaches, for Logged MDT, the UE may receive the area scope when the MDT configuration is sent to the UE. A corresponding IE may be called AreaConfiguration as defined in 3GPP TS 36.331.

[0052] Figure 8 illustrates an AreaConfiguration IE that may be sent to a UE as described in 3GPP TS 36.331.

[0053] In some approaches, for Logged MDT (in management-based or signaling based MDT), a UE camping normally on a cell may check if the serving cell is part of the area scope if configured, as illustrated in TS 36.331 and in Figure 9.

[0054] In some approaches, for Logged MDT, a UE camping normally in a cell may perform MDT logging if the serving cell is part of the configured area (i.e., AreaConfiguration).

[0055] In some approaches, for signaling-based MDT, the area scope can be also included in the MDT configuration. After the UE is selected by OAM and mobility management entity (MME) for MDT functionality, MME may send Trace Start containing the MDT configuration to the serving eNode B (eNB) of the UE, if the area scope criterion is specified and satisfied. If the area criterion is specified and is not satisfied, the MME may keep the MDT configuration first and then forward it to the serving eNB only when the area criterion is satisfied.

[0056] In some approaches, when a UE is served by a cell that is in the eNB but not in the MDT area scope then the eNB may store the MDT configuration and configure the UE when the UE moves to a cell in the eNB (intra eNB handover) that satisfies the area scope.

- [0057]** In some approaches, during intra-radio access terminal (intra-RAT) handover, an eNB may propagate the MDT parameters to the target cell regardless of whether the source or target cell is part of the configured area scope in case of an Intra-PLMN handover over interfaces X2 or S1.
- [0058]** Possible inclusion of beam level information in MDT in 3GPP will now be discussed.
- [0059]** Best beam index (e.g., SSB index) of the camped cell may be included as part of the logged MDT report. Other measurements may be for further study.
- [0060]** An attempted SSB index can be indicated as part of random access procedure (RACH) failure information.
- [0061]** SSB related information including an SSB index and number of preambles sent for each tried SSB in the RACH information report may be included.
- [0062]** SS Block index, channel state information reference signal (CSI-RS) index for both of serving and neighbouring cells could be included in the NR radio link failure (RLF) report.
- [0063]** CSI-RS index and the corresponding number of preambles sent for each tried beam carrying CSI-RS index could be included in the NR RLF report also, if it is RACH procedure failure leading to the RLF.
- [0064]** Both of SSB index of the downlink beams of both serving cell and neighbour cells and supplementary uplink (SUL)/normal uplink (NUL) carrier information could be included in the 5G NR RRC connection failure reporting.
- [0065]** Beam RSRP/RSRQ of the best beam of camped cell could be included in logged MDT report.
- [0066]** The number of good beams associated to the cells within the rangeToBestCell of the R value of the highest ranked cell could be included as part of the beam level measurements in the logged MDT report.
- [0067]** For cell reselection in multi-beam operations, a UE may detect beams of a cell and derive the cell quality of a cell amongst the beams corresponding to the same cell based on SS/PBCH block.
- [0068]** As explained above, existing approaches for performing MDT may incur costs including, e.g., UE memory use, traffic overhead, etc. While it may have been

agreed in 3GPP RAN2 meetings that some beam information may be provided in Logged MDT, Immediate MDT, RLF Report, and accessibility measurement report, existing MDT approaches may not provide sufficient granularity to lower MDT costs.

[0069] In various embodiments, a method may be provided for a radio communication network to configure a UE with BeamConfiguration in a Logged MDT configuration.

[0070] In various embodiments, a UE may perform MDT measurements logging when a beam index of a detected beam matches with a configured beam index in a BeamConfiguration.

[0071] Advantages of various embodiments may enable a UE to only perform measurements logging when a beam configuration condition is fulfilled. From the network perspective, the network may collect more data which is relevant to the found problems (e.g., beam coverage issue) for a given logged MDT duration, interval and fixed reserved UE memory. From UE perspective, a UE may not need to store all of the measurements at each configured logging interval; instead, a UE may only store the corresponding measurements when the beam configuration condition is met, which may save UE memory.

[0072] Beam Configuration of various embodiments will now be described.

[0073] For cell reselection in multi-beam operations, a UE may detect beams of a cell and derive the cell quality of a cell amongst the beams corresponding to the same cell based on SS/PBCH block which is referred to as SSB. Furthermore, in an existing Logged MDT mechanism, a UE may perform logging when if the serving cell of the UE is part of the area indicated AreaConfiguration.

[0074] In various embodiments, a Beam Configuration for MDT may be included. The Beam Configuration (also referred to herein as beam configuration and BeamConfiguration) may include at least the identity of a beam and a cell identity of the beam. Beam Configuration may also include the identities of multiple beams and corresponding cell identities for each of the beams. Beam Configuration may be included in a list, a table, a mapping, a message, an information element, etc. Beam Configuration may include one or more beam indexes and each beam index may identify a beam and a cell identity of the beam. The Beam Configuration may also, or alternatively, include one

or more beam indexes and each beam index may identify a beam, a cell identity of the beam, and a beam threshold. Further, the beam index may include a SSB index. The beam configuration may be configured by the network to a UE as a part of the logged MDT configuration. When a UE moves close to at least one beam in a list of beams configured by the network, the UE may perform measurement logging based on the configured logging interval specified in the existing MDT configuration; otherwise, the UE may not need to store the measurements.

[0075] Figure 10 illustrates a Logged MDT procedure in accordance with some embodiments of the present disclosure.

[0076] In some embodiments, when a UE is received with logged MDT configuration which includes a beam configuration, the UE may perform measurement logging at the configured regular time intervals if the beam configuration condition is fulfilled.

[0077] In another embodiment, the beam configuration may contain one or more than one beam indexes and each beam index may include one or more than one beam indexes and a cell identity of the beams.

[0078] In another embodiment, the beam configuration may contain one or more than one beam indexes and each beam index may include one or more than one beam indexes, a cell identity of the beams and a beam threshold. The beam threshold may be a defined value.

[0079] Fulfilling the beam configuration is now described further.

[0080] In some embodiments, a UE may use a strongest beam to check if the beam configuration is fulfilled.

[0081] In some embodiments, if a UE is configured with logged MDT configuration which includes a BeamConfiguration, the UE may check if the strongest beam among the detected beams of the serving cell is a part of the BeamConfiguration. If so, the UE may store the corresponding measurement result and reports to the network during the reporting procedure. Otherwise, the UE may not store the corresponding measurement result.

[0082] Figure 11 illustrates an example of a UE detecting beams SSB A1, SSB A2, and SSB A3 during one measurement on the serving cell. For example, if SSB A2 is the

strongest beam, the UE may check to determine whether SSB A2 is a part of the BeamConfiguration.

[0083] In another embodiment, if a UE is configured with logged MDT configuration which includes a BeamConfiguration, the UE may check if the strongest beam among the detected beams of the neighboring cell is a part of the BeamConfiguration. If so, the UE may store the corresponding measurement result and reports to the network during the reporting procedure. Otherwise, UE may not store the corresponding measurement result.

[0084] In another embodiment, if a UE is configured with logged MDT configuration which includes a BeamConfiguration, the UE may check if the strongest beam among the detected beams of the serving cell and the neighboring cell is a part of the BeamConfiguration. If either the strongest beam of the serving cell or the strongest beam of the neighbor cell or both fulfil the beam configuration, UE may store the corresponding measurement result and reports to the network during the reporting procedure. Otherwise, UE may not store the corresponding measurement result. Referring to the example in Figure 11, if the strongest beam of the neighboring cell B is SSB B2 and the BeamConfiguration contains SSB A2 or SSB B2 or both, the BeamConfiguration is fulfilled.

[0085] In other embodiments, a UE may use all detected beams to check if a BeamConfiguration is fulfilled.

[0086] In one embodiment, if a UE is configured with logged MDT configuration which includes a BeamConfiguration, the UE may check if at least one beam among the detected beams of the serving cell is a part of the BeamConfiguration. If so, the UE may store the corresponding measurement result and reports to the network during the reporting procedure.

[0087] In another embodiment, if a UE is configured with logged MDT configuration which includes a BeamConfiguration, the UE may check if at least one beam among the detected beams of the neighboring cell is a part of the BeamConfiguration. If so, the UE may store the corresponding measurement result and reports to the network during the reporting procedure. Otherwise, UE may not store the corresponding measurement result.

[0088] In another embodiment, if a UE is configured with logged MDT configuration which includes a BeamConfiguration, the UE may check if at least one beam among the detected beams of the serving cell and the neighboring cell is a part of the BeamConfiguration. If either the beams in the serving cell or the beams in the neighbor cell or both fulfil the BeamConfiguration, and the UE may store the corresponding measurement result and reports to the network during the reporting procedure. Otherwise, the UE may not store the corresponding measurement result.

[0089] In other embodiments, a UE may use beams within a range to the strongest beam to check if BeamConfiguration is fulfilled.

[0090] In one embodiment, if a UE is configured with logged MDT configuration which includes a BeamConfiguration, the UE may check if at least one beam which is within a range to the strongest beam among the detected beams of the serving cell is a part of the BeamConfiguration. If so, UE may store the corresponding measurement result and reports to the network during the reporting procedure.

[0091] In another embodiment, if a UE is configured with logged MDT configuration which includes a BeamConfiguration, the UE may check if at least one beam which is within a range to the strongest beam among the detected beams of the neighboring cell is a part of the BeamConfiguration. If so, the UE may store the corresponding measurement result and reports to the network during the reporting procedure. Otherwise, the UE may not store the corresponding measurement result.

[0092] In another embodiment, if a UE is configured with logged MDT configuration which includes a BeamConfiguration, the UE may check if at least one beam which is within a range to the strongest beam among the detected beams of the serving cell and the neighboring cell is a part of the BeamConfiguration. If either the beams of the serving cell or the beams of the neighbor cell or both fulfill the beam configuration, the UE may store the corresponding measurement result and reports to the network during the reporting procedure. Otherwise, the UE may not store the corresponding measurement result.

[0093] In a further embodiment, whether a beam is within a range to the strongest beam among the detected beams may be determined by a defined beam threshold which is configured by the network.

[0094] Example messages in accordance with various embodiments are illustrated in Figures 12-14.

[0095] Figure 12 illustrates a LoggedMeasurementConfiguration message, in accordance with some embodiments of the present disclosure;

[0096] Figure 13 illustrates an AreaConfiguration information element included in a LoggedMeasurementConfiguration message;

[0097] Figure 14 illustrates a BeamConfiguration information element included in a LoggedMeasurementConfiguration message, in accordance with some embodiments of the present disclosure;

[0098] For example, in some embodiments, while the timer for a configured logging duration is running and the UE is performing logging, the UE can perform the following operations:

- 1> perform the logging in accordance with the following:
 - 2> if the UE is in any cell selection state:
 - 4> perform the logging at regular time intervals, as defined by the loggingInterval in VarLogMeasConfig;
 - 2> else if the UE is camping normally on an NR cell and if the RPLMN is included in plmn-IdentityList stored in VarLogMeasReport and, if the cell is part of the area indicated by areaConfiguration if configured in VarLogMeasConfig:
 - 3> If beamConfiguration is configured in VarLogMeasConfig:
 - 4> If the SSB index of the strongest beam among the detected beams of the NR cell is part of the SSB indexes in beamConfiguration:
 - 4> If the SSB index of the strongest beam among the detected beams of one of the neighboring NR cell is part of the SSB indexes in beamConfiguration:
 - 4> If the SSB index of the strongest beam among the detected beams of either the NR cell or one of the neighboring NR cell is part of the SSB indexes in beamConfiguration:

5>perform the logging at regular time intervals, as defined by the loggingInterval in VarLogMeasConfig;

3> else:

4>perform the logging at regular time intervals, as defined by the loggingInterval in VarLogMeasConfig.

[0099] While the example above describes an example of some embodiments, other examples of the various embodiments described in the present disclosure will be apparent to one of skill in the art.

[00100] Content of a logged measurement and a report will now be described.

[00101] In various embodiments, if the BeamConfiguration is fulfilled, the UE may add a logged measurement entry in a UE variable (for example, in a VarLogMeasReport).

[00102] In one embodiment, the measurement entry can include at least the following fields:

- The SSB index of the best beam;
- The RSRP value of the best beam;
- The RSRQ value of the best beam

[00103] In another embodiment, the measurement entry can include at least the following fields

- The SSB index of the beam which is a part of the configured BeamConfiguration;
- The RSRP value of the beam which is a part of the configured BeamConfiguration;
- The RSRQ value of the beam which is a part of the configured BeamConfiguration.

[00104] In another embodiment, the measurement entry can include at least the following fields:

- The SSB index of the beam which is a part of the configured BeamConfiguration;
- The RSRP value of the beam which is a part of the configured BeamConfiguration;

- The RSRQ value of the beam which is a part of the configured BeamConfiguration;
- The SSB index of the best beam;
- The RSRP value of the best beam;
- The RSRQ value of the best beam.

[00105] MDT configured beam in dual connectivity and carrier aggregation scenarios will now be described.

[00106] Various embodiments described in the present disclosure also apply to dual connectivity scenarios which means that the UE can be configured by a secondary node (SN) or a master node (MN) to only monitor the beams based on configured beams of a master cell group (MCG) or a secondary cell group (SCG) or both, provided in MDT area configuration.

[00107] In one embodiment of a dual connectivity (DC) scenario, a MN can provide a common area configuration that covers both MCG and SCG or separate configuration for MCG and SCG. This may be useful in multi radio access technology (RAT) DC scenarios since only NR RAT would support the beam concept and it may be relevant to provide MDT configuration including beam specification for NR RAT only.

[00108] Various embodiments described in the present disclosure also apply to carrier aggregation scenarios which means that a UE can be configured to monitor beams based on configured beams provided in MDT area configuration.

[00109] Presently disclosed embodiments may provide potential advantages including, but not limited to, enabling a UE to only perform measurements logging when the beam configuration is fulfilled. From the network perspective, the network may collect more data, which may be relevant to found problems (e.g., a beam coverage issue) for a given logged MDT duration, interval and fixed reserved UE memory. From a UE perspective, a UE may not need to store all of the measurements at each configured logging interval. Instead, a UE may store the corresponding measurements when the beam configuration is met, which may save UE memory.

[00110] These and other related operations will now be described in the context of the operational flowcharts of Figures 15-23. Figures 15-19 are flowcharts of operations

that may be performed by a UE. Figures 20-23 are flowcharts of operations that may be performed by a network node.

[00111] Referring initially to Figure 15, operations can be performed by a UE (e.g., 2400 in Fig. 24) in a radio communication network. The operations include receiving (1500) from the radio communication network a MDT configuration including a beam configuration. The beam configuration may include at least the identity of a beam and a cell identity of the beam. The operations further include detecting (1502) at least one beam of a cell proximate to the user equipment. The operations further include determining (1504) from the beam configuration whether the at least one detected beam is included in the beam configuration; performing (1506) MDT measurements; and performing (1508) logging of the MDT measurements at an interval of a periodic logging interval when the at least one detected beam is included in the beam configuration. The operations further include omitting (1510) logging of the MDT measurements at an interval of the periodic logging interval when the at least one detected beam is not included in the beam configuration.

[00112] In at least some embodiments, the MDT configuration is a logged MDT configuration.

[00113] In some embodiments, the MDT configuration is an immediate MDT configuration.

[00114] In at least some embodiments, the beam configuration includes one or more beam indexes and each beam index identifies a beam and a cell identity of the beam.

[00115] In at least some embodiments, the beam configuration includes one or more beam indexes and each beam index identifies a beam, a cell identity of the beam, and a beam threshold.

[00116] In some embodiments, the beam index includes a synchronization signal block (SSB) index.

[00117] Still referring to Figure 15, in at least some embodiments, the UE can perform operations where the detecting (1502) at least one beam of a cell proximate to the user equipment includes detecting a strongest beam of a serving cell; and where the determining (1504) from the beam configuration whether the at least one detected

beam is included in the beam configuration includes identifying whether the detected strongest beam is included in the beam configuration.

[00118] In some embodiments, the UE can perform operations where the detecting (1502) at least one beam of a cell proximate to the user equipment includes detecting a strongest beam of a neighboring cell; and where the determining (1504) from the beam configuration whether the at least one detected beam is included in the beam configuration includes identifying whether the detected strongest beam is included in the beam configuration.

[00119] In other embodiments, the UE can perform operations where the detecting (1502) at least one beam of a cell proximate to the user equipment includes detecting at least one strongest beam of a serving cell and/or a neighboring cell; and where the determining (1504) from the beam configuration whether the at least one detected beam is included in the beam configuration includes identifying whether the at least one detected strongest beam of the serving cell, the neighboring cell, and/or the serving cell and the neighboring cell is included in the beam configuration.

[00120] In some embodiments, the UE can perform operations where the detecting (1502) at least one beam of a cell proximate to the user equipment includes detecting multiple beams of a serving cell; and where the determining (1504) from the beam configuration whether the at least one detected beam is included in the beam configuration includes identifying whether at least one of the detected multiple beams is included in the beam configuration.

[00121] In some embodiments, the UE can perform operations where the detecting (1502) at least one beam of a cell proximate to the user equipment includes detecting multiple beams of a neighboring cell; and where the determining (1504) from the beam configuration whether the at least one detected beam is included in the beam configuration includes identifying whether at least one of the detected multiple beams is included in the beam configuration.

[00122] In some embodiments, the UE can perform operations where the detecting (1502) at least one beam of a cell proximate to the user equipment includes detecting multiple beams of a serving cell and/or a neighboring cell; and where the determining (1504) from the beam configuration whether the at least one detected

beam is included in the beam configuration includes identifying whether at least one of the detected multiple beams of the serving cell, the neighboring cell, and/or the serving cell and the neighboring cell is included in the beam configuration.

[00123] In some embodiments, the UE can perform operations where the detecting (1502) at least one beam of a cell proximate to the user equipment includes detecting at least one beam within a range to a detected strongest beam among detected beams of a serving cell; and where the determining (1504) from the beam configuration whether the at least one detected beam is included in the beam configuration includes identifying whether at least one of the detected beams within range to the detected strongest beam among the detected beams is included in the beam configuration.

[00124] In some embodiments, the UE can perform operations where the detecting (1502) at least one beam of a cell proximate to the user equipment includes detecting at least one beam within a range to a detected strongest beam among detected beams of a neighboring cell; and where the determining (15604) from the beam configuration whether the at least one detected beam is included in the beam configuration includes identifying whether at least one of the detected beams within range to the detected strongest beam among the detected beams is included in the beam configuration.

[00125] In some embodiments, the UE can perform operations where the detecting (1502) at least one beam of a cell proximate to the user equipment includes detecting at least one beam within a range to a detected strongest beam among detected beams of a serving cell and/or a neighboring cell; and where the determining (1504) from the beam configuration whether the at least one detected beam is included in the beam configuration comprises identifying whether at least one of the detected beams within range to the detected strongest beam among the detected beams of the serving cell, the neighboring cell, and/or the serving cell and the neighboring cell is included in the beam configuration

[00126] Still referring to Figure 15, in some embodiments, detecting (1502) at least one beam within a range to a detected strongest beam among detected beams may be based on a defined beam threshold configured by the network.

[00127] With reference to Figure 16, further operations that can be performed by the UE can include storing (1600) the MDT measurements when the at least one detected beam is included in the beam configuration. Further operations can include reporting (1602) the MDT measurements to the radio communication network when the at least one detected beam is included in the beam configuration.

[00128] In some embodiments, storing (1600) the MDT measurements can include one or more of:

- an SSB index of a best beam;
- a reference signal received power value of the best beam;
- a reference signal received quality value of the best beam;
- an SSB index of the beam that is part of the beam configuration;
- a reference signal received power value of the beam that is part of the beam configuration; and
- a reference signal received quality value of the beam that is part of the beam configuration.

[00129] With reference to Figure 17, further operations that can be performed by the UE can include receiving (1700) a configuration from a master node (2500) or a secondary node (2500) of the radio communication network for dual connectivity including a configuration for monitoring beams based on configured beams of a master cell group, a secondary cell group, or both a master cell group and a secondary cell group provided in an MDT area configuration.

[00130] With reference to Figure 18, further operations that can be performed by the UE can include receiving (1800) a configuration from a master node (2500) of the radio communication network for dual connectivity including a configuration for both a master cell group and a secondary cell group or providing a separate configuration for a master cell group and a secondary cell group.

[00131] With reference to Figure 19, further operations that can be performed by the UE can include receiving (1900) a configuration from the radio communication network for carrier aggregation including a configuration for monitoring beams based on configured beams provided in an MDT area configuration

[00132] Various operations from the flow chart of Figure 15 may be optional with respect to some embodiments of user equipment and related methods. Regarding methods of example embodiments (set forth above), for example, operations of blocks 1508 and 1510 of Figure 15 may be optional.

[00133] Figure 20 is a flowchart of operations that can be performed by a network node in a radio communications network (e.g., 2500 in Fig. 25) in accordance with some embodiments.

[00134] Referring to Figure 20, the operations include sending (2000), to a user equipment (2400), a MDT configuration including a beam configuration. The beam configuration can include at least the identity of a beam and a cell identity of the beam. The operations further include receiving (2002), from the user equipment, MDT measurements during an interval of a periodic logging interval when the user equipment detected at least one beam included in the beam configuration.

[00135] In some embodiments, the MDT configuration is a logged MDT configuration.

[00136] In some embodiments, the MDT configuration is an immediate MDT configuration.

[00137] In some embodiments, the beam configuration can include one or more beam indexes and each beam index identifies a beam and a cell identity of the beam.

[00138] In some embodiments, the beam configuration can include one or more beam indexes and each beam index identifies a beam, a cell identity of the beam, and a beam threshold.

[00139] In some embodiments, the beam index includes a synchronization signal block (SSB) index.

[00140] With reference to Figure 21, further operations that can be performed by the network node can include sending (2100), to the user equipment, a configuration for dual connectivity including a configuration for monitoring beams based on configured beams of a master cell group, a secondary cell group, or both a master cell group and a secondary cell group provided in an MDT area configuration.

[00141] With reference to Figure 22, further operations that can be performed by the network node can include sending (2200), to the user equipment, a configuration for

dual connectivity including a configuration for both a master cell group and a secondary cell group or providing a separate configuration for a master cell group and a secondary cell group.

[00142] With reference to Figure 23, further operations that can be performed by the network node can include sending (2300), to the user equipment, a configuration for carrier aggregation including a configuration for monitoring beams based on configured beams provided in an MDT area configuration.

[00143] Various operations from the flow chart of Figure 20 may be optional with respect to some embodiments of a network node and related methods. Regarding methods of example embodiments (set forth above), for example, operations of block 2002 of Figure 20 may be optional.

[00144] Figure 24 is a block diagram illustrating an exemplary UE 2400 that is configured according to some embodiments. The UE 2400 can include, without limitation, a wireless terminal, a wireless communication device, a wireless communication terminal, a terminal node/UE/device, etc. The UE 2400 includes a RF front-end 2430 comprising one or more power amplifiers that transmit and receive through antennas of an antenna array 2440 to provide uplink and downlink radio communications with a radio network node (e.g., a base station, eNB, gNB, etc.) of a radio communications network. UE 2400 further includes at least one processor circuit 2410 (also referred to as at least one processor) coupled to the RF front end 2430 and a memory circuit 2420 (also referred to as memory). The memory 2420 stores computer readable program code that when executed by the at least one processor 2410 causes the at least one processor 2410 to perform operations according to embodiments disclosed herein.

[00145] Figure 25 is a block diagram illustrating an exemplary network node 2500 (e.g., a base station, gNB, etc.) of a radio communications network. The network node 2500 includes at least one processor circuit 2510 (also referred to as at least one processor), a memory circuit 2520 (also referred to as memory), and a network interface 2550 (e.g., wired network interface and/or wireless network interface) configured to communicate with other network nodes. The network node 2500 may be configured as a radio network node containing a RF front end with one or more power amplifiers 2430

that transmit and receive through antennas of an antenna array 2540. The memory 2520 stores computer readable program code that when executed by the at least one processor 2510 causes the at least one processor 2510 to perform operations according to embodiments disclosed herein.

[00146] Listing of Embodiments: Example Embodiments are discussed below. Reference numbers/letters are provided in parenthesis by way of example/illustration without limiting example embodiments to particular elements indicated by reference numbers/letters.

[00147] Embodiment 1. A method performed by a user equipment (2400) in a radio communication network. The method includes receiving (1500) from the radio communication network a minimization of drive tests (MDT) configuration comprising a beam configuration, wherein the beam configuration comprises at least the identity of a beam and a cell identity of the beam. The method further includes detecting (1502) at least one beam of a cell proximate to the user equipment. The method further includes determining (1504) from the beam configuration whether the at least one detected beam is included in the beam configuration. The method further includes performing (1506) MDT measurements. The method further includes performing (1508) logging of the MDT measurements at an interval of a periodic logging interval when the at least one detected beam is included in the beam configuration. The method further includes omitting (1510) logging of the MDT measurements at an interval of the periodic logging interval when the at least one detected beam is not included in the beam configuration.

[00148] Embodiment 2. The method of Embodiment 1, wherein the MDT configuration is a logged MDT configuration.

[00149] Embodiment 3. The method of Embodiment 1, wherein the MDT configuration is an immediate MDT configuration.

[00150] Embodiment 4. The method of any of Embodiments 1 to 3, wherein the beam configuration includes one or more beam indexes and each beam index identifies a beam and a cell identity of the beam.

[00151] Embodiment 5. The method of any of Embodiments 1 to 3, wherein the beam configuration includes one or more beam indexes and each beam index identifies a beam, a cell identity of the beam, and a beam threshold.

[00152] Embodiment 6. The method of any of Embodiments 4 to 5, wherein the beam index includes a synchronization signal block (SSB) index.

[00153] Embodiment 7. The method of any of Embodiments 1 to 6, wherein the detecting at least one beam of a cell proximate to the user equipment includes detecting a strongest beam of a serving cell, and wherein the determining from the beam configuration whether the at least one detected beam is included in the beam configuration includes identifying whether the detected strongest beam is included in the beam configuration.

[00154] Embodiment 8. The method of any of Embodiments 1 to 6, wherein the detecting at least one beam of a cell proximate to the user equipment includes detecting a strongest beam of a neighboring cell, and wherein the determining from the beam configuration whether the at least one detected beam is included in the beam configuration includes identifying whether the detected strongest beam is included in the beam configuration.

[00155] Embodiment 9. The method of any of Embodiments 1 to 6, wherein the detecting at least one beam of a cell proximate to the user equipment includes detecting at least one strongest beam of a serving cell and/or a neighboring cell, and wherein the determining from the beam configuration whether the at least one detected beam is included in the beam configuration includes identifying whether the at least one detected strongest beam of the serving cell, the neighboring cell, and/or the serving cell and the neighboring cell is included in the beam configuration.

[00156] Embodiment 10. The method of any of Embodiments 1 to 6, wherein the detecting at least one beam of a cell proximate to the user equipment includes detecting multiple beams of a serving cell, and wherein the determining from the beam configuration whether the at least one detected beam is included in the beam configuration includes identifying whether at least one of the detected multiple beams is included in the beam configuration.

[00157] Embodiment 11. The method of any of Embodiments 1 to 6, wherein the detecting at least one beam of a cell proximate to the user equipment includes detecting multiple beams of a neighboring cell, and wherein the determining from the beam configuration whether the at least one detected beam is included in the beam

configuration includes identifying whether at least one of the detected multiple beams is included in the beam configuration.

[00158] Embodiment 12. The method of any of Embodiments 1 to 6, wherein the detecting at least one beam of a cell proximate to the user equipment includes detecting multiple beams of a serving cell and/or a neighboring cell, and wherein the determining from the beam configuration whether the at least one detected beam is included in the beam configuration comprises identifying whether at least one of the detected multiple beams of the serving cell, the neighboring cell, and/or the serving cell and the neighboring cell is included in the beam configuration.

[00159] Embodiment 13. The method of any of Embodiments 1 to 6, wherein the detecting at least one beam of a cell proximate to the user equipment includes detecting at least one beam within a range to a detected strongest beam among detected beams of a serving cell, and wherein the determining from the beam configuration whether the at least one detected beam is included in the beam configuration includes identifying whether at least one of the detected beams within range to the detected strongest beam among the detected beams is included in the beam configuration.

[00160] Embodiment 14. The method of any of Embodiments 1 to 6, wherein the detecting at least one beam of a cell proximate to the user equipment includes detecting at least one beam within a range to a detected strongest beam among detected beams of a neighboring cell, and wherein the determining from the beam configuration whether the at least one detected beam is included in the beam configuration includes identifying whether at least one of the detected beams within range to the detected strongest beam among the detected beams is included in the beam configuration.

[00161] Embodiment 15. The method of any of Embodiments 1 to 6, wherein the detecting at least one beam of a cell proximate to the user equipment includes detecting at least one beam within a range to a detected strongest beam among detected beams of a serving cell and/or a neighboring cell, and wherein the determining from the beam configuration whether the at least one detected beam is included in the beam configuration includes identifying whether at least one of the detected beams within range to the detected strongest beam among the detected beams of the serving cell, the

neighboring cell, and/or the serving cell and the neighboring cell is included in the beam configuration.

[00162] Embodiment 16. The method of any of Embodiments 13 to 15, wherein the detecting at least one beam within a range to a detected strongest beam among detected beams is based on a defined beam threshold configured by the network.

[00163] Embodiment 17. The method of any of Embodiments 1 to 16, further including storing (1600) the MDT measurements when the at least one detected beam is included in the beam configuration; and reporting (1602) the MDT measurements to the radio communication network when the at least one detected beam is included in the beam configuration.

[00164] Embodiment 18. The method of Embodiment 17, wherein storing the MDT measurements includes storing one or more of: an SSB index of a best beam; a reference signal received power value of the best beam; a reference signal received quality value of the best beam; an SSB index of the beam that is part of the beam configuration; a reference signal received power value of the beam that is part of the beam configuration; and a reference signal received quality value of the beam that is part of the beam configuration.

[00165] Embodiment 19. The method of any of Embodiments 1 to 18, further including receiving (1700) a configuration from a master node (2500) or a secondary node (2500) of the radio communication network for dual connectivity comprising a configuration for monitoring beams based on configured beams of a master cell group, a secondary cell group, or both a master cell group and a secondary cell group provided in an MDT area configuration.

[00166] Embodiment 20. The method of any of Embodiments 1 to 18, further including receiving (1800) a configuration from a master node (2500) of the radio communication network for dual connectivity comprising a configuration for both a master cell group and a secondary cell group or providing a separate configuration for a master cell group and a secondary cell group.

[00167] Embodiment 21. The method of any of Embodiments 1 to 18, further including receiving (1900) a configuration from the radio communication network for

carrier aggregation comprising a configuration for monitoring beams based on configured beams provided in an MDT area configuration.

[00168] Embodiment 22. A user equipment (2400) for operating in a radio communication network. The user equipment includes at least one processor (2410); and a memory (2420) coupled with the at least one processor, wherein the memory includes instructions that when executed by the at least one processor causes the user equipment to perform operations according to any of Embodiments 1 to 21.

[00169] Embodiment 23. A user equipment (2400) adapted to perform according to any of Embodiments 1 to 21.

[00170] Embodiment 24. A user equipment (2400) for operating in a radio communication network. The user equipment configured to: receive from the radio communication network a minimization of drive tests (MDT) configuration comprising a beam configuration, wherein the beam configuration comprises at least the identity of a beam and a cell identity of the beam; detect at least one beam of a cell proximate to the user equipment; determine from the beam configuration whether the at least one detected beam is included in the beam configuration; perform MDT measurements; perform logging of the MDT measurements at an interval of a periodic logging interval when the at least one detected beam is included in the beam configuration; and omit logging of the MDT measurements at an interval of the periodic logging interval when the at least one detected beam is not included in the beam configuration.

[00171] Embodiment 25. A computer program including program code to be executed by at least one processor (2410) of a user equipment (2400) configured to operate in a radio communication network, whereby execution of the program code causes the user equipment (2400) to perform operations according to any of Embodiments 1 to 21.

[00172] Embodiment 26. A computer program product including a non-transitory storage medium including program code to be executed by at least one processor (2410) of a user equipment (2400) configured to operate in a radio communication network, whereby execution of the program code causes the user device (2000) to perform operations according to any of Embodiments 1 to 21.

[00173] Embodiment 27. A method by a network node (2500) in a radio communications network. The method includes: sending (2000), to a user equipment (2400), a minimization of drive tests (MDT) configuration including a beam configuration, wherein the beam configuration includes at least the identity of a beam and a cell identity of the beam; and receiving (2002), from the user equipment, MDT measurements during an interval of a periodic logging interval when the user equipment detected at least one beam included in the beam configuration.

[00174] Embodiment 28. The method of Embodiment 27, wherein the MDT configuration is a logged MDT configuration.

[00175] Embodiment 29. The method of Embodiment 27, wherein the MDT configuration is an immediate MDT configuration.

[00176] Embodiment 30. The method of any of Embodiments 27 to 29, wherein the beam configuration includes one or more beam indexes and each beam index identifies a beam and a cell identity of the beam.

[00177] Embodiment 31. The method of any of Embodiments 27 to 29, wherein the beam configuration includes one or more beam indexes and each beam index identifies a beam, a cell identity of the beam, and a beam threshold.

[00178] Embodiment 33. The method of any of Embodiments 30 to 31, wherein the beam index includes a synchronization signal block (SSB) index.

[00179] Embodiment 34. The method of any of Embodiments 27 to 32, further including: sending (2100), to the user equipment, a configuration for dual connectivity comprising a configuration for monitoring beams based on configured beams of a master cell group, a secondary cell group, or both a master cell group and a secondary cell group provided in an MDT area configuration.

[00180] Embodiment 35. The method of any of Embodiments 27 to 32, further including: sending (2200), to the user equipment, a configuration for dual connectivity including a configuration for both a master cell group and a secondary cell group or providing a separate configuration for a master cell group and a secondary cell group.

[00181] Embodiment 36. The method of any of Embodiments 27 to 32, further including: sending (2300), to the user equipment, a configuration for carrier aggregation

including a configuration for monitoring beams based on configured beams provided in an MDT area configuration.

[00182] Embodiment 37. A network node (2500) adapted to perform according to any of Embodiments 27 to 35.

[00183] Embodiment 38. A network node (2500) for configuring a user equipment (2400) with a beam configuration for a minimization of drive tests (MDT) configuration in a radio communication network. The network node configured to: send, to the user equipment, the MDT configuration comprising a beam configuration, wherein the beam configuration comprises at least the identity of a beam and a cell identity of the beam; and receiving, from the user equipment, MDT measurements during an interval of a periodic logging interval when the user equipment detected at least one beam included in the beam configuration.

[00184] Embodiment 39. A network node (2500) for configuring a user equipment (2400) with a beam configuration for a minimization of drive tests (MDT) configuration in a radio communication network. The network node including: at least one processor (2510); and a memory (2520) coupled to the at least one processor, wherein the memory stores instructions that when executed by the at least one processor causes the processor to perform operations according to any of Embodiments 27 to 35.

[00185] Embodiment 40. A computer program including program code to be executed by at least one processor (2510) of a network node (2500) configured to operate in a radio communication network, whereby execution of the program code causes the network node (2500) to perform operations according to any of Embodiments 27 to 35.

[00186] Embodiment 41. A computer program product including a non-transitory storage medium including program code to be executed by at least one processor (2510) of a network node (2500) configured to operate in a radio communication network, whereby execution of the program code causes the network node (2500) to perform operations according to any of Embodiments 27 to 35.

[00187] Further definitions and embodiments are discussed below.

[00188] In the above-description of various embodiments of present inventive concepts, it is to be understood that the terminology used herein is for the purpose of

describing particular embodiments only and is not intended to be limiting of present inventive concepts. Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which present inventive concepts belong. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of this specification and the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[00189] When an element is referred to as being "connected", "coupled", "responsive", or variants thereof to another element, it can be directly connected, coupled, or responsive to the other element or intervening elements may be present. In contrast, when an element is referred to as being "directly connected", "directly coupled", "directly responsive", or variants thereof to another element, there are no intervening elements present. Like numbers refer to like elements throughout. Furthermore, "coupled", "connected", "responsive", or variants thereof as used herein may include wirelessly coupled, connected, or responsive. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. Well-known functions or constructions may not be described in detail for brevity and/or clarity. The term "and/or" includes any and all combinations of one or more of the associated listed items.

[00190] It will be understood that although the terms first, second, third, etc. may be used herein to describe various elements/operations, these elements/operations should not be limited by these terms. These terms are only used to distinguish one element/operation from another element/operation. Thus, a first element/operation in some embodiments could be termed a second element/operation in other embodiments without departing from the teachings of present inventive concepts. The same reference numerals or the same reference designators denote the same or similar elements throughout the specification.

[00191] As used herein, the terms "comprise", "comprising", "comprises", "include", "including", "includes", "have", "has", "having", or variants thereof are open-ended, and include one or more stated features, integers, elements, steps, components

or functions but does not preclude the presence or addition of one or more other features, integers, elements, steps, components, functions or groups thereof. Furthermore, as used herein, the common abbreviation "e.g.", which derives from the Latin phrase "exempli gratia," may be used to introduce or specify a general example or examples of a previously mentioned item, and is not intended to be limiting of such item. The common abbreviation "i.e.", which derives from the Latin phrase "id est," may be used to specify a particular item from a more general recitation.

[00192] Example embodiments are described herein with reference to block diagrams and/or flowchart illustrations of computer-implemented methods, apparatus (systems and/or devices) and/or computer program products. It is understood that a block of the block diagrams and/or flowchart illustrations, and combinations of blocks in the block diagrams and/or flowchart illustrations, can be implemented by computer program instructions that are performed by one or more computer circuits. These computer program instructions may be provided to a processor circuit of a general purpose computer circuit, special purpose computer circuit, and/or other programmable data processing circuit to produce a machine, such that the instructions, which execute via the processor of the computer and/or other programmable data processing apparatus, transform and control transistors, values stored in memory locations, and other hardware components within such circuitry to implement the functions/acts specified in the block diagrams and/or flowchart block or blocks, and thereby create means (functionality) and/or structure for implementing the functions/acts specified in the block diagrams and/or flowchart block(s).

[00193] These computer program instructions may also be stored in a tangible computer-readable medium that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer-readable medium produce an article of manufacture including instructions which implement the functions/acts specified in the block diagrams and/or flowchart block or blocks. Accordingly, embodiments of present inventive concepts may be embodied in hardware and/or in software (including firmware, resident software, micro-code, etc.) that runs on a processor such as a digital signal processor, which may collectively be referred to as "circuitry," "a module" or variants thereof.

[00194] It should also be noted that in some alternate implementations, the functions/acts noted in the blocks may occur out of the order noted in the flowcharts. For example, two blocks shown in succession may in fact be executed substantially concurrently or the blocks may sometimes be executed in the reverse order, depending upon the functionality/acts involved. Moreover, the functionality of a given block of the flowcharts and/or block diagrams may be separated into multiple blocks and/or the functionality of two or more blocks of the flowcharts and/or block diagrams may be at least partially integrated. Finally, other blocks may be added/inserted between the blocks that are illustrated, and/or blocks/operations may be omitted without departing from the scope of inventive concepts. Moreover, although some of the diagrams include arrows on communication paths to show a primary direction of communication, it is to be understood that communication may occur in the opposite direction to the depicted arrows.

[00195] Many variations and modifications can be made to the embodiments without substantially departing from the principles of the present inventive concepts. All such variations and modifications are intended to be included herein within the scope of present inventive concepts. Accordingly, the above disclosed subject matter is to be considered illustrative, and not restrictive, and the examples of embodiments are intended to cover all such modifications, enhancements, and other embodiments, which fall within the spirit and scope of present inventive concepts. Thus, to the maximum extent allowed by law, the scope of present inventive concepts are to be determined by the broadest permissible interpretation of the present disclosure including the examples of embodiments and their equivalents, and shall not be restricted or limited by the foregoing detailed description.

[00196] Additional explanation is provided below.

[00197] Generally, all terms used herein are to be interpreted according to their ordinary meaning in the relevant technical field, unless a different meaning is clearly given and/or is implied from the context in which it is used. All references to a/an/the element, apparatus, component, means, step, etc. are to be interpreted openly as referring to at least one instance of the element, apparatus, component, means, step, etc., unless explicitly stated otherwise. The steps of any methods disclosed herein do not

have to be performed in the exact order disclosed, unless a step is explicitly described as following or preceding another step and/or where it is implicit that a step must follow or precede another step. Any feature of any of the embodiments disclosed herein may be applied to any other embodiment, wherever appropriate. Likewise, any advantage of any of the embodiments may apply to any other embodiments, and vice versa. Other objectives, features and advantages of the enclosed embodiments will be apparent from the following description.

[00198] Some of the embodiments contemplated herein will now be described more fully with reference to the accompanying drawings. Other embodiments, however, are contained within the scope of the subject matter disclosed herein, the disclosed subject matter should not be construed as limited to only the embodiments set forth herein; rather, these embodiments are provided by way of example to convey the scope of the subject matter to those skilled in the art.

[00199] Figure 26: A wireless network in accordance with some embodiments.

[00200] Although the subject matter described herein may be implemented in any appropriate type of system using any suitable components, the embodiments disclosed herein are described in relation to a wireless network, such as the example wireless network illustrated in Figure 26. For simplicity, the wireless network of Figure 26 only depicts network QQ106, network nodes QQ160 and QQ160b, and WDs QQ110, QQ110b, and QQ110c (also referred to as mobile terminals). In practice, a wireless network may further include any additional elements suitable to support communication between wireless devices or between a wireless device and another communication device, such as a landline telephone, a service provider, or any other network node or end device. Of the illustrated components, network node QQ160 and wireless device (WD) QQ110 are depicted with additional detail. The wireless network may provide communication and other types of services to one or more wireless devices to facilitate the wireless devices' access to and/or use of the services provided by, or via, the wireless network.

[00201] The wireless network may comprise and/or interface with any type of communication, telecommunication, data, cellular, and/or radio network or other similar type of system. In some embodiments, the wireless network may be configured to operate according to specific standards or other types of predefined rules or procedures.

Thus, particular embodiments of the wireless network may implement communication standards, such as Global System for Mobile Communications (GSM), Universal Mobile Telecommunications System (UMTS), Long Term Evolution (LTE), and/or other suitable 2G, 3G, 4G, or 5G standards; wireless local area network (WLAN) standards, such as the IEEE 802.11 standards; and/or any other appropriate wireless communication standard, such as the Worldwide Interoperability for Microwave Access (WiMax), Bluetooth, Z-Wave and/or ZigBee standards.

[00202] Network QQ106 may comprise one or more backhaul networks, core networks, IP networks, public switched telephone networks (PSTNs), packet data networks, optical networks, wide-area networks (WANs), local area networks (LANs), wireless local area networks (WLANs), wired networks, wireless networks, metropolitan area networks, and other networks to enable communication between devices.

[00203] Network node QQ160 and WD QQ110 comprise various components described in more detail below. These components work together in order to provide network node and/or wireless device functionality, such as providing wireless connections in a wireless network. In different embodiments, the wireless network may comprise any number of wired or wireless networks, network nodes, base stations, controllers, wireless devices, relay stations, 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.

[00204] As used herein, network node refers to equipment capable, configured, arranged and/or operable to communicate directly or indirectly with a wireless device and/or with other network nodes or equipment in the wireless network to enable and/or provide wireless access to the wireless device and/or to perform other functions (e.g., administration) in the wireless 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) and NR NodeBs (gNBs)). Base stations may be categorized based on the amount of coverage they provide (or, stated differently, their transmit power level) and may then also 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). Yet further examples of network nodes include 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), core network nodes (e.g., MSCs, MMEs), O&M nodes, OSS nodes, SON nodes, positioning nodes (e.g., E-SMLCs), and/or MDTs. As another example, a network node may be a virtual network node as described in more detail below. More generally, however, network nodes may represent any suitable device (or group of devices) capable, configured, arranged, and/or operable to enable and/or provide a wireless device with access to the wireless network or to provide some service to a wireless device that has accessed the wireless network.

[00205] In Figure 26, network node QQ160 includes processing circuitry QQ170, device readable medium QQ180, interface QQ190, auxiliary equipment QQ184, power source QQ186, power circuitry QQ187, and antenna QQ162. Although network node QQ160 illustrated in the example wireless network of Figure 26 may represent a device that includes the illustrated combination of hardware components, other embodiments may comprise network nodes with different combinations of components. It is to be understood that a network node comprises any suitable combination of hardware and/or software needed to perform the tasks, features, functions and methods disclosed herein. Moreover, while the components of network node QQ160 are depicted as single boxes located within a larger box, or nested within multiple boxes, in practice, a network node may comprise multiple different physical components that make up a single illustrated component (e.g., device readable medium QQ180 may comprise multiple separate hard drives as well as multiple RAM modules).

[00206] Similarly, network node QQ160 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 network node QQ160 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 NodeB's. In such a scenario, each unique NodeB and RNC pair, may in some instances be considered a single separate network node. In some embodiments, network node QQ160 may be configured to support multiple radio access technologies (RATs). In such embodiments, some components may be duplicated (e.g., separate device readable medium QQ180 for the different RATs) and some components may be reused (e.g., the same antenna QQ162 may be shared by the RATs). Network node QQ160 may also include multiple sets of the various illustrated components for different wireless technologies integrated into network node QQ160, such as, for example, GSM, WCDMA, LTE, NR, WiFi, 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 QQ160.

[00207] Processing circuitry QQ170 is configured to perform any determining, calculating, or similar operations (e.g., certain obtaining operations) described herein as being provided by a network node. These operations performed by processing circuitry QQ170 may include processing information obtained by processing circuitry QQ170 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.

[00208] Processing circuitry QQ170 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 QQ160 components, such as device readable medium QQ180, network node QQ160 functionality. For example, processing circuitry QQ170 may execute instructions stored in device readable medium QQ180 or in memory within processing circuitry QQ170. Such functionality may include providing any of the various wireless features,

functions, or benefits discussed herein. In some embodiments, processing circuitry QQ170 may include a system on a chip (SOC).

[00209] In some embodiments, processing circuitry QQ170 may include one or more of radio frequency (RF) transceiver circuitry QQ172 and baseband processing circuitry QQ174. In some embodiments, radio frequency (RF) transceiver circuitry QQ172 and baseband processing circuitry QQ174 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 QQ172 and baseband processing circuitry QQ174 may be on the same chip or set of chips, boards, or units.

[00210] In certain embodiments, some or all of the functionality described herein as being provided by a network node, base station, eNB or other such network device may be performed by processing circuitry QQ170 executing instructions stored on device readable medium QQ180 or memory within processing circuitry QQ170. In alternative embodiments, some or all of the functionality may be provided by processing circuitry QQ170 without executing instructions stored on a separate or discrete device readable medium, such as in a hard-wired manner. In any of those embodiments, whether executing instructions stored on a device readable storage medium or not, processing circuitry QQ170 can be configured to perform the described functionality. The benefits provided by such functionality are not limited to processing circuitry QQ170 alone or to other components of network node QQ160, but are enjoyed by network node QQ160 as a whole, and/or by end users and the wireless network generally.

[00211] Device readable medium QQ180 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 processing circuitry QQ170. Device readable medium QQ180 may store any suitable instructions, data or information, including a computer program, software, an application including one or more of logic, rules, code,

tables, etc. and/or other instructions capable of being executed by processing circuitry QQ170 and, utilized by network node QQ160. Device readable medium QQ180 may be used to store any calculations made by processing circuitry QQ170 and/or any data received via interface QQ190. In some embodiments, processing circuitry QQ170 and device readable medium QQ180 may be considered to be integrated.

[00212] Interface QQ190 is used in the wired or wireless communication of signalling and/or data between network node QQ160, network QQ106, and/or WDs QQ110. As illustrated, interface QQ190 comprises port(s)/terminal(s) QQ194 to send and receive data, for example to and from network QQ106 over a wired connection. Interface QQ190 also includes radio front end circuitry QQ192 that may be coupled to, or in certain embodiments a part of, antenna QQ162. Radio front end circuitry QQ192 comprises filters QQ198 and amplifiers QQ196. Radio front end circuitry QQ192 may be connected to antenna QQ162 and processing circuitry QQ170. Radio front end circuitry may be configured to condition signals communicated between antenna QQ162 and processing circuitry QQ170. Radio front end circuitry QQ192 may receive digital data that is to be sent out to other network nodes or WDs via a wireless connection. Radio front end circuitry QQ192 may convert the digital data into a radio signal having the appropriate channel and bandwidth parameters using a combination of filters QQ198 and/or amplifiers QQ196. The radio signal may then be transmitted via antenna QQ162. Similarly, when receiving data, antenna QQ162 may collect radio signals which are then converted into digital data by radio front end circuitry QQ192. The digital data may be passed to processing circuitry QQ170. In other embodiments, the interface may comprise different components and/or different combinations of components.

[00213] In certain alternative embodiments, network node QQ160 may not include separate radio front end circuitry QQ192, instead, processing circuitry QQ170 may comprise radio front end circuitry and may be connected to antenna QQ162 without separate radio front end circuitry QQ192. Similarly, in some embodiments, all or some of RF transceiver circuitry QQ172 may be considered a part of interface QQ190. In still other embodiments, interface QQ190 may include one or more ports or terminals QQ194, radio front end circuitry QQ192, and RF transceiver circuitry QQ172, as part of a

radio unit (not shown), and interface QQ190 may communicate with baseband processing circuitry QQ174, which is part of a digital unit (not shown).

[00214] Antenna QQ162 may include one or more antennas, or antenna arrays, configured to send and/or receive wireless signals. Antenna QQ162 may be coupled to radio front end circuitry QQ190 and may be any type of antenna capable of transmitting and receiving data and/or signals wirelessly. In some embodiments, antenna QQ162 may comprise one or more omni-directional, sector or panel antennas operable to transmit/receive radio signals between, for example, 2 GHz and 66 GHz. An omni-directional antenna may be used to transmit/receive radio signals in any direction, a sector antenna may be used to transmit/receive radio signals from devices within a particular area, and a panel antenna may be a line of sight antenna used to transmit/receive radio signals in a relatively straight line. In some instances, the use of more than one antenna may be referred to as MIMO. In certain embodiments, antenna QQ162 may be separate from network node QQ160 and may be connectable to network node QQ160 through an interface or port.

[00215] Antenna QQ162, interface QQ190, and/or processing circuitry QQ170 may be configured to perform any receiving operations and/or certain obtaining operations described herein as being performed by a network node. Any information, data and/or signals may be received from a wireless device, another network node and/or any other network equipment. Similarly, antenna QQ162, interface QQ190, and/or processing circuitry QQ170 may be configured to perform any transmitting operations described herein as being performed by a network node. Any information, data and/or signals may be transmitted to a wireless device, another network node and/or any other network equipment.

[00216] Power circuitry QQ187 may comprise, or be coupled to, power management circuitry and is configured to supply the components of network node QQ160 with power for performing the functionality described herein. Power circuitry QQ187 may receive power from power source QQ186. Power source QQ186 and/or power circuitry QQ187 may be configured to provide power to the various components of network node QQ160 in a form suitable for the respective components (e.g., at a voltage and current level needed for each respective component). Power source QQ186

may either be included in, or external to, power circuitry QQ187 and/or network node QQ160. For example, network node QQ160 may be connectable to an external power source (e.g., an electricity outlet) via an input circuitry or interface such as an electrical cable, whereby the external power source supplies power to power circuitry QQ187. As a further example, power source QQ186 may comprise a source of power in the form of a battery or battery pack which is connected to, or integrated in, power circuitry QQ187. The battery may provide backup power should the external power source fail. Other types of power sources, such as photovoltaic devices, may also be used.

[00217] Alternative embodiments of network node QQ160 may include additional components beyond those shown in Figure 26 that may be responsible 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, network node QQ160 may include user interface equipment to allow input of information into network node QQ160 and to allow output of information from network node QQ160. This may allow a user to perform diagnostic, maintenance, repair, and other administrative functions for network node QQ160.

[00218] As used herein, wireless device (WD) refers to a device capable, configured, arranged and/or operable to communicate wirelessly with network nodes and/or other wireless devices. Unless otherwise noted, the term WD may be used interchangeably herein with user equipment (UE). Communicating wirelessly may involve transmitting and/or receiving wireless signals using electromagnetic waves, radio waves, infrared waves, and/or other types of signals suitable for conveying information through air. In some embodiments, a WD may be configured to transmit and/or receive information without direct human interaction. For instance, a WD may be designed to transmit information to a network on a predetermined schedule, when triggered by an internal or external event, or in response to requests from the network. Examples of a WD include, but are not limited to, a smart phone, a mobile phone, a cell phone, a voice over IP (VoIP) phone, a wireless local loop phone, a desktop computer, a personal digital assistant (PDA), a wireless cameras, a gaming console or device, a music storage device, a playback appliance, a wearable terminal device, a wireless endpoint, a mobile station, a tablet, a laptop, a laptop-embedded equipment (LEE), a laptop-mounted equipment

(LME), a smart device, a wireless customer-premise equipment (CPE), a vehicle-mounted wireless terminal device, etc. A WD may support device-to-device (D2D) communication, for example by implementing a 3GPP standard for sidelink communication, vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-everything (V2X) and may in this case be referred to as a D2D communication device. As yet another specific example, in an Internet of Things (IoT) scenario, a WD 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 WD and/or a network node. The WD may in this case be a machine-to-machine (M2M) device, which may in a 3GPP context be referred to as an MTC device. As one particular example, the WD may be a UE or other terminal implementing the 3GPP narrow band internet of things (NB-IoT) standard. Particular examples of such machines or devices are sensors, metering devices such as power meters, industrial machinery, or home or personal appliances (e.g. refrigerators, televisions, etc.) personal wearables (e.g., watches, fitness trackers, etc.). In other scenarios, a WD may represent a vehicle or other equipment that is capable of monitoring and/or reporting on its operational status or other functions associated with its operation. A WD as described above may represent the endpoint of a wireless connection, in which case the device may be referred to as a wireless terminal. Furthermore, a WD as described above may be mobile, in which case it may also be referred to as a mobile device or a mobile terminal.

[00219] As illustrated, wireless device QQ110 includes antenna QQ111, interface QQ114, processing circuitry QQ120, device readable medium QQ130, user interface equipment QQ132, auxiliary equipment QQ134, power source QQ136 and power circuitry QQ137. WD QQ110 may include multiple sets of one or more of the illustrated components for different wireless technologies supported by WD QQ110, such as, for example, GSM, WCDMA, LTE, NR, WiFi, WiMAX, or Bluetooth wireless technologies, just to mention a few. These wireless technologies may be integrated into the same or different chips or set of chips as other components within WD QQ110.

[00220] Antenna QQ111 may include one or more antennas or antenna arrays, configured to send and/or receive wireless signals, and is connected to interface QQ114. In certain alternative embodiments, antenna QQ111 may be separate from WD QQ110

and be connectable to WD QQ110 through an interface or port. Antenna QQ111, interface QQ114, and/or processing circuitry QQ120 may be configured to perform any receiving or transmitting operations described herein as being performed by a WD. Any information, data and/or signals may be received from a network node and/or another WD. In some embodiments, radio front end circuitry and/or antenna QQ111 may be considered an interface.

[00221] As illustrated, interface QQ114 comprises radio front end circuitry QQ112 and antenna QQ111. Radio front end circuitry QQ112 comprise one or more filters QQ118 and amplifiers QQ116. Radio front end circuitry QQ114 is connected to antenna QQ111 and processing circuitry QQ120, and is configured to condition signals communicated between antenna QQ111 and processing circuitry QQ120. Radio front end circuitry QQ112 may be coupled to or a part of antenna QQ111. In some embodiments, WD QQ110 may not include separate radio front end circuitry QQ112; rather, processing circuitry QQ120 may comprise radio front end circuitry and may be connected to antenna QQ111. Similarly, in some embodiments, some or all of RF transceiver circuitry QQ122 may be considered a part of interface QQ114. Radio front end circuitry QQ112 may receive digital data that is to be sent out to other network nodes or WDs via a wireless connection. Radio front end circuitry QQ112 may convert the digital data into a radio signal having the appropriate channel and bandwidth parameters using a combination of filters QQ118 and/or amplifiers QQ116. The radio signal may then be transmitted via antenna QQ111. Similarly, when receiving data, antenna QQ111 may collect radio signals which are then converted into digital data by radio front end circuitry QQ112. The digital data may be passed to processing circuitry QQ120. In other embodiments, the interface may comprise different components and/or different combinations of components.

[00222] Processing circuitry QQ120 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 WD QQ110 components, such as device readable medium QQ130, WD QQ110 functionality. Such

functionality may include providing any of the various wireless features or benefits discussed herein. For example, processing circuitry QQ120 may execute instructions stored in device readable medium QQ130 or in memory within processing circuitry QQ120 to provide the functionality disclosed herein.

[00223] As illustrated, processing circuitry QQ120 includes one or more of RF transceiver circuitry QQ122, baseband processing circuitry QQ124, and application processing circuitry QQ126. In other embodiments, the processing circuitry may comprise different components and/or different combinations of components. In certain embodiments processing circuitry QQ120 of WD QQ110 may comprise a SOC. In some embodiments, RF transceiver circuitry QQ122, baseband processing circuitry QQ124, and application processing circuitry QQ126 may be on separate chips or sets of chips. In alternative embodiments, part or all of baseband processing circuitry QQ124 and application processing circuitry QQ126 may be combined into one chip or set of chips, and RF transceiver circuitry QQ122 may be on a separate chip or set of chips. In still alternative embodiments, part or all of RF transceiver circuitry QQ122 and baseband processing circuitry QQ124 may be on the same chip or set of chips, and application processing circuitry QQ126 may be on a separate chip or set of chips. In yet other alternative embodiments, part or all of RF transceiver circuitry QQ122, baseband processing circuitry QQ124, and application processing circuitry QQ126 may be combined in the same chip or set of chips. In some embodiments, RF transceiver circuitry QQ122 may be a part of interface QQ114. RF transceiver circuitry QQ122 may condition RF signals for processing circuitry QQ120.

[00224] In certain embodiments, some or all of the functionality described herein as being performed by a WD may be provided by processing circuitry QQ120 executing instructions stored on device readable medium QQ130, which in certain embodiments may be a computer-readable storage medium. In alternative embodiments, some or all of the functionality may be provided by processing circuitry QQ120 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 device readable storage medium or not, processing circuitry QQ120 can be configured to perform the described functionality. The benefits provided

by such functionality are not limited to processing circuitry QQ120 alone or to other components of WD QQ110, but are enjoyed by WD QQ110 as a whole, and/or by end users and the wireless network generally.

[00225] Processing circuitry QQ120 may be configured to perform any determining, calculating, or similar operations (e.g., certain obtaining operations) described herein as being performed by a WD. These operations, as performed by processing circuitry QQ120, may include processing information obtained by processing circuitry QQ120 by, for example, converting the obtained information into other information, comparing the obtained information or converted information to information stored by WD QQ110, 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.

[00226] Device readable medium QQ130 may be operable to store a computer program, software, an application including one or more of logic, rules, code, tables, etc. and/or other instructions capable of being executed by processing circuitry QQ120. Device readable medium QQ130 may include computer memory (e.g., Random Access Memory (RAM) or Read Only Memory (ROM)), mass storage media (e.g., a hard disk), removable storage media (e.g., 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 processing circuitry QQ120. In some embodiments, processing circuitry QQ120 and device readable medium QQ130 may be considered to be integrated. User interface equipment QQ132 may provide components that allow for a human user to interact with WD QQ110. Such interaction may be of many forms, such as visual, audial, tactile, etc. User interface equipment QQ132 may be operable to produce output to the user and to allow the user to provide input to WD QQ110. The type of interaction may vary depending on the type of user interface equipment QQ132 installed in WD QQ110. For example, if WD QQ110 is a smart phone, the interaction may be via a touch screen; if WD QQ110 is a smart meter, the interaction may be through a screen that provides usage (e.g., the number of gallons used) or a speaker that provides an audible alert (e.g., if smoke is detected). User interface equipment QQ132 may include input interfaces,

devices and circuits, and output interfaces, devices and circuits. User interface equipment QQ132 is configured to allow input of information into WD QQ110, and is connected to processing circuitry QQ120 to allow processing circuitry QQ120 to process the input information. User interface equipment QQ132 may include, for example, a microphone, a proximity or other sensor, keys/buttons, a touch display, one or more cameras, a USB port, or other input circuitry. User interface equipment QQ132 is also configured to allow output of information from WD QQ110, and to allow processing circuitry QQ120 to output information from WD QQ110. User interface equipment QQ132 may include, for example, a speaker, a display, vibrating circuitry, a USB port, a headphone interface, or other output circuitry. Using one or more input and output interfaces, devices, and circuits, of user interface equipment QQ132, WD QQ110 may communicate with end users and/or the wireless network, and allow them to benefit from the functionality described herein.

[00227] Auxiliary equipment QQ134 is operable to provide more specific functionality which may not be generally performed by WDs. This may comprise specialized sensors for doing measurements for various purposes, interfaces for additional types of communication such as wired communications etc. The inclusion and type of components of auxiliary equipment QQ134 may vary depending on the embodiment and/or scenario.

[00228] Power source QQ136 may, in some embodiments, be in the form of a battery or battery pack. Other types of power sources, such as an external power source (e.g., an electricity outlet), photovoltaic devices or power cells, may also be used. WD QQ110 may further comprise power circuitry QQ137 for delivering power from power source QQ136 to the various parts of WD QQ110 which need power from power source QQ136 to carry out any functionality described or indicated herein. Power circuitry QQ137 may in certain embodiments comprise power management circuitry. Power circuitry QQ137 may additionally or alternatively be operable to receive power from an external power source; in which case WD QQ110 may be connectable to the external power source (such as an electricity outlet) via input circuitry or an interface such as an electrical power cable. Power circuitry QQ137 may also in certain embodiments be operable to deliver power from an external power source to power source QQ136. This

may be, for example, for the charging of power source QQ136. Power circuitry QQ137 may perform any formatting, converting, or other modification to the power from power source QQ136 to make the power suitable for the respective components of WD QQ110 to which power is supplied.

CLAIMS:

1. A method performed by a user equipment (2400) in a radio communication network, the method comprising:
 - receiving (1500) from the radio communication network a minimization of drive tests (MDT) configuration comprising a beam configuration, wherein the beam configuration comprises at least the identity of a beam and a cell identity of the beam;
 - detecting (1502) at least one beam of a cell proximate to the user equipment;
 - determining (1504) from the beam configuration whether the at least one detected beam is included in the beam configuration;
 - performing (1506) MDT measurements;
 - performing (1508) logging of the MDT measurements at an interval of a periodic logging interval when the at least one detected beam is included in the beam configuration; and
 - omitting (1510) logging of the MDT measurements at an interval of the periodic logging interval when the at least one detected beam is not included in the beam configuration.
2. The method of Claim 1, wherein the MDT configuration is at least one of a logged MDT configuration and an immediate MDT configuration.
3. The method of any of Claims 1 to 2, wherein the beam configuration comprises one or more beam indexes and each beam index identifies at least one or more of (1) a beam, (2) a cell identity of the beam, and (3) a beam threshold.
4. The method of Claim 3, wherein the beam index comprises a synchronization signal block (SSB) index.
5. The method of any of Claims 1 to 4, wherein the detecting (1502) at least one beam of a cell proximate to the user equipment comprises detecting at least one or more of (1) a strongest beam of a serving cell, (2) a strongest beam of a neighboring cell, (3) multiple beams of a serving cell and/or a neighboring cell, and (4) at least one beam

within a range to a detected strongest beam among detected beams of a serving cell and/or a neighboring cell, and

wherein the determining (1504) from the beam configuration whether the at least one detected beam is included in the beam configuration comprises identifying whether one or more of (1) the detected strongest beam is included in the beam configuration, (2) the at least one detected strongest beam of the serving cell, the neighboring cell, and/or the serving cell and the neighboring cell is included in the beam configuration, (3) at least one of the detected multiple beams is included in the beam configuration, (4) at least one of the detected multiple beams of the serving cell, the neighboring cell, and/or the serving cell and the neighboring cell is included in the beam configuration, (5) at least one of the detected beams within range to the detected strongest beam among the detected beams is included in the beam configuration, and (6) at least one of the detected beams within range to the detected strongest beam among the detected beams of the serving cell, the neighboring cell, and/or the serving cell and the neighboring cell is included in the beam configuration.

6. The method of Claim 5, wherein the detecting at least one beam within a range to a detected strongest beam among detected beams is based on a defined beam threshold configured by the network.

7. The method of any of Claims 1 to 6, further comprising:

storing (1600) the MDT measurements when the at least one detected beam is included in the beam configuration; and

reporting (1602) the MDT measurements to the radio communication network when the at least one detected beam is included in the beam configuration.

8. The method of Claim 7, wherein storing (1600) the MDT measurements comprises storing one or more of:

an SSB index of a best beam;

a reference signal received power value of the best beam;

a reference signal received quality value of the best beam;

- an SSB index of the beam that is part of the beam configuration;
- a reference signal received power value of the beam that is part of the beam configuration; and
- a reference signal received quality value of the beam that is part of the beam configuration.

9. The method of any of Claims 1 to 8, further comprising one of:

- receiving (1700) a configuration from a master node (2500) or a secondary node (2500) of the radio communication network for dual connectivity comprising a configuration for monitoring beams based on configured beams of a master cell group, a secondary cell group, or both a master cell group and a secondary cell group provided in an MDT area configuration;
- receiving (1800) a configuration from a master node (2500) of the radio communication network for dual connectivity comprising a configuration for both a master cell group and a secondary cell group or providing a separate configuration for a master cell group and a secondary cell group; and
- receiving (1900) a configuration from the radio communication network for carrier aggregation comprising a configuration for monitoring beams based on configured beams provided in an MDT area configuration.

10. A user equipment (2400) for operating in a radio communication network, the user equipment comprising:

- at least one processor (2410); and
- a memory (2420) coupled with the at least one processor, wherein the memory includes instructions that when executed by the at least one processor causes the user equipment to perform operations comprising:
 - receiving from the radio communication network a minimization of drive tests (MDT) configuration comprising a beam configuration, wherein the beam configuration comprises at least the identity of a beam and a cell identity of the beam;
 - detecting at least one beam of a cell proximate to the user equipment;

determining from the beam configuration whether the at least one detected beam is included in the beam configuration;

performing MDT measurements;

performing logging of the MDT measurements at an interval of a periodic logging interval when the at least one detected beam is included in the beam configuration; and

omitting logging of the MDT measurements at an interval of the periodic logging interval when the at least one detected beam is not included in the beam configuration.

11. The user equipment (2400) of Claim 10, wherein the a memory (2420) coupled with the at least one processor and including instructions that when executed by the at least one processor causes the user equipment to perform operations according to Claims 2 to 9.

12. A user equipment (2400) for operating in a radio communication network, the user equipment adapted to perform operations comprising:

receiving from the radio communication network a minimization of drive tests (MDT) configuration comprising a beam configuration, wherein the beam configuration comprises at least the identity of a beam and a cell identity of the beam;

detecting at least one beam of a cell proximate to the user equipment;

determining from the beam configuration whether the at least one detected beam is included in the beam configuration;

performing MDT measurements;

performing logging of the MDT measurements at an interval of a periodic logging interval when the at least one detected beam is included in the beam configuration; and

omitting logging of the MDT measurements at an interval of the periodic logging interval when the at least one detected beam is not included in the beam configuration.

13. The user equipment (2400) of Claim 12 adapted to perform operations according to any of Claims 2 to 9.

14. A computer program comprising program code to be executed by at least one processor (2410) of a user equipment (2400) configured to operate in a radio communication network, whereby execution of the program code causes the user equipment (2400) to perform operations comprising:

receiving from the radio communication network a minimization of drive tests (MDT) configuration comprising a beam configuration, wherein the beam configuration comprises at least the identity of a beam and a cell identity of the beam;

detecting at least one beam of a cell proximate to the user equipment;

determining from the beam configuration whether the at least one detected beam is included in the beam configuration;

performing MDT measurements;

performing logging of the MDT measurements at an interval of a periodic logging interval when the at least one detected beam is included in the beam configuration; and

omitting logging of the MDT measurements at an interval of the periodic logging interval when the at least one detected beam is not included in the beam configuration.

15. The computer program of Claim 14, whereby execution of the program code causes the user equipment (2400) to perform operations according to any of Claims 2 to 9.

16. A computer program product comprising a non-transitory storage medium including program code to be executed by at least one processor (2410) of a user equipment (2400) configured to operate in a radio communication network, whereby execution of the program code causes the user device (2000) to perform operations comprising:

receiving from the radio communication network a minimization of drive tests (MDT) configuration comprising a beam configuration, wherein the beam configuration comprises at least the identity of a beam and a cell identity of the beam;

detecting at least one beam of a cell proximate to the user equipment;

determining from the beam configuration whether the at least one detected beam is included in the beam configuration;

performing MDT measurements;

performing logging of the MDT measurements at an interval of a periodic logging interval when the at least one detected beam is included in the beam configuration; and

omitting logging of the MDT measurements at an interval of the periodic logging interval when the at least one detected beam is not included in the beam configuration.

17. The computer program product of Claim 16, whereby execution of the program code causes the user equipment (2400) to perform operations according to any of Claims 2 to 9.

18. A method by a network node (2500) in a radio communications network, the method comprising:

sending (2000), to a user equipment (2400), a minimization of drive tests (MDT) configuration comprising a beam configuration, wherein the beam configuration comprises at least the identity of a beam and a cell identity of the beam; and

receiving (2002), from the user equipment, MDT measurements during an interval of a periodic logging interval when the user equipment detected at least one beam included in the beam configuration.

19. The method of Claim 18, wherein the MDT configuration comprises at least one of a logged MDT configuration and an immediate MDT configuration.

20. The method of any of Claims 18 to 19, wherein the beam configuration comprises one or more beam indexes and each beam index identifies at least one of a beam, a cell identity of the beam, and a beam threshold, and wherein the beam index comprises a synchronization signal block (SSB) index.

21. The method of any of Claims 18 to 20, further comprising:

sending (2100, 2200), to the user equipment, a configuration for dual connectivity comprising a configuration for at least one of (1) monitoring beams based on configured beams of a master cell group, a secondary cell group, or both a master cell group and a secondary cell group provided in an MDT area configuration, and (2) both a master cell

group and a secondary cell group or providing a separate configuration for a master cell group and a secondary cell group.

22. The method of any of Claims 18 to 20, further comprising:
sending (2300), to the user equipment, a configuration for carrier aggregation comprising a configuration for monitoring beams based on configured beams provided in an MDT area configuration.

23. A network node (2500) adapted to perform operations comprising:
sending, to a user equipment (2400), a minimization of drive tests (MDT) configuration comprising a beam configuration, wherein the beam configuration comprises at least the identity of a beam and a cell identity of the beam; and
receiving, from the user equipment, MDT measurements during an interval of a periodic logging interval when the user equipment detected at least one beam included in the beam configuration.

24. The network node(2500) of Claim 23 adapted to perform operations according to any of Claims 18 to 21.

25. A network node (2500) for configuring a user equipment (2400) with a beam configuration for a minimization of drive tests (MDT) configuration in a radio communication network, the network node comprising:
at least one processor (2510); and
a memory (2520) coupled to the at least one processor, wherein the memory stores instructions that when executed by the at least one processor causes the processor to perform operations comprising:
sending, to a user equipment (2400), the MDT configuration comprising a beam configuration, wherein the beam configuration comprises at least the identity of a beam and a cell identity of the beam; and

receiving, from the user equipment, MDT measurements during an interval of a periodic logging interval when the user equipment detected at least one beam included in the beam configuration.

26. The network node (2500) of Claim 25, wherein the memory (2520) coupled to the at least one processor (251) and storing instructions that when executed by the at least one processor causes the processor to perform operations according to any of Claims 19 to 20.

27. A computer program comprising program code to be executed by at least one processor (2510) of a network node (2500) configured to operate in a radio communication network, whereby execution of the program code causes the network node (2500) to perform operations according to any of Claims 18 to 22.

28. A computer program product comprising a non-transitory storage medium including program code to be executed by at least one processor (2510) of a network node (2500) configured to operate in a radio communication network, whereby execution of the program code causes the network node (2500) to perform operations according to any of Claims 18 to 22.

MDT mode	RRC states	Measurement quantities
Logged MDT	RRC_IDLE	RSRP and RSRQ of the serving cell and available UE measurements for intra-frequency/inter-frequency/inter-RAT, time stamp and detailed location information if available.

Figure 1

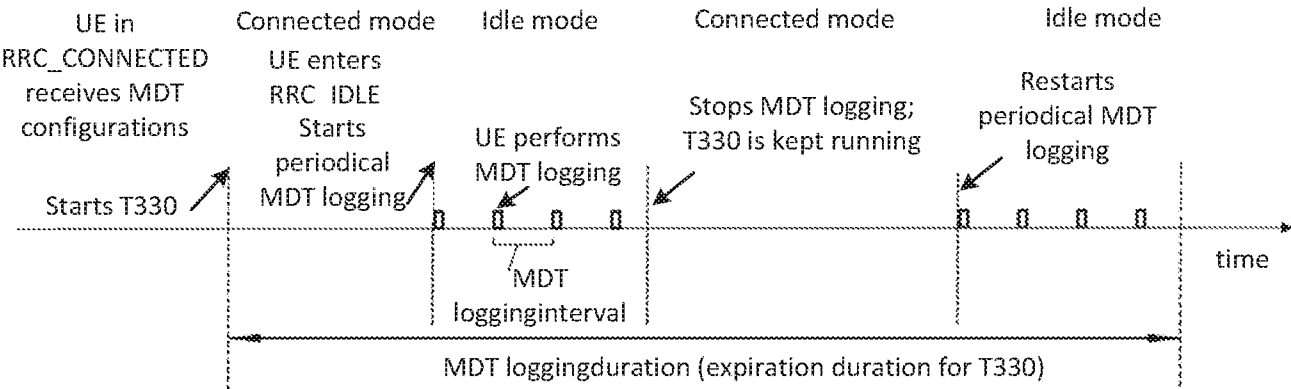


Figure 2

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MDT mode	RRC states	Measurement quantities
Immediate MDT	RRC_CONNECTED	M1: RSRP and RSRQ measurement by UE. M2: Power Headroom measurement by UE. M3: Received Interference Power measurement by eNB. M4: Data Volume measurement separately for DL and UL, per QCI per UE, by eNB. M5: Scheduled IP Throughput for MDT measurement separately for DL and UL, per RAB per UE and per UE for the DL, per UE for the UL, by eNB. M6: Packet Delay measurement, separately for DL and UL, per QCI per UE, see UL PDCP Delay, by the UE, and Packet Delay in the DL per QCI, by the eNB. M7: Packet Loss rate measurement, separately for DL and UL per QCI per UE, by the eNB. M8: RSSI measurement by UE. M9: RTT measurement by UE.

Figure 3

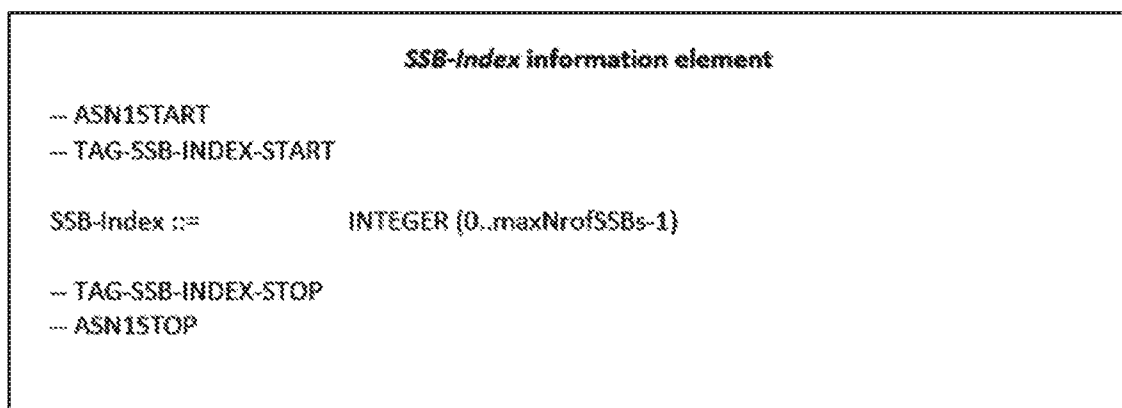


Figure 4

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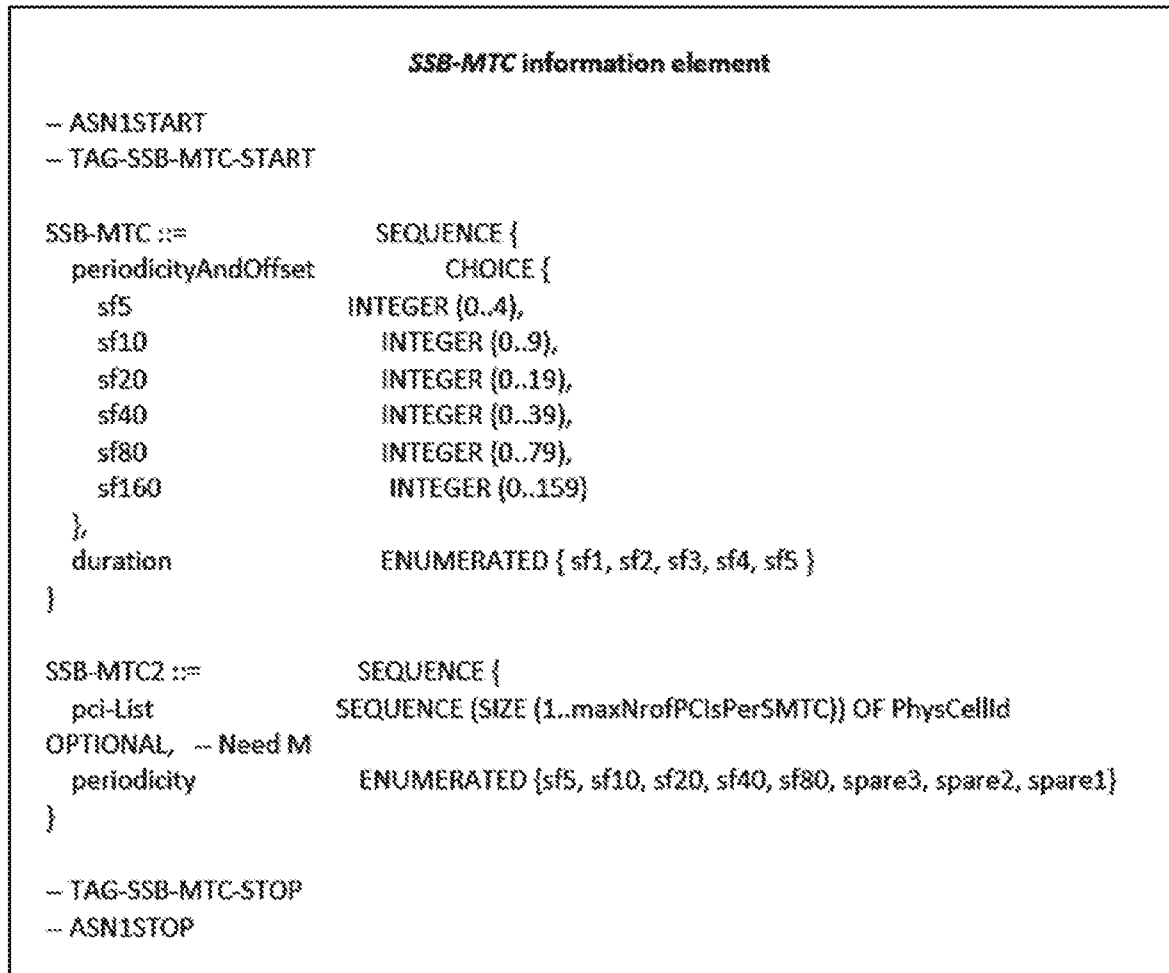


Figure 5

SSB-MTC field descriptions	
duration	Duration of the measurement window in which to receive SS/PBCH blocks. It is given in number of subframes (see TS 38.213 [13], clause 4.1).
periodicityAndOffset	Periodicity and offset of the measurement window in which to receive SS/PBCH blocks, see 5.5.2.10. Periodicity and offset are given in number of subframes.

Figure 6

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IE/Group Name	Range
CHOICE <i>Area Scope of MDT</i>	
> <i>Cell based</i>	
>> Cell ID List for MDT	1 .. <maxnoofCellIDforMDT>
>>>E-CGI (i.e., E-UTRAN Cell Global Identifier)	
> <i>TA based</i>	
>> TA List for MDT	1 .. <maxnoofTAforMDT>
>>>TAC (i.e., Tracking Area Code)	
> <i>TAI based</i>	
>> TAI List for MDT	1 .. <maxnoofTAforMDT>
>>>TAI (i.e., Tracking Area Identifier, PLMN +TAC)	

Figure 7

<i>AreaConfiguration</i> information element which is sent to UE	
-- ASN1START	
AreaConfiguration-r10 ::= CHOICE {	
cellGlobalIdList-r10 CellGlobalIdList-r10,	
trackingAreaCodeList-r10 TrackingAreaCodeList-r10	
}	
AreaConfiguration-v1130 ::= SEQUENCE {	
trackingAreaCodeList-v1130 TrackingAreaCodeList-v1130	
}	
CellGlobalIdList-r10 ::= SEQUENCE {SIZE (1..32)} OF CellGlobalIdEUTRA	
TrackingAreaCodeList-r10 ::= SEQUENCE {SIZE (1..8)} OF TrackingAreaCode	
TrackingAreaCodeList-v1130 ::= SEQUENCE {	
plmn-identity-perTAC-List-r11 SEQUENCE {SIZE (1..8)} OF PLMN-identity	
}	
-- ASN1STOP	

Figure 8

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3> if the UE is in *any cell selection state*:

4> perform the logging at regular time intervals, as defined by the *loggingInterval* in *VarLogMeasConfig*;

3> else if the UE is camping normally on an E-UTRA cell and if the RPLMN is included in *plmn-IdentityList* stored in *VarLogMeasReport* and, if the cell is part of the area indicated by *areaConfiguration* if configured in *VarLogMeasConfig*:

4> perform the logging at regular time intervals, as defined by the *loggingInterval* in *VarLogMeasConfig*;

Figure 9

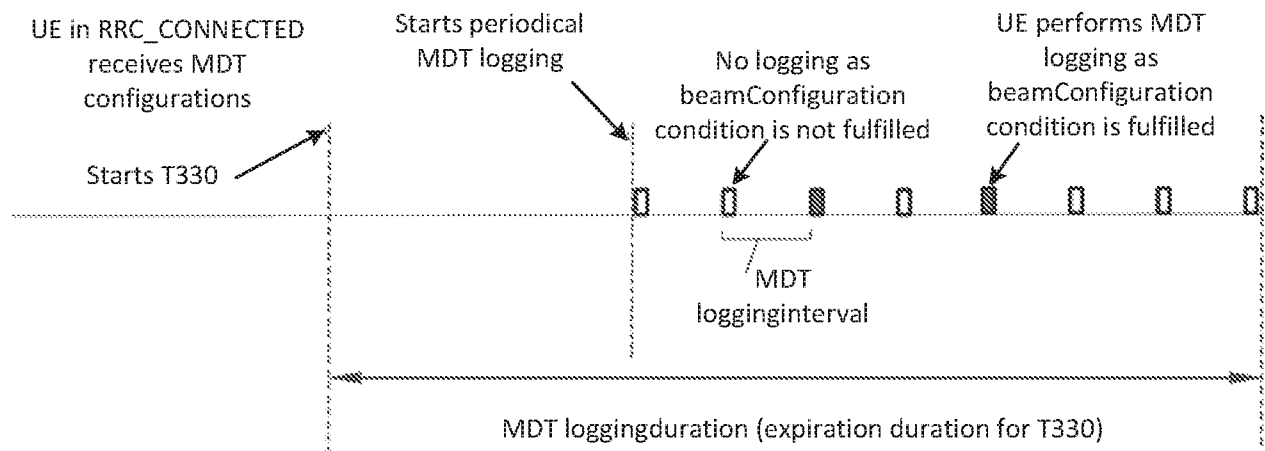


Figure 10

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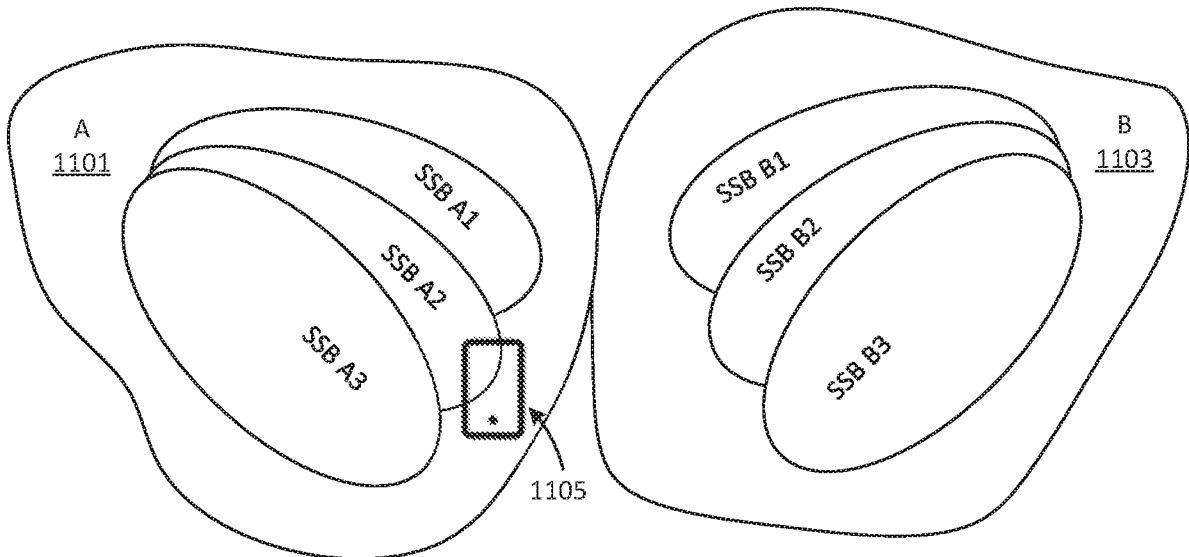


Figure 11

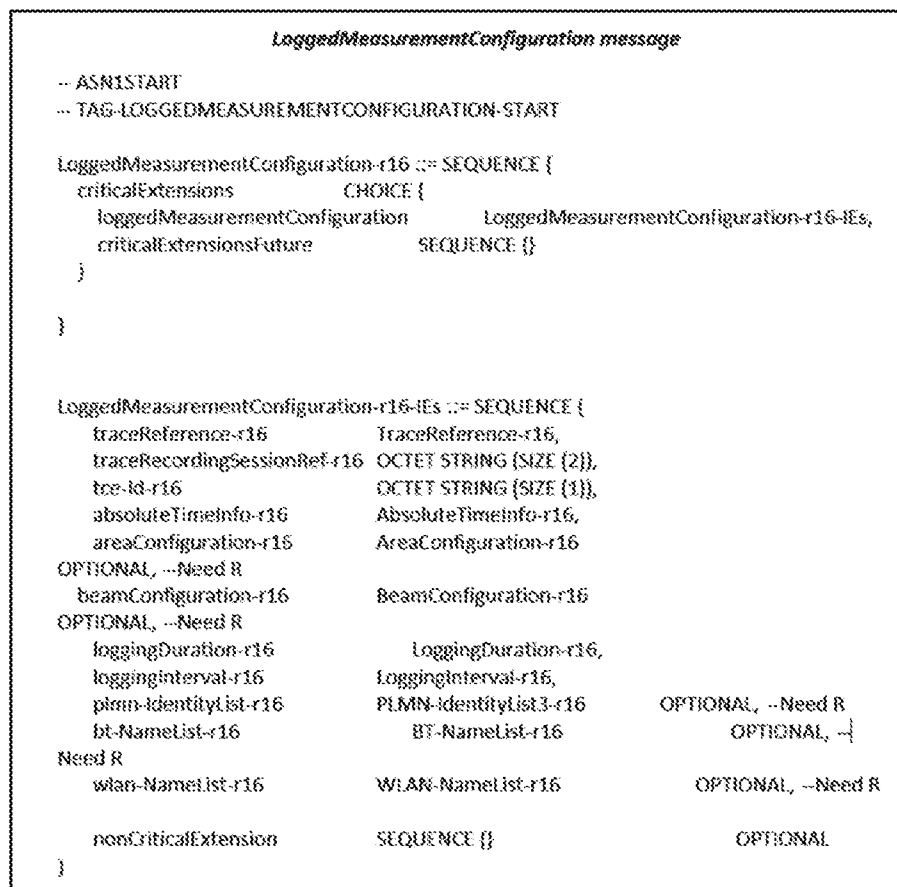


Figure 12

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```

AreaConfiguration information element included in LoggedMeasurementConfiguration

-- ASN1START

AreaConfiguration-r16 ::= CHOICE {
    cellGlobalIdList-r16      CellGlobalIdList-r16,
    trackingAreaCodeList-r16   TrackingAreaCodeList-r16,
    trackingAreaIdentityList-r16 TrackingAreaIdentityList-r16
}

CellGlobalIdList-r16 ::= SEQUENCE (SIZE (1..FFS)) OF CellIdentity

TrackingAreaCodeList-r16 ::= SEQUENCE (SIZE (1..FFS)) OF TrackingAreaCode

TrackingAreaIdentityList-r16 ::= SEQUENCE (SIZE (1..FFS)) OF TrackingAreaIdentity-r16

TrackingAreaIdentity-r16 ::= SEQUENCE {
    plmn-identity      PLMN-identity,
    trackingAreaCode    TrackingAreaCode
}

-- ASN1STOP

```

Figure 13

```

BeamConfiguration information element included in LoggedMeasurementConfiguration

-- ASN1START

BeamConfiguration-r16 ::= CHOICE {
    ssbIndexesList-r16      SEQUENCE (SIZE (1..FFS)) OF SSB-index-r16,
}

SSB-index-r16 ::= SEQUENCE {
    ssbIndexes-r16      SSB-index,
    cellGlobalId-r16     CellIdentity
}

-- ASN1STOP

```

Figure 14

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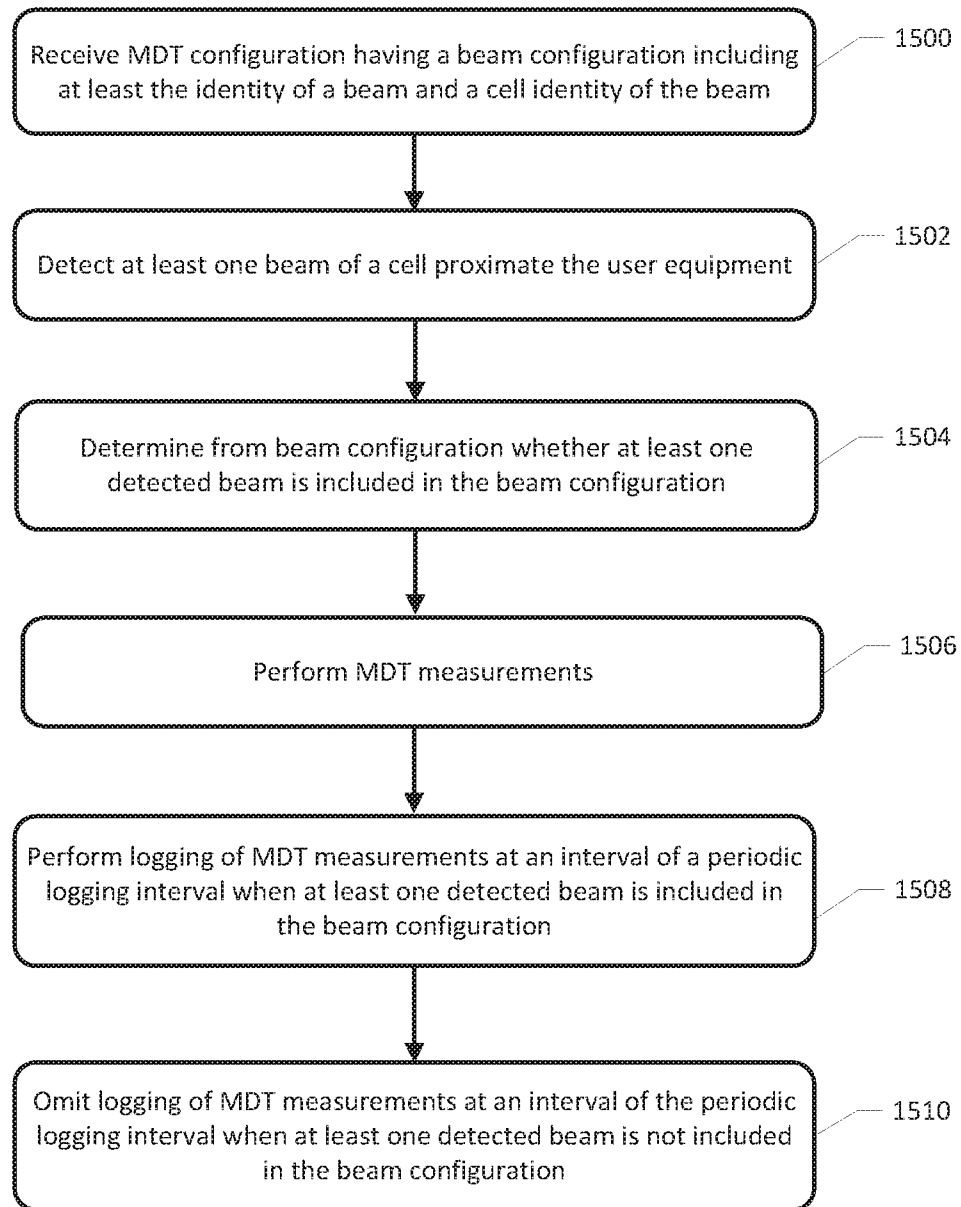


Figure 15

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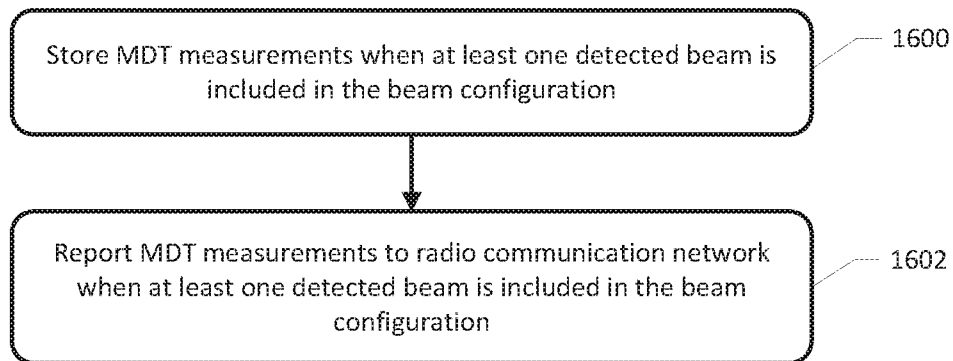


Figure 16

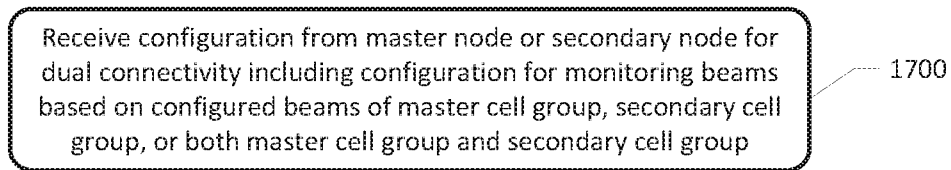


Figure 17

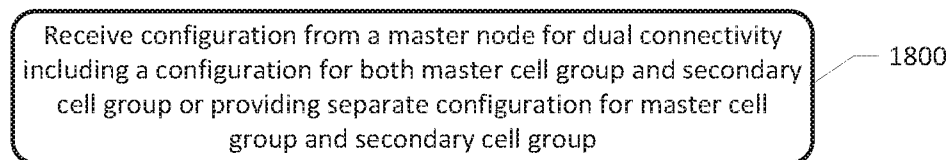


Figure 18

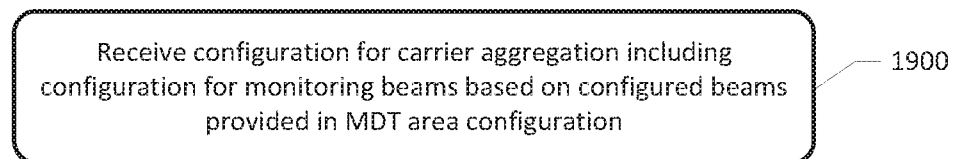


Figure 19

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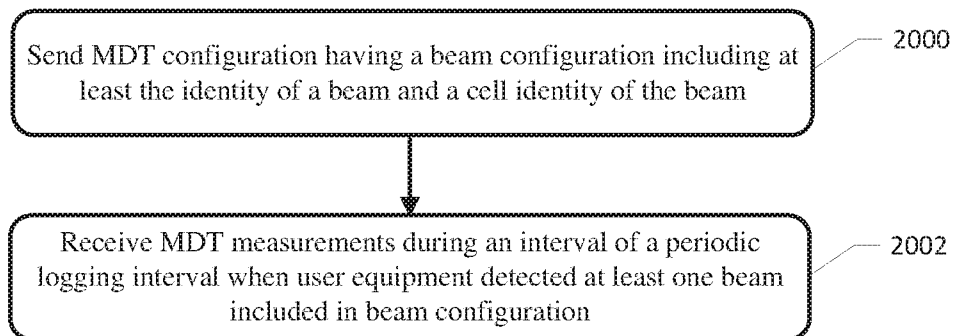


Figure 20

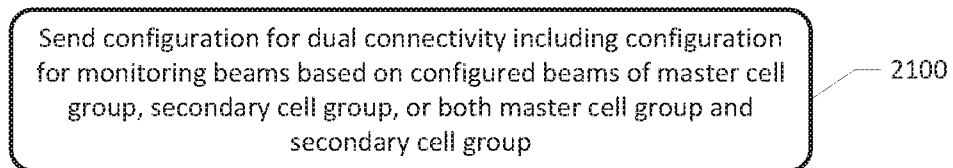


Figure 21

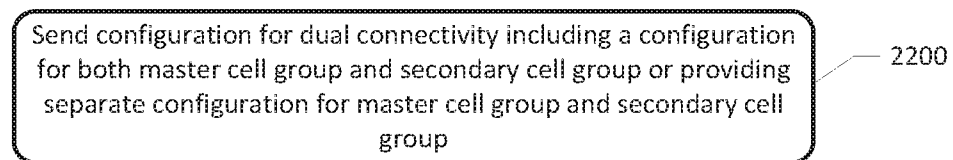


Figure 22

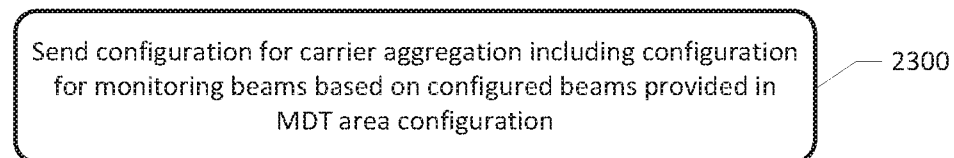


Figure 23

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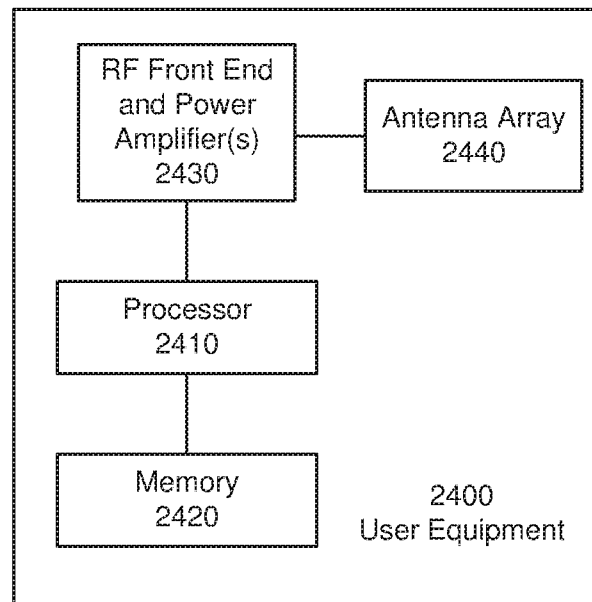


Figure 24

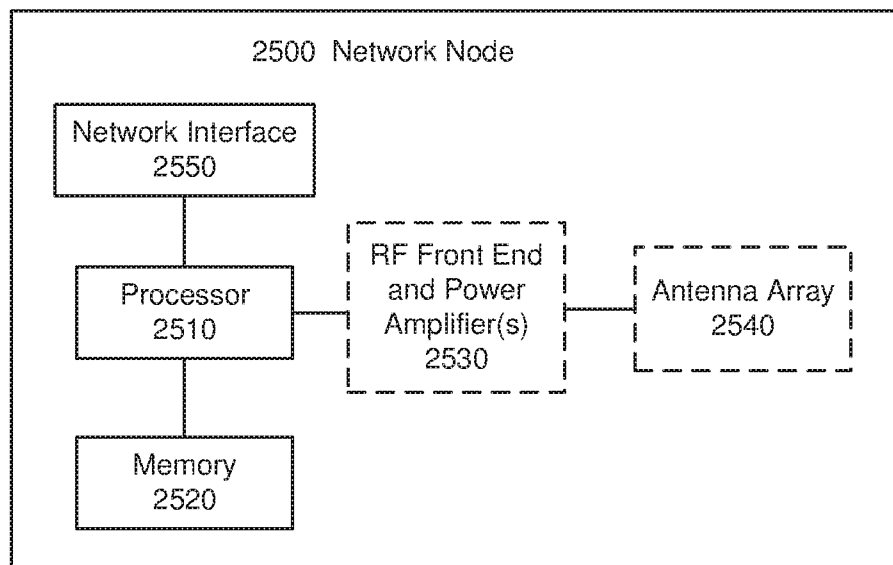
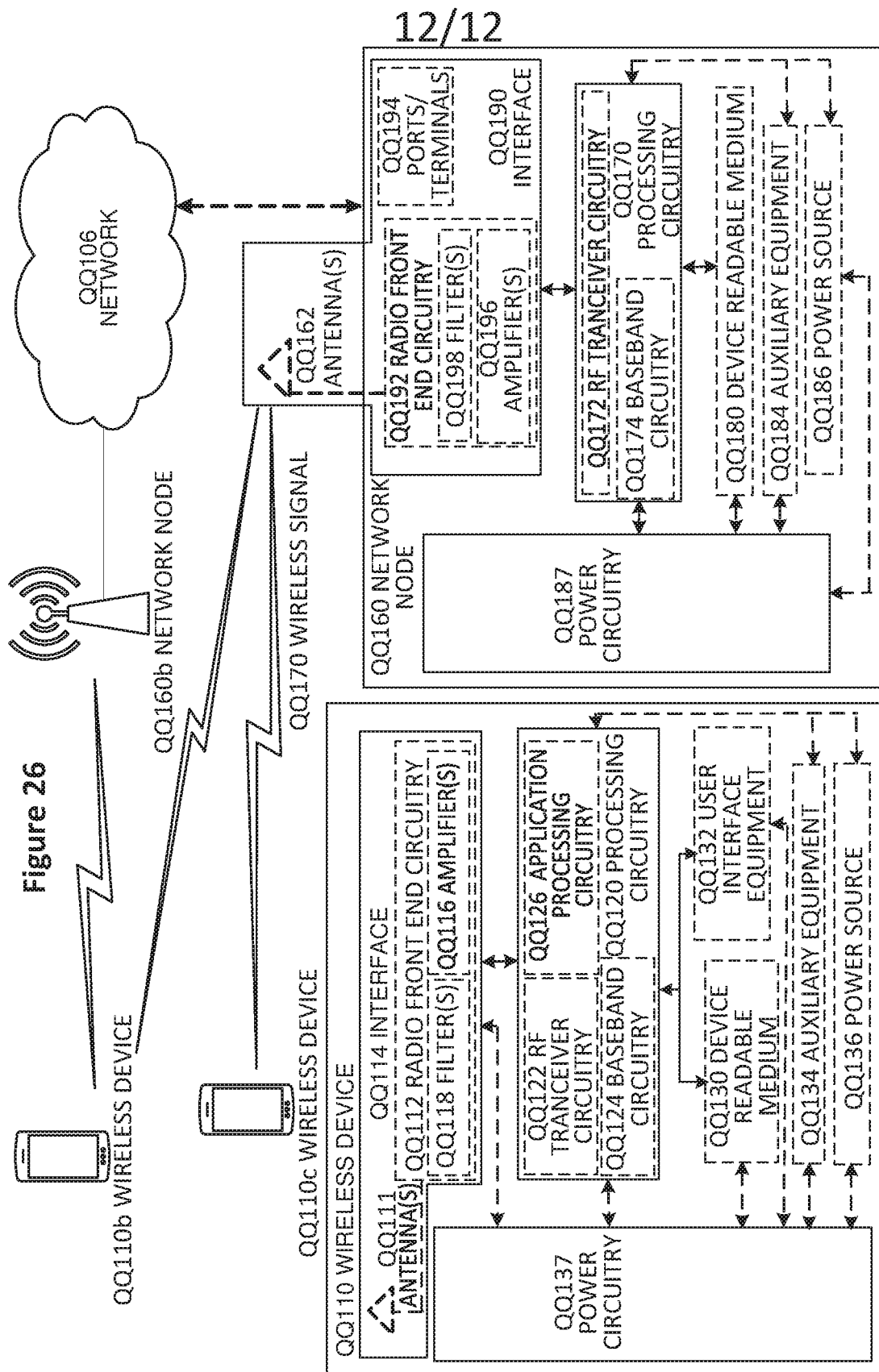


Figure 25



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/057497

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W24/10

ADD. H04W16/28

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HUAWEI ET AL: "Considerations on MDT configurations", 3GPP DRAFT; R2-1907692 CONSIDERATIONS ON MDT CONFIGURATIONS, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG2, no. Reno, Nevada, USA; 20190513 - 20190517 3 May 2019 (2019-05-03), XP051711972, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg%5Fran/WG2%5FRL2/TSGR2%5F106/Docs/R2%2D1907692%2Ezip [retrieved on 2019-05-03] the whole document ----- -/-	1-28



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

6 October 2020

Date of mailing of the international search report

14/10/2020

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer

Aulló Navarro, A

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2020/057497

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CMCC: "Beam Related Measurements for NR MDT", 3GPP DRAFT; R2-1904345-BEAM RELATED MEASUREMENTS FOR MDT, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG2, no. Xi'an, China; 20190408 - 20190412 29 March 2019 (2019-03-29), XP051693565, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg%5Fran/WG2%5FRL2/TSGR2%5F105bis/Docs/R2%2D1904345%2Ezip [retrieved on 2019-03-29] the whole document -----	1-28
A	ERICSSON ET AL: "Details of beam level measurements to be included in MDT", 3GPP DRAFT; R2-1906874 - DETAILS OF BEAM LEVEL INFORMATION TO BE INCLUDED IN MDT, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOL , vol. RAN WG2, no. Reno, USA; 20190513 - 20190517 13 May 2019 (2019-05-13), XP051730326, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/Meetings%5F3GP%5FSYNC/RAN2/Docs/R2%2D1906874%2Ezip [retrieved on 2019-05-13] the whole document -----	1-28
A	CMCC: "Network aspects of MDT for NR", 3GPP DRAFT; R3-190568_NETWORK ASPECTS OF MDT FOR NR, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG3, no. Athens, Greece; 20190225 - 20190301 16 February 2019 (2019-02-16), XP051604506, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg%5Fran/WG3%5FIu/TSGR3%5F103/Docs/R3%2D190568%2Ezip [retrieved on 2019-02-16] the whole document ----- -/--	1-28

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/057497

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X, P	WO 2020/038374 A1 (GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP LTD [CN]) 27 February 2020 (2020-02-27) paragraph [0004] paragraph [0033] - paragraph [0043] paragraph [0071] - paragraph [0072] paragraph [0088] - paragraph [0108] paragraph [0121] - paragraph [0127] -----	1-28

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2020/057497

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2020038374	A1	27-02-2020	NONE
