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# BEAM MANAGEMENT


## Abstract

Examples of the disclosure relate to beam management within networks comprising User Equipments (UEs) that can be configured to receive power from different beams. The UEs can be configured to receive information indicative of at least one expanded transmission configuration from a node apparatus. The expanded transmission configuration comprises a primary beam configuration and a secondary beam configuration wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus. The UE is also configured so that, in response to receiving the information indicative of the at least one expanded transmission configuration, the UE is enabled to use the primary beam configuration and/or the secondary beam configuration to receive signals from the node apparatus.



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## Background/Summary

TECHNOLOGICAL FIELD
[0001] Examples of the disclosure relate to beam management. Some relate to beam management within networks comprising User Equipments (UEs) that can be configured to receive power from different beams.
BACKGROUND
[0002] Beam management can be used to reduce losses between a UE and access nodes such as a Base Station (gNB). Beam management can provide for improved alignment of beams between the UE and the access nodes.
BRIEF SUMMARY
[0003] According to various, but not necessarily all, examples of the disclosure there may be provided a User Equipment (UE) comprising: [0004] at least one processor; and [0005] at least one memory including computer program code [0006] the at least one memory and the computer program code configured to, with the at least one processor, cause the UE at least to perform: [0007] receiving information indicative of at least one expanded transmission configuration from a node apparatus wherein the expanded transmission configuration comprises a primary beam configuration and a secondary beam configuration wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus; and [0008] in response to receiving the information indicative of the at least one expanded transmission configuration enabling the UE to use the primary beam configuration and/or the secondary beam configuration to receive signals from the node apparatus.
[0009] The information indicative of the at least one expanded transmission configuration may be received in response to a report transmitted by the UE indicating at least the primary beam configuration and an availability of one or more secondary beam configurations.
[0010] The transmitted report may indicate one or more beam configurations that the UE has determined to be receiving power above a threshold level.
[0011] The primary beam configuration may make use of a Primary-Angular Power Area (P-APA) and the secondary beam configuration makes use of a Secondary Useable-Angular Power Area (SU-APA) wherein an angular power area comprises a range of angular directions from which the UE is receiving power from the node apparatus.
[0012] The at least one expanded transmission configuration may be indicated by using one or more bits in a pre-agreed structure within a message.
[0013] The at least one expanded transmission configuration may comprise an indication of a cell and a bandwidth part.
[0014] The at least one expanded transmission configuration may enable the node apparatus to transmit Downlink (DL) signals.
[0015] The at least one expanded transmission configuration may enable the UE to receive signals based on one or more Quasi Co-Location (QCL) assumptions.
[0016] The at least one expanded transmission configuration may comprise one or more Transmission Configuration Indicator (TCI) states.
[0017] According to various, but not necessarily all, examples of the disclosure there may be provided a method comprising: [0018] receiving information indicative of at least one expanded transmission configuration from a node apparatus wherein the expanded transmission configuration comprises a primary beam configuration and a secondary beam configuration wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from

which the UE receives power from the node apparatus; and [0019] in response to receiving the information indicative of the at least one expanded transmission configuration enabling the UE to use the primary beam configuration and/or the secondary beam configuration to receive signals from the node apparatus.
[0020] According to various, but not necessarily all, examples of the disclosure there may be provided a computer program comprising computer program instructions that, when executed by processing circuitry, cause: [0021] receiving information indicative of at least one expanded transmission configuration from a node apparatus wherein the expanded transmission configuration comprises a primary beam configuration and a secondary beam configuration wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus; and [0022] in response to receiving the information indicative of the at least one expanded transmission configuration enabling the UE to use the primary beam configuration and/or the secondary beam configuration to receive signals from the node apparatus.
[0023] According to various, but not necessarily all, examples of the disclosure there may be provided a User Equipment (UE) comprising means for: [0024] receiving information indicative of at least one expanded transmission configuration from a node apparatus wherein the expanded transmission configuration comprises a primary beam configuration and a secondary beam configuration wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus; and [0025] in response to receiving the information indicative of the at least one expanded transmission configuration enabling the UE to use the primary beam configuration and/or the secondary beam configuration to receive signals from the node apparatus.
[0026] According to various, but not necessarily all, examples of the disclosure there may be provided a node apparatus comprising: [0027] at least one processor; and [0028] at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the node apparatus at least to perform: [0029] receiving a report from a User Equipment (UE) indicating at least a primary beam configuration and an availability of one or more secondary beam configurations wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus; and [0030] in response to receiving the report enabling at least one expanded transmission configuration based, at least in part, on the availability of the one or more secondary beam configurations wherein the expanded transmission configuration comprises the primary beam configuration and a secondary beam configuration.
[0031] The received report may indicate one or more beam configurations that the UE has determined to be receiving power above a threshold level.
[0032] The primary beam configuration may make use of a Primary-Angular Power Area (P-APA) and the secondary beam configuration makes use of a Secondary Useable-Angular Power Area (SU-APA) wherein an angular power area comprises a range of angular directions from which the UE is receiving power from the node apparatus.
[0033] The at least one processor and at least one memory may be configured to perform transmitting information indicative of the at least one expanded transmission configuration to the UE.
[0034] The at least one expanded transmission configuration may be indicated by using one or more bits in a pre-agreed structure within a message.
[0035] The at least one expanded transmission configuration may comprise an indication of a cell and a bandwidth part.
[0036] The at least one expanded transmission configuration may enable the node apparatus to transmit Downlink (DL) signals.
[0037] The at least one expanded transmission configuration may enable the UE to receive signals

based on one or more Quasi Co-Location (QCL) assumptions.
[0038] The at least one expanded transmission configuration may comprise one or more Transmission Configuration Indicator (TCI) states.
[0039] The at least one expanded transmission configuration may be enabled based on one or more requirements of the node apparatus.
[0040] According to various, but not necessarily all, examples of the disclosure there may be provided a method comprising: [0041] receiving a report from a User Equipment (UE) indicating at least a primary beam configuration and an availability of one or more secondary beam configurations wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus; and [0042] in response to receiving the report enabling at least one expanded transmission configuration based, at least in part, on the availability of the one or more secondary beam configurations wherein the expanded transmission configuration comprises the primary beam configuration and a secondary beam configuration.
[0043] According to various, but not necessarily all, examples of the disclosure there may be provided a computer program comprising computer program instructions that, when executed by processing circuitry, cause: [0044] receiving a report from a User Equipment (UE) indicating at least a primary beam configuration and an availability of one or more secondary beam configurations wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus; and [0045] in response to receiving the report enabling at least one expanded transmission configuration based, at least in part, on the availability of the one or more secondary beam configurations wherein the expanded transmission configuration comprises the primary beam configuration and a secondary beam configuration.
[0046] According to various, but not necessarily all, examples of the disclosure there may be provided a node apparatus comprising means for: [0047] receiving a report from a User Equipment (UE) indicating at least a primary beam configuration and an availability of one or more secondary beam configurations wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus; and [0048] in response to receiving the report enabling at least one expanded transmission configuration based, at least in part, on the availability of the one or more secondary beam configurations wherein the expanded transmission configuration comprises the primary beam configuration and a secondary beam configuration.

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## Description

BRIEF DESCRIPTION
[0049] Some examples will now be described with reference to the accompanying drawings in which:
[0050] FIG. **1** shows an example network;
[0051] FIGS. **2**A and **2**B shows example TCI-states
[0052] FIGS. **3**A and **3**B show example methods;
[0053] FIG. **4** shows an example expanded TCI-state
[0054] FIG. **5** shows an example signaling chart;
[0055] FIG. **6** shows an example method for determining availability of SU-APAs;
[0056] FIG. **7** shows an example controller.
DEFINITIONS
[0057] CQI Channel Quality Indicator [0058] CSI Channel State Information [0059] CSI RS CSI Reference Signal [0060] DCI Downlink Control Information [0061] DL Downlink [0062] FSPL

Free Space Path Loss [0063] GBBR Group Based beam Reporting [0064] gNB NR Base Station [0065] NZP Non Zero Power [0066] PDCCH Physical Downlink Control Channel [0067] PDSCH Physical Downlink Shared Channel [0068] QCL Quasi Co-Location [0069] RRC Radio Resource Control [0070] RS Reference Signal [0071] RSRP Reference Signal Received Power [0072] RX Receiving [0073] SSB Synchronisation Signal Block [0074] TC Transmission Configuration Indicator [0075] TX Transmitting [0076] UE User Equipment

DETAILED DESCRIPTION

[0077] FIG. **1** illustrates an example of a network **100** comprising a plurality of network nodes including terminal nodes **110**, access nodes **120** and one or more core nodes **130**. The terminal nodes **110** and access nodes **120** communicate with each other. The one or more core nodes **130** communicate with the access nodes **120**.

[0078] The one or more core nodes **130** can, in some examples, communicate with each other. The one or more access nodes **120** can, in some examples, communicate with each other.

[0079] The network **100** may be a cellular network comprising a plurality of cells **122** each served by an access node **120**. In this example, the interface between the terminal nodes **110** and an access node **120** defining a cell **122** is a wireless interface **124**.

[0080] The access node **120** comprises a cellular radio transceiver. The terminal nodes **110** comprise a cellular radio transceiver.

[0081] In the example illustrated the cellular network **100** is a third generation Partnership Project (3GPP) network in which the terminal nodes **110** are user equipment (UE) and the access nodes **120** are base stations.

[0082] In the particular example illustrated the network **100** is a Universal Terrestrial Radio Access network (UTRAN). The UTRAN consists of UTRAN NodeBs **120**, providing the UTRA user plane and control plane (RRC) protocol terminations towards the UE **110**. The NodeBs **120** are interconnected with each other and are also connected by means of the interface **128** to the Mobility Management Entity (MME) **130**.

[0083] The term ‘user equipment’ is used to designate mobile equipment comprising a smart card for authentication/encryption etc such as a subscriber identity module (SIM). In other examples the term ‘user equipment’ is used to designate mobile equipment comprising circuitry embedded as part of the user equipment for authentication/encryption such as software SIM.

[0084] The NodeB can be any suitable base station. A base station is an access node **120**. It can be a network element in radio access network responsible for radio transmission and reception in one or more cells to or from the user equipment.

[0085] The UTRAN can be a 4G or 5G network, for example. It can for example be a New Radio (NR) network that uses gNB or eNB as access nodes **120**. New radio is the 3GPP name for 5G technology.

[0086] Such networks **100** can also comprise next generation mobile and communication network, for example, a 6G network.

[0087] The access nodes **120** can have different transmission configurations. These different transmission configurations can be defined by beams or spatial filters that are used by the access nodes **120** and the UEs **110**. In some examples the different transmission configurations can enable the UEs **110** to receive signals from different angular areas.

[0088] A Transmission Configuration Indicator-State (TCI-State) can indicate a transmission configuration between an access node **120** and a UE **110**. The TCI-State can be defined by the access node **120** when the UE **110** is in Radio Resource Control (RRC) connected mode. A TCI state can comprise the identity of the relevant cell and Bandwidth part. The TCI State can also specify the relevant Synchronisation Signals (SS)/Physical Broadcast Channel (PBCH) Block or Channel State Information (CSI)

[0089] Reference Signal, and the relevant Quasi Co-Location (QCL) Type.

[0090] The network **100** can be configured so that a pool comprising of up to 64 TCI-states can be

configured for Physical Downlink Control Channel (PDCCH). The network **100** can be configured so that eight of these can be active (Physical Downlink Shared Channel (PDSCH) Medium Access Control-Control Element (MAC-CE)) at the same time.

[0091] In order to select TCI-States it is useful for the access node **120** to obtain information about the beam configurations that are being received by the UE **110**. It can be useful for the access node **120** to obtain information about different angular areas that the UE **110** is receiving power from. This could be used to enable the access node **120** to switch beam configurations. For instance, if a primary beam configuration makes use of a first angular area and there is a blockage in this area then the access node **120** could be configured to switch to a secondary beam configuration that uses a different angular area. In such examples the access node **120** could update the TCI-state to make use of the different angular area for receiving power.

[0092] FIGS. **2**A and **2**B show example TCI-states. FIGS. **2**A and **2**B show an access node **120** and a UE **110**. The access node and the UE **110** could be part of a network **100** such as the network **100** of FIG. **1**. The UE **110** could be a smartphone or any other suitable type of UE **110**. The access node **120** could be a gNB or any other suitable type of access node **120**.

[0093] FIGS. **2**A and **2**B show two alternative TCI-states that can be maintained by the access node **120**. In both of these examples the access node **120** is configured to transmit using a narrow beam configuration and the UE **110** is configured to receive using a narrow beam configuration. In these examples the access node **120** transmits using a P**2** configuration and the UE **110** receives using a P**3** configuration.

[0094] P**2** and P**3** are processes that are used for beam management. The process P**1** is used for beam selection to find the best SSB (wide) beam transmitted by the access node **120**. The process P**2** is used for beam refinement at the access node **120** to find the best CSI (narrow) beam that is transmitted by the access node **120**. The Process P**3** is used for beam refinement at the UE **110** to find the best narrow beam used by the UE **110** for reception.

[0095] FIG. **2**A shows a primary TCI-state **201**. In the example of FIG. **2**A the beam from the access node **120** is transmitted directly from the access node **120** to the UE **110**. There are no reflections or changes of direction of the beam between the transmission of the beam by the access node **120** and the reception of the beam by the UE **110**. There is a building **203** located between the access node **120** and the UE **110** but in this example, there are no reflections from the building **203**.

[0096] This beam that is transmitted directly to the UE **110** provides a primary TCI-state **201**. The beam that is used to provide the primary TCI-state has a beam direction and a beam width. This covers an Angular Power Area (APA) at the UE **110**.

[0097] An APA can comprise a range of directions from which a UE **110** can receive power from an access node **120**. An APA can comprise an angular range comprising a direction of arrival of one or more signals. An APA does not need to be defined precisely or in absolute values or angular ranges. A UE **110** can identify different APAs without needing to determine the actual angle of arrival of any of the signals in the APA.

[0098] FIG. **2**B shows a secondary TCI-state **205**. In the example of FIG. **2**B the beam from the access node **120** is reflected from the building **203** towards the UE **110**. Due to the reflection from the building **203** the UE **110** receives less power using the secondary TCI-state **205** than using the primary TCI-state **201**. The Secondary TCI-state **205** can be received from a different APA to the Primary TCI-state **201**.

[0099] The APA from which the UE **110** receives the primary TCI-state **201** can provide a Primary-APA (P-APA) and the APA from which the UE **110** receives the secondary TCI-state **205** can provide a Secondary Useable-APA (SU-APA).

[0100] In the examples of FIGS. **2**A and **2**B the access node **120** can be configured so that the access node **120** can switch between using the Primary TCI-state **201** at a first time and using the Secondary TCI-state **205** at a second time. This requires the access node **120** to make resources available for both the Primary TCI-state **201** and the Secondary TCI-state **205**. This can also lead to

invalid TCI-states if the coherence time of the channel between the access node **120** and the UE **110** is low. In many cases the resources used to maintain the Secondary TCI-state **205** would be wasted if the alternative link is not needed. For example, if the changes in the channel conditions are favorable to the Primary TCI-state **201** the access node **120** might never need to make use of the Secondary TCI-state **205** then any resources allocated to this will have been wasted.

[0101] Examples of the disclosure reduce the resources used to maintain the secondary TCI-state by enabling an expanded TCI-state to be configured. In examples of the disclosure the expanded TCI-state is enabled in response to the access node **120** receiving a report from a UE **110** indicating that the UE **110** can receive power from a direction or APA other than the direction or APA of the primary TCI-state **201**. In some examples of the disclosure the expanded TCI-state is enabled in response to the access node **120** receiving a report from a UE **110** indicating that the UE **110** can receive power from an SU-APA.

[0102] FIGS. **3**A and **3**B show example methods that can be performed by a UE **110** and an access node **120**. These methods can be performed if a UE **110** has identified that it can receive signals from different access node **120** beam configurations where the different access node **120** beam configurations cover different angular areas. For example, the UE **110** can determine that the UE **110** can receive power from an SU-APA. In such cases a primary transmission configuration, such as a primary TCI-state, could make use of the P-APA. The signals that are received by the SU-APA can be used to enable an expanded transmission configuration using a secondary beam configuration or secondary TCI-state at the access node **120**.

[0103] FIG. **3**A shows an example method that could be performed by a node apparatus. The node apparatus could be an access node **120** or a controller within an access node **120** or any other suitable apparatus. The access node **120** could be configured to communicate with the UE **110** in a network **100** such as the network shown in FIG. **1** or any other suitable type of network.

[0104] The method comprises, at block **301**, receiving a report from a UE **110**. The report indicates at least a primary beam configuration and an availability of one or more secondary beam configurations that can be used by the UE **110** to receive power from the access node **120**. The primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus or access node **120**.

[0105] For example, the report can indicate that the UE **110** can receive power from a P-APA and also from one or more SU-APAs. The UE **110** can use the received power levels of reference signals from the access node **120** to identify the P-APA and any SU-APAs. FIG. **6** shows an example method that can be used to identify the P-APA and any SU-APAs. Other methods could be used in other examples of the disclosure.

[0106] The report that is received at block **301** can indicate one or more beam configurations that the UE **110** has determined to be receiving power above a threshold level. For example, only reference signals that are above a threshold power can be considered to be received from an SU-APA. The threshold power level could be set by the access node **120** or any other suitable network entity.

[0107] In response to receiving the report, the method comprises, at block **303**, enabling at least one expanded transmission configuration. The expanded beam configuration comprises both the primary beam configuration and the secondary beam configuration. The expanded beam configuration covers the angular areas of both the primary beam configuration and the secondary beam configuration.

[0108] The expanded transmission configuration is enabled based, at least in part, on the availability of the one or more secondary beam configurations as indicated in the report. The expanded transmission configuration will only be enabled if the report provides an indication of at least one secondary beam configuration.

[0109] The access node **120** can also decide whether or not to enable the expanded transmission configuration based on other criteria. The other criteria could comprise reliability and robustness

requirements, current channel conditions and other suitable factors. For instance, if the access node **120** is performing applications that require high reliability then expanded transmission configuration can be configured. Whereas if the access node **120** is performing applications that require resources to be minimised the access node **120** could ignore the information relating to the availability of one or more secondary beam configurations and can continue to use just the primary transmission configuration.

[0110] The primary beam configuration can be configured to make use of the P-APA and the secondary beam configuration makes use of the SU-APA. The P-APA and the SU-APA can comprise different angular directions. The different angular directions can be such that a blockage or obstruction that affects the P-APA might not affect the SU-APA.

[0111] In some examples the at least one expanded transmission configuration can comprise an indication of a cell and a bandwidth part. The at least one expanded transmission configuration can enable the access node **120** to transmit Downlink (DL) signals using either the primary beam configuration or the secondary beam configuration. The at least one expanded transmission configuration can enable the UE **110** to receive signals based on one or more QCL assumptions.

[0112] The at least one expanded transmission configuration can comprise one or more TCI-states or any other suitable type of transmission configurations.

[0113] When the expanded transmission configuration has been enabled the node apparatus **120** can be configured to enable information indicative of the at least one expanded transmission configuration to be transmitted to the UE **110**. The expanded transmission configuration can be indicated using any suitable means. In some examples the at least one expanded transmission configuration can be indicated by using one or more bits in a pre-agreed structure within a message.

[0114] In some examples the expanded transmission configuration can be indicated by adding data to a CSI-ResourceConfig message or any other suitable message. For instance, where the expanded transmission configuration comprises an expanded TCI-state then a bit can be added to the CSI-ResourceConfig with the following meaning: [0115] 0 indicates No expanded TCI-state for aperiodic Non Zero Power (NZP)-CSI-RS with repetition ON [0116] 1 indicates Expanded TCI-state for aperiodic NZP-CSI-RS with repetition ON

[0117] In such examples the TCI-states can be configured by the access node **120** and updated using a Downlink Control Information (DCI) message. Information regarding the use of a transmission configuration could be added to either the NZP-CSI-RS-ResourceSet sequence, the NZP-CSI-RS-Resource sequence or the TCI-stateID sequence, or any other suitable message. Examples of such messages are as follows:

TABLE-US-00001 NZP-CSI-RS-ResourceSet ::= SEQUENCE { nzp-CSI-ResourceSetId NZP-CSI-RS-ResourceSetId, nzp-CSI-RS-Resources SEQUENCE (SIZE (1..maxNrofNZP-CSI-RS- ResourcesPerSet)) OF NZP-CSI-RSResourceId, repetition ENUMERATED { on, off } OPTIONAL, Expanded TCI-State BIT STRING (SIZE (1)) OPTIONAL, aperiodicTriggeringOffset INTEGER(0..4) OPTIONAL, trs-Info ENUMERATED {true} OPTIONAL, ... } NZP-CSI-RS-Resource ::= SEQUENCE { nzp-CSI-RS-ResourceId NZP-CSI-RS-ResourceId, resourceMapping CSI-RS-ResourceMapping, powerControlOffset INTEGER (−8..15), powerControlOffsetSS ENUMERATED{db-3, db0, db3, db6} OPTIONAL, -- Need R scramblingID ScramblingId, periodicityAndOffset CSI-ResourcePeriodicityAndOffset OPTIONAL,- qcl-InfoPeriodicCSI-RS TCI-StateId OPTIONAL, -- Cond Periodic Expanded TCI-State BIT STRING (SIZE (1)) OPTIONAL, ... } TCI-State ::= SEQUENCE { tci-StateId TCI-StateId, qcl-Type1 QCL-Info, qcl-Type2 QCL-Info OPTIONAL, - - Need R Expanded TCI-State BIT STRING (SIZE (1)) OPTIONAL, ... } Another example for the TCI-structure could be: Expanded-TCI-State ::= SEQUENCE { tci-StateId TCI-StateId qcl-Type1_1 QCL-Info // first QCL-TypeA/B/C RS qcl-Type1_2 QCL-Info // second QCL-TypeA/B/C RS qcl-Type2_1 QCL-Info //

first QCL-TypeD RS qcl-Type2_2 QCL-Info // second QCL-TypeD RS ... }
[0118] Other implementations for providing the information of the expanded TCI-state for aperiodic NZP-CSI-RS with repetition ON, could be used in other examples.
[0119] FIG. **3**B shows a method corresponding to the method of FIG. **3**A. The example method of FIG. **3**B could be performed by a UE **110**. The UE **110** could be a smartphone or any other suitable type of UE **110**. The UE **110** can be configured to communicate with an access node **120** that performs the method shown in FIG. **3**A. The UE **110** could be in a network **100** as shown in FIG. **1** or any other suitable type of network. The UE **110** that performs the method of FIG. **3**B is the UE **110** from which the access node **120** receives the report at block **301**. The UE **110** can be configured to identify at least a primary access node **120** beam configuration and an availability of one or more secondary beam configurations wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE **110** receives power from the node apparatus **120**. For example, the UE **110** can be configured to identify a P-APA and an SU-APA.
[0120] At block **305** the method comprises receiving information indicative of at least one expanded transmission configuration from a node apparatus. The node apparatus could be an access node **120** or any other suitable type of node apparatus. The node apparatus could be a node apparatus that has performed the method of claim **3**A.
[0121] The information indicative of the at least one expanded transmission configuration can be received in response to a report transmitted by the UE **110** indicating at least the primary beam configuration and an availability of one or more secondary beam configurations. For example, the UE **110** can transmit a report indicating any secondary access node **120** beam configurations that can be used to receive power by the UE **110**. The transmitted report can indicate one or more access node **120** beam configurations that the UE **110** has determined to be receiving power above a threshold level.
[0122] The expanded transmission configuration comprises a primary beam configuration and a secondary beam configuration wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus. The information indicative of at least one expanded transmission configuration that is received from the node apparatus can provide an indication of the primary beam configuration and/or the secondary beam configuration.
[0123] The information indicative of the at least one expanded transmission configuration can be received in any suitable format. For instance, the information indicative of the at least one expanded transmission configuration can comprise one or more bits in a pre-agreed structure within a message. The position and/or value of the bits in the message can provide an indication of the whether or not an expanded transmission configuration is available.
[0124] In some examples the at least one expanded transmission configuration can comprise an indication of a cell and a bandwidth part. The at least one expanded transmission configuration can enable the access node **120** to transmit Downlink (DL) signals using either the primary beam configuration combined with the secondary beam configuration. The at least one expanded transmission configuration can enable the
[0125] UE **110** to receive signals based on one or more QCL assumptions.
[0126] The at least one expanded transmission configuration can comprise one or more TCI-states or any other suitable type of transmission configurations.
[0127] In response to receiving the information indicative of the at least one expanded transmission configuration, the method comprises, at block **307**, enabling the UE **110** to use the primary beam configuration and/or a secondary beam configuration to receive signals from the node apparatus. This can enable the UE **110** to use either primary access node **12** beam configuration alone to receive signals using the non-expanded transmission configuration or to use the primary and/or secondary beam configuration to receive signals using the expanded beam configuration. The

primary beam configuration makes use of a P-APA and the secondary beam configuration makes use of an SU-APA.

[0128] FIG. **4** shows an example expanded transmission configuration. In this example the expanded transmission configuration is an expanded TCI-state.

[0129] FIG. **4** shows an access node **120** and a UE **110**. The access node **120** and the UE **110** could be part of a network **100** such as the network **100** of FIG. **1**. The UE **110** could be a smartphone or any other suitable type of UE **110**. The access node **120** could be a gNB or any other suitable type of access node **120**.

[0130] In the example of FIG. **4** the access node **120** is configured to transmit using a wider expanded beam configuration and the UE **110** is configured to receive using a narrow beam configuration. In these examples the access node **120** transmits using an expanded P**1** like configuration and the UE **110** receives using a P**3** configuration.

[0131] The access node **120** can be configured to transmit reference signals to the UE **110**. For instance, the access node transmits an SSB (Synchronisation Signal Block) sweep. The SSB beam sweep can be transmitted in a plurality of different angular directions. The UE **110** can then measure Reference Signal Received Power (RSRP) values for the different SSBs. If two or more SSB indices are above a threshold power level and are received from different angular areas then this can be reported from the UE **110** to the access node **120**. The SSBs can be considered to be received from different angular areas if they are determined to be received from different APAs. FIG. **6** shows an example that can be used to determine if signals are received from different APAs.

[0132] In the example of FIG. **4** the UE **110** has reported to the access node **120** that the UE **110** can received SSBs from different APAs. This indicates that a secondary beam configuration could be used to receive power from the access node **120**. In response to this report the access node **120** has configured the expanded transmission configuration as shown in FIG. **4**. The expanded transmission configuration as shown in FIG. **4** comprises a combination of the primary and secondary beam configurations as shown in FIGS. **2**A and **2**B.

[0133] In the example of FIG. **4** the expanded transmission configuration comprises a primary angular direction **401** which enables a beam to be transmitted directly from the access node **120** to the UE **110**. This primary angular direction **401** is not reflected from any buildings and so may provide the highest power signal to the UE **110**. The expanded transmission configuration also comprises an angular direction **403**. The secondary angular direction is reflected from the building **203** towards the UE **110**. Due to the reflection from the building **203** the UE **110** receives less power using the secondary angular direction **403** than using the primary angular direction **401**.

[0134] Any suitable means can be used to provide the expanded transmission configuration. In examples where the expanded transmission configuration comprises an expanded TCI-state the access node **120** can expand the TCI-state of the primary TCI-state when configuring NZP-CSI-RS with repetition ON.

[0135] An expanded TCI-state can be enabled if the QCL assumption source can be constructed from multiple reference signals. For instance, if the UE **110** detects that there are two SSB beams that are received above a threshold level then the access node **120** can configure the QCL-Type D Reference Signal (RS) field with two SSBs instead of one.

[0136] The access node **120** can indicate the expanded TCI-state to the UE **110** using any suitable type of indication. In some examples the access node **120** can indicate the expanded TCI state by adding a single bit to the DCI associated with the primary TCI-state or by any other suitable means.

[0137] In some examples the access node **120** might also require one or more additional conditions to be satisfied before the expanded transmission configuration. Such conditions could be a time threshold since the last measurement of the reference signal

[0138] (RS), the applicability of the QCL assumptions or any other suitable criteria. The applicability of the QCL assumptions could be signaled explicitly. For instance, it could be provided as a bit in the DCI. For instance, if the time since the last measurement of the RS and/or

the time since the last reporting of the RS is above a threshold then the second RS in the TCI-state providing the second QCL-Type D assumption is not valid.
[0139] In such cases the expanded transmission configuration would not be enabled.
[0140] The UE **110** can receive information indicative of the expanded transmission configuration. For example, the UE **110** can receive a CSI-ResourceConfig comprising one or more bits indicating whether or not an expanded transmission configuration is available. These bits could be as described above in relation to FIG. **3**A or any other suitable message and format could be used.
[0141] The UE **110** will interpret an indication that an expanded transmission configuration is available as an acknowledgement from the access node **120**, that it has received the indication of the alternative SSB beam that is received via a different APA at the UE **110**.
[0142] When the UE **110** receives this indication the UE **110** can assume that the access node **120** uses a combined transmission beam of the first and second SSB as indicated in the report from the UE **110** for the DL transmission. The combined transmission beam comprises an expanded transmission configuration. The UE **110** can configure separate beams that each will cover the APAs included in the expanded transmission configuration. That is a first UE **110** beam can cover the primary access node **120** beam configuration **401** and a second UE **110** beam can cover the secondary access node **120** beam configuration **403**. In the example of FIG. **4**A the UE **110** can configure beams that each will independently cover the primary and the alternative SSB beam when sending aperiodic NZP-CSI-RS with repetition ON.
[0143] In examples of the disclosure the access node **120** is in control of whether or not the expanded transmission configuration is used. The access node **120** can decide whether or not the expanded transmission configuration is used based on requirements such as the reliability and robustness of communication that is needed. The access node **120** might decide not to use the expanded transmission configuration if a higher antenna gain is needed due to poor channel conditions or for any other suitable reason.
[0144] If the access node **120** decides not to use the expanded transmission configuration this can be indicated to the UE **110**. For example, if the access node **120** decides not to use the alternative SSB beam for aperiodic NZP-CSI-RS with repetition ON the bit value #**0** would be used in the messages as described above.
[0145] Examples of the disclosure therefore provide the benefit that the access node **120** can enable the UE **110** to align beams toward a plurality of different access node **120** beam configurations within the expanded transmission configuration wherein the different beam configurations are received from different angular areas. In examples, the UE **110** can align a first beam configuration towards a primary beam configuration and a second beam towards the secondary beam configuration. This additional UE **110** beam alignment does not require any additional resources. This alignment also does not need the expanded transmission configuration to be initiated.
[0146] The examples of the disclosure can therefore enable the alternative beam configuration to be P**1** (wide beam) aligned at the access node **120** and P**3** (Narrow beam) aligned at the UE **110** with no additional resources. If the access node **120** decides to switch to the secondary beam configuration it can quickly set up the transmission configuration or TCI-state for that beam configuration because the angular direction is known and the UE **110** is already P**3** aligned. To enable the full alignment the access node **120** only need to perform CSI beam refinement (P**2**).
[0147] FIG. **5** shows an example signaling chart that can be used in examples where the UE **110** has the capability to report APAs. For example, the UE **110** could report a P-APA and one or more SU-APAs. The signaling chart shows a method that can be implemented by a system comprising a UE **110** and an access node **120** such as a gNB. The UE **110** and the access node **120** can be within a network **100** such as the network **100** of FIG. **1** or any other suitable type of network.
[0148] At block **501** the access node **120** and the UE **110** configure the UE **110** in an RRC connected state. Any suitable process can be used to configure the UE **110** in the RRC connected state.

[0149] At block **503** the UE **110** transmits a report indicative of the UE **110** capabilities to the access node **120**. This report can indicate the format or data structure that will be used to report that the UE **110** is able to characterize if SSBs are received from different directions and above a threshold level. Other types of reporting or information could be used in other examples of the disclosure.
[0150] At block **505** the UE **110** sends the SSB report to the access node **120**. In this example the SSB report can report that the UE **110** can receive more than one SSB above a threshold power level and that these SSBs can be received from different directions. For instance, the UE **110** can report the availability of one or more SU-APAs. In some examples the UE **110** could indicate the SSB Indices and the APAs associated with the indices.
[0151] At block **507** the access node **120** can evaluate whether an expanded TCI-state is needed. For examples the access node **120** can determine if an expanded TCI-state for aperiodic CSI-RS with repetition "ON" is needed. The access node **120** can base this evaluation on the SSB report that is received from the UE **110** at block **505**, the Channel Quality Indicator (CQI) of the current active link between the UE **110** or any other suitable factor.
[0152] At block **509** the access node **120** prepares a beam configuration that covers both the angular directions of a primary beam configuration and a secondary beam configuration. The primary beam configuration can be the active SSB and the secondary beam configuration can be the alternative SSB beam that is reported by the UE **110** at block **505**. The beam configuration covers the spatial domain of both the active SSB beam, or CSI beam, and the alternative SSB beam that is reported by the UE **110** at block **505**.
[0153] At block **511** the access node **120** allocates resources for the expanded transmission configuration. In this example the access node **120** allocates resources for aperiodic CSI-RS with repetition "ON". The access node **120** can also indicated to the UE **110** that the resources have been allocated. Any suitable means can be used to indicate to the UE **110** that the resources have been allocated. In some examples, the indication of the access node **120** configuring an expanded TCI-state can be added to such messages to the UE **110** by a simple added bit setting.
[0154] At block **513** the access node **120** indicates the allocation for the expanded configuration state to the UE **110**. At block **515** the access node **120** transmits using the expanded TCI-state. The access node **120** transmits an aperiodic CSI-RS with repetition "ON" using the expanded TCI-state.
[0155] At block **517** the UE **110** can decide whether to use the angular direction of the primary access node **120** beam configuration or the angular direction of the secondary access node **120** beam configuration. In this example the UE **110** can decide whether or not to do P**3** beam alignment on the active SSB beam and/or on the alternative SSB beam that was reported by the UE **110** at block **505**. Whether or not the UE **110** activates one link or two can depend on the hardware capabilities of the UE **110**.
[0156] In some examples of the disclosure the UE **110** can determine whether or not reference signals from the access node **120** are received from different APA or from the same APA. If different APAs are used then if the signals received from this APA are above a threshold level they can be considered to be SU-APAs. FIG. **6** shows an example method for determining whether or not one or more SU-APAs are available. The example method of FIG. **6** could be performed by a UE **110**. The UE **110** could be a smartphone or any other suitable type of UE **110**.
[0157] At block **601** the method comprises activating a first set of receivers of the UE **110**, where a set of receives could be one or multiple. The set of receivers could be one or multiple of the panels or beams within the UE **110**.
[0158] At block **603** a reference signal is received by the UE **110** and measured. The received power levels of the reference signal could be measured. The reference signal can be any suitable type of reference signal. For instance, the reference signal could be an SSB signal or a CSI-RS signal.
[0159] The measured signal values could comprise the received power levels of the reference

signal or any other suitable type of values. For example, the measured signal values could comprise the RSRP values or any other suitable type of values.
[0160] The measured signal values are stored at block **605**. The measured signal values can be stored so that they can be used to compare different signals at a later point in time. The measured signal values can be stored so that they can be used to compare different signals after all of the reference signals have been received and measured. The measured signal values can be stored in a memory of the UE **110** or in any other suitable storage location.
[0161] At block **607** it is determined whether or not all of the expected reference signals have been measured. If all of the signals have not been measured then the process moves to block **609** and the next reference signal is measured. Once the next reference signal has been measured the process returns to block **605** to store the measured value.
[0162] If, at block **607**, it is determined that all of the expected reference signals have been measured then the process moves to block **611** and it Is determined whether or not all receivers have been used.
[0163] If all of the receivers have not been used then the process moves to block **613** and the next receiver is activated. Once the next has been activated the process returns to block **603** to measure the reference signals that have been received by the next receiver.
[0164] If, at block **611**, it is determined that all of the receivers have been used then the process moves to block **615** and relative signal values are determined.
[0165] Any suitable process can be used to determine the relative signal values. The relative signal values can comprise the difference in the power levels for a given reference signal received on the different receivers. For example, the relative signal values could comprise the differences in the RSRP values for a given SSB index for each of the receivers.
[0166] In some examples the method can comprise generating a vector for at least some of the received reference signals. The values within the vector can comprise reference signal receive power (RSRP) values for two or more the receivers used.
[0167] At block **617** the relative signal values can be compared. This enables the relative signal strengths of the received signals to be compared. In some examples this can be comparing the vectors that might formed at block **615**.
[0168] Reference signals can be classed as being from the same APA if they have differences that are similar to each other. For instance, two or more vectors can be compared and if they are within a threshold of each other the reference signals corresponding to the vectors can be considered to be received from the same APA. However, if the vectors are not within a threshold of each other then the reference signals can be classed as being from different APAs.
[0169] In some examples the method can comprise grouping reference signals to different APAs. Reference signals with similar differences between measured values can be classified together in the same group. This grouping can be used to identify which reference signals have been received by a P-APA and which have been received by an SU-APA.
[0170] If it is determined that the reference signals are received from different APAs then a P-APA and one or more SU-APAs can be identified based on received power levels or any other suitable criteria.
[0171] The APAs do not need to be defined precisely. That is, the angular ranges covered by the APAs do not need to be determined either in absolute terms or relative terms. It is sufficient to identify that a P-APA is different from an SU-APA. This can enable the P-APA and the SU-APA to be identified without any known and/or pre-characterized spatial filtering at the UE **110**. This can enable the UE **110** to identify the P-APA and the SU-APA in any conditions, including conditions in which the users' hands are blocking one or more panels of the UE **110**.
[0172] In the example of FIG. **6** the reference signals have been received sequentially. In other examples the reference signals could be received simultaneously, or substantially simultaneously.
[0173] Examples of the disclosure therefore provide the increased robustness and/or reliability for

communications between a UE **110** and an access node **120** because the access node **120** is made aware of an SU-APA. The SU-APA can be associated with an SSB beam index so that the access node can use this information to set up an expanded transmission configuration.
[0174] Examples of the disclosure also provide for a short time for finding and setting up the expanded transmission configuration because the access node **120** can already be informed of the one or more SU-APAs that could be used. There is no need for any more expanded reference signals to be transmitted by the access node **120** in order to find the SU-APAs.
[0175] FIG. **7** illustrates an example of a controller **700**. The controller **700** could be provided within an apparatus such as a UE **110** or a gNB. Implementation of a controller **700** may be as controller circuitry. The controller **700** may be implemented in hardware alone, have certain aspects in software including firmware alone or can be a combination of hardware and software (including firmware).
[0176] As illustrated in FIG. **7** the controller **700** can be implemented using instructions that enable hardware functionality, for example, by using executable instructions of a computer program **706** in a general-purpose or special-purpose processor **702** that may be stored on a computer readable storage medium (disk, memory etc.) to be executed by such a processor **702**.
[0177] The processor **702** is configured to read from and write to the memory **704**. The processor **702** may also comprise an output interface via which data and/or commands are output by the processor **702** and an input interface via which data and/or commands are input to the processor **702**.
[0178] The memory **704** stores a computer program **706** comprising computer program instructions (computer program code) that controls the operation of the apparatus when loaded into the processor **702**. The computer program instructions, of the computer program **706**, provide the logic and routines that enables the apparatus to perform the methods illustrated in FIGS. **3** to **6** The processor **702** by reading the memory **704** is able to load and execute the computer program **706**.
[0179] In examples where the controller **700** is provided within a UE **110** the controller **700** therefore comprises: at least one processor; and at least one memory including computer program code; the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to perform; [0180] receiving information indicative of at least one expanded transmission configuration from a node apparatus wherein the expanded transmission configuration comprises a primary beam configuration and a secondary beam configuration wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus; and [0181] in response to receiving the information indicative of the at least one expanded transmission configuration enabling the UE to use the primary beam configuration and/or the secondary beam configuration to receive signals from the node apparatus.
[0182] In examples where the controller **700** is provided within an access node **120** the controller **700** therefore comprises: at least one processor; and at least one memory including computer program code; the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to perform; [0183] receiving a report from a User Equipment (UE) indicating at least a primary beam configuration and an availability of one or more secondary beam configurations wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus; and [0184] in response to receiving the report enabling at least one expanded transmission configuration based, at least in part, on the availability of the one or more secondary beam configurations wherein the expanded transmission configuration comprises the primary beam configuration and a secondary beam configuration.
[0185] The computer program **706** may arrive at the apparatus or network apparatus via any suitable delivery mechanism **708**. The delivery mechanism **708** may be, for example, a machine readable medium, a computer-readable medium, a non-transitory computer-readable storage

medium, a computer program product, a memory device, a record medium such as a Compact Disc Read-Only Memory (CD-ROM) or a Digital Versatile Disc (DVD) or a solid-state memory, an article of manufacture that comprises or tangibly embodies the computer program **706**. The delivery mechanism may be a signal configured to reliably transfer the computer program **706**. The apparatus may propagate or transmit the computer program **706** as a computer data signal.
[0186] The computer program **706** can comprise computer program instructions for causing a UE **110** to perform at least the following or for performing at least the following: [0187] receiving information indicative of at least one expanded transmission configuration from a node apparatus wherein the expanded transmission configuration comprises a primary beam configuration and a secondary beam configuration wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus; and [0188] in response to receiving the information indicative of the at least one expanded transmission configuration enabling the UE to use the primary beam configuration and/or the secondary beam configuration to receive signals from the node apparatus.
[0189] The computer program **706** can comprise computer program instructions for causing an access node **120** to perform at least the following or for performing at least the following: [0190] receiving a report from a User Equipment (UE) indicating at least a primary beam configuration and an availability of one or more secondary beam configurations wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus; and [0191] in response to receiving the report enabling at least one expanded transmission configuration based, at least in part, on the availability of the one or more secondary beam configurations wherein the expanded transmission configuration comprises the primary beam configuration and a secondary beam configuration.
[0192] The computer program instructions may be comprised in a computer program, a non-transitory computer readable medium, a computer program product, a machine readable medium. In some but not necessarily all examples, the computer program instructions may be distributed over more than one computer program.
[0193] Although the memory **704** is illustrated as a single component/circuitry it may be implemented as one or more separate components/circuitry some or all of which may be integrated/removable and/or may provide permanent/semi-permanent/dynamic/cached storage.
[0194] Although the processor **702** is illustrated as a single component/circuitry it may be implemented as one or more separate components/circuitry some or all of which may be integrated/removable. The processor **702** may be a single core or multi-core processor.
[0195] References to ‘computer-readable storage medium’, ‘computer program product’, ‘tangibly embodied computer program’ etc. or a ‘controller’, ‘computer’, ‘processor’ etc. should be understood to encompass not only computers having different architectures such as single/multi-processor architectures and sequential (Von Neumann)/parallel architectures but also specialized circuits such as field-programmable gate arrays (FPGA), application specific circuits (ASIC), signal processing devices and other processing circuitry. References to computer program, instructions, code etc. should be understood to encompass software for a programmable processor or firmware such as, for example, the programmable content of a hardware device whether instructions for a processor, or configuration settings for a fixed-function device, gate array or programmable logic device etc.
[0196] As used in this application, the term ‘circuitry’ may refer to one or more or all of the following: [0197] (a) hardware-only circuitry implementations (such as implementations in only analog and/or digital circuitry) and [0198] (b) combinations of hardware circuits and software, such as (as applicable): [0199] (i) a combination of analog and/or digital hardware circuit(s) with software/firmware and [0200] (ii) any portions of hardware processor(s) with software (including digital signal processor(s)), software, and memory (ies) that work together to cause an apparatus, such as a mobile phone or server, to perform various functions and [0201] (c) hardware circuit(s)

and or processor(s), such as a microprocessor(s) or a portion of a microprocessor(s), that requires software (e.g. firmware) for operation, but the software may not be present when it is not needed for operation.

[0202] This definition of circuitry applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term circuitry also covers an implementation of merely a hardware circuit or processor and its (or their) accompanying software and/or firmware. The term circuitry also covers, for example and if applicable to the particular claim element, a baseband integrated circuit for a mobile device or a similar integrated circuit in a server, a cellular network device, or other computing or network device.

[0203] The stages illustrated in FIGS. **3** to **6** can represent steps in a method and/or sections of code in the computer program **706**. The illustration of a particular order to the blocks does not necessarily imply that there is a required or preferred order for the blocks and the order and arrangement of the block may be varied. Furthermore, it can be possible for some blocks to be omitted.

[0204] Where a structural feature has been described, it may be replaced by means for performing one or more of the functions of the structural feature whether that function or those functions are explicitly or implicitly described.

[0205] In some but not necessarily all examples, the UE **110**, and the network **100** are configured to communicate data with or without local storage of the data in a memory **704** at the UE **110**, or the access nodes **120** and with or without local processing of the data by circuitry or processors at the UE **110**, or the access nodes **120**.

[0206] The data may be stored in processed or unprocessed format remotely at one or more devices. The data may be stored in the Cloud.

[0207] The data may be processed remotely at one or more devices. The data may be partially processed locally and partially processed remotely at one or more devices.

[0208] The data may be communicated to the remote devices wirelessly via short range radio communications such as Wi-Fi or Bluetooth, for example, or over long range cellular radio links. The apparatus may comprise a communications interface such as, for example, a radio transceiver for communication of data.

[0209] The UE **110** and/or the network **100** can be part of the Internet of Things forming part of a larger, distributed network.

[0210] The processing of the data, whether local or remote, can be for the purpose of health monitoring, data aggregation, patient monitoring, vital signs monitoring or other purposes.

[0211] The processing of the data, whether local or remote, may involve artificial intelligence or machine learning algorithms. The data may, for example, be used as learning input to train a machine learning network or may be used as a query input to a machine learning network, which provides a response. The machine learning network may for example use linear regression, logistic regression, vector support machines or an acyclic machine learning network such as a single or multi hidden layer neural network.

[0212] The processing of the data, whether local or remote, may produce an output. The output may be communicated to the UE **110**, and the access nodes **120** where it may produce an output sensible to the subject such as an audio output, visual output or haptic output.

[0213] The above-described examples find application as enabling components of: automotive systems; telecommunication systems; electronic systems including consumer electronic products; distributed computing systems; media systems for generating or rendering media content including audio, visual and audio visual content and mixed, mediated, virtual and/or augmented reality; personal systems including personal health systems or personal fitness systems; navigation systems; user interfaces also known as human machine interfaces; networks including cellular, non-cellular, and optical networks; ad-hoc networks; the internet; the internet of things; virtualized networks; and related software and services.

[0214] The term ‘comprise’ is used in this document with an inclusive not an exclusive meaning. That is any reference to X comprising Y indicates that X may comprise only one Y or may comprise more than one Y. If it is intended to use ‘comprise’ with an exclusive meaning then it will be made clear in the context by referring to “comprising only one . . . ” or by using “consisting”.
[0215] In this description, reference has been made to various examples. The description of features or functions in relation to an example indicates that those features or functions are present in that example. The use of the term ‘example’ or ‘for example’ or ‘can’ or ‘may’ in the text denotes, whether explicitly stated or not, that such features or functions are present in at least the described example, whether described as an example or not, and that they can be, but are not necessarily, present in some of or all other examples. Thus ‘example’, ‘for example’, ‘can’ or ‘may’ refers to a particular instance in a class of examples. A property of the instance can be a property of only that instance or a property of the class or a property of a sub-class of the class that includes some but not all of the instances in the class. It is therefore implicitly disclosed that a feature described with reference to one example but not with reference to another example, can where possible be used in that other example as part of a working combination but does not necessarily have to be used in that other example.
[0216] Although examples have been described in the preceding paragraphs with reference to various examples, it should be appreciated that modifications to the examples given can be made without departing from the scope of the claims.
[0217] Features described in the preceding description may be used in combinations other than the combinations explicitly described above.
[0218] Although functions have been described with reference to certain features, those functions may be performable by other features whether described or not.
[0219] Although features have been described with reference to certain examples, those features may also be present in other examples whether described or not.
[0220] The term ‘a’ or ‘the’ is used in this document with an inclusive not an exclusive meaning. That is any reference to X comprising a/the Y indicates that X may comprise only one Y or may comprise more than one Y unless the context clearly indicates the contrary. If it is intended to use ‘a’ or ‘the’ with an exclusive meaning then it will be made clear in the context. In some circumstances the use of ‘at least one’ or ‘one or more’ may be used to emphasis an inclusive meaning but the absence of these terms should not be taken to infer any exclusive meaning.
[0221] The presence of a feature (or combination of features) in a claim is a reference to that feature or (combination of features) itself and also to features that achieve substantially the same technical effect (equivalent features). The equivalent features include, for example, features that are variants and achieve substantially the same result in substantially the same way. The equivalent features include, for example, features that perform substantially the same function, in substantially the same way to achieve substantially the same result.
[0222] In this description, reference has been made to various examples using adjectives or adjectival phrases to describe characteristics of the examples. Such a description of a characteristic in relation to an example indicates that the characteristic is present in some examples exactly as described and is present in other examples substantially as described.
[0223] Whilst endeavoring in the foregoing specification to draw attention to those features believed to be of importance it should be understood that the Applicant may seek protection via the claims in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not emphasis has been placed thereon.

## Claims

**1**. A User Equipment (UE) comprising: at least one processor; and at least one memory including computer program code the at least one memory and the computer program code configured to,

with the at least one processor, cause the UE at least to perform: receiving information indicative of at least one expanded transmission configuration from a node apparatus wherein the expanded transmission configuration comprises a primary beam configuration and a secondary beam configuration wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus; and in response to receiving the information indicative of the at least one expanded transmission configuration enabling the UE to use the primary beam configuration and/or the secondary beam configuration to receive signals from the node apparatus.

**2**. The UE as claimed in claim 1 wherein the information indicative of the at least one expanded transmission configuration is received in response to a report transmitted by the UE indicating at least the primary beam configuration and an availability of one or more secondary beam configurations.

**3**. The UE as claimed in claim 2 wherein the transmitted report indicates one or more beam configurations that the UE has determined to be receiving power above a threshold level.

**4**. The UE as claimed in claim 1 wherein the primary beam configuration makes use of a Primary-Angular Power Area (P-APA) and the secondary beam configuration makes use of a Secondary Useable-Angular Power Area (SU-APA) wherein an angular power area comprises a range of angular directions from which the UE is receiving power from the node apparatus.

**5**. The UE as claimed in claim 1 wherein the at least one expanded transmission configuration is indicated by using one or more bits in a pre-agreed structure within a message.

**6**. The UE as claimed in claim 1 wherein the at least one expanded transmission configuration comprises an indication of a cell and a bandwidth part.

**7**. The UE as claimed in claim 1 wherein the at least one expanded transmission configuration enables the node apparatus to transmit Downlink (DL) signals and/or enables the UE to receive signals based on one or more Quasi Co-Location (QCL) assumptions.

**8**. The UE as claimed in claim 1 wherein the at least one expanded transmission configuration comprises one or more Transmission Configuration Indicator (TCI) states.

**9**. A method comprising: receiving information indicative of at least one expanded transmission configuration from a node apparatus wherein the expanded transmission configuration comprises a primary beam configuration and a secondary beam configuration wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus; and in response to receiving the information indicative of the at least one expanded transmission configuration enabling the UE to use the primary beam configuration and/or the secondary beam configuration to receive signals from the node apparatus.

**10**. (canceled)

**11**. A node apparatus comprising: at least one processor; and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the node apparatus at least to perform: receiving a report from a User Equipment (UE) indicating at least a primary beam configuration and an availability of one or more secondary beam configurations wherein the primary beam configuration and the secondary beam configuration comprise different angular areas from which the UE receives power from the node apparatus; and in response to receiving the report enabling at least one expanded transmission configuration based, at least in part, on the availability of the one or more secondary beam configurations wherein the expanded transmission configuration comprises the primary beam configuration and a secondary beam configuration.

**12**. A The node apparatus as claimed in claim 11 wherein the received report indicates one or more beam configurations that the UE has determined to be receiving power above a threshold level.

**13**. A The node apparatus as claimed in claim 11 wherein the primary beam configuration makes use of a Primary-Angular Power Area (P-APA) and the secondary beam configuration makes use of

a Secondary Useable-Angular Power Area (SU-APA) wherein an angular power area comprises a range of angular directions from which the UE is receiving power from the node apparatus.

**14**. A The node apparatus as claimed in claim 11 wherein the at least one processor and at least one memory are configured to perform transmitting information indicative of the at least one expanded transmission configuration to the UE.

**15**. A The node apparatus as claimed in claim 11 wherein the at least one expanded transmission configuration is indicated by using one or more bits in a pre-agreed structure within a message.

**16**. A The node apparatus as claimed in claim 11 wherein the at least one expanded transmission configuration enables the node apparatus to transmit Downlink (DL) signals and/or enables the UE to receive signals based on one or more Quasi Co-Location (QCL) assumptions.

**17**. A The node apparatus as claimed in claim 11 wherein the at least one expanded transmission configuration comprises one or more Transmission Configuration Indicator (TCI) states.

**18**. A The node apparatus as claimed in claim 11 wherein the at least one expanded transmission configuration is enabled based on one or more requirements of the node apparatus.

**19**-**20**. (canceled)