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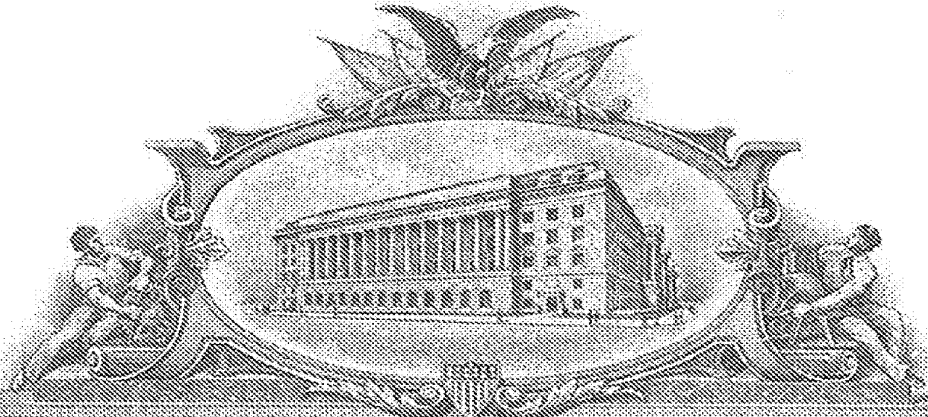
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APPLICATION NUMBER: 62/653,824

FILING DATE: *April 06, 2018*

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS *US62/653,824*



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Document Description: Power of Attorney

PTO/AIA/82A (07-12)

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Application Number	to be assigned			
Filing Date	herewith			
First Named Inventor	Mihai Enescu et al.			
Title	BEAM INDICATION FOR MULTI-PANEL UE			
Art Unit				
Examiner Name				
Attorney Docket Number	800.2366.P1(US)			
SIGNATURE of Applicant or Patent Practitioner				
Signature			Date	4/6/2018
Name	Garth Clarke		Telephone	203 925-9400
Registration Number	60,292			

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10948

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I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Nokia Technologies Oy

- ☐ Inventor or Joint Inventor (title not required below)
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
- ☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
- ☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

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Signature Jukka Nihtila Date (Optional) 23 January 2015

Name Jukka Nihtila

Title Head, Business Development

Legal & IP

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Nokia Technologies Oy
Karaportti 3
02610 Espoo
Finland

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Customer Number: 10,948

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By: [Signature]

Name: Harri Hovi
Title: Director, Legal & IP
Date: 23 January 2015

By: [Signature]

Name: Jukka Nihtilä
Title: Head, Business Development
Date: 23 January 2015

Electronic Acknowledgement Receipt

EFS ID:	32268641
Application Number:	62653824
International Application Number:	
Confirmation Number:	7840
Title of Invention:	Beam Indication for Multi-Panel UE
First Named Inventor/Applicant Name:	Mihai Enescu
Customer Number:	10948
Filer:	Mark F. Harrington/John Sheehan
Filer Authorized By:	Mark F. Harrington
Attorney Docket Number:	800.2366.P1(US)
Receipt Date:	06-APR-2018
Filing Date:	
Time Stamp:	15:09:07
Application Type:	Provisional

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$ 280
RAM confirmation Number	040918INTEFSW00001611501924
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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			0079ed169b7c4fc3d0a12e7a2628f1fbd6da5451		
Warnings:					
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2	Specification	NC105352_Specification.PDF	1582946	no	39
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Express Mail Label No. _____

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Mihai	Enescu	Espoo, Finland
Sami	Hakola	Kempele, Finland
Lars	Dalsgaard	Oulu, Finland
Jorma	Kaikkonen	Oulu, Finland
Timo	Koskela	Oulu, Finland
Additional inventors are being named on the <u>third page</u> separately numbered sheets attached hereto.		
TITLE OF THE INVENTION (500 characters max):		
BEAM INDICATION FOR MULTI-PANEL UE		
Direct all correspondence to: CORRESPONDENCE ADDRESS		
☒ The address corresponding to Customer Number: 10948		
OR		
☐ Firm or ☐ Individual Name		
Address		
City	State	Zip
Country	Telephone	Email
ENCLOSED APPLICATION PARTS (check all that apply)		
☒ Application Data Sheet. See 37 CFR 1.76. ☐ CD(s), Number of CDs _____		
☒ Drawing(s) Number of Sheets <u>14</u> ☒ Other (specify) <u>Power of Attorney</u>		
☒ Specification (e.g., description of the invention) Number of Pages <u>39</u>		
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☐ Applicant asserts small entity status. See 37 CFR 1.27.		
☐ Applicant certifies micro entity status. See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.		
☐ A check or money order made payable to the <i>Director of the United States Patent and Trademark Office</i> is enclosed to cover the filing fee and application size fee (if applicable).		
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\$280.00 TOTAL FEE AMOUNT (\$)		

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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

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SIGNATURE _____

DATE _____

TYPED OR PRINTED NAME Garth ClarkeREGISTRATION NO. 60,292
(if appropriate)TELEPHONE 203-925-9400DOCKET NUMBER 800.2366.P1(US)

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET – Page 1 of 2

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INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Juha	Karjalainen	Oulu, Finland

Additional inventors are being named on the _____ separately numbered sheets attached hereto.

TITLE OF THE INVENTION (500 characters max):

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☐ The address corresponding to Customer Number:

OR

☐ Firm or Individual Name

Address _____

City	State	Zip
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ENCLOSED APPLICATION PARTS (check all that apply)

☐ Application Data Sheet. See 37 CFR 1.76. ☐ CD(s), Number of CDs _____

☐ Drawing(s) Number of Sheets _____ ☐ Other (specify) _____

☐ Specification (e.g., description of the invention) Number of Pages _____

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BEAM INDICATION FOR MULTI-PANEL UE

TECHNICAL FIELD:

[0001] The teachings in accordance with the exemplary embodiments of this invention relate generally to Radio Standards including physical layer (PHY), Medium access control (MAC), Radio Link Control (RLC), Radio Resource Control (RRC), etc., and particularly, to radio physical layer design. More specifically, teachings in accordance with the exemplary embodiments relate to beam management methods that support user equipment with different kind of beamforming capabilities.

BACKGROUND:

[0002] At higher carrier frequencies, for example, at carrier frequencies above 6 GHz, user equipment (UEs) often have multiple transmit and receive antenna panels and operate using narrower RF beams than omni pattern for both the reception and transmission. As an example, a UE may be equipped with four cross-polarized antenna panels. In contrast to number of panels, there may be a limited number of transceiver units (TXRUs) available at the UE. For instance, a UE may have only two TXRUs while having four x-pol antenna panels. In that instance only one x-pol panel or two one-dimensional panels may be in use at a time (for example, one TXRU per polarization dimension per panel). Changing a TX or RX beam “within a panel” may be performed within some tens to hundred nanoseconds but switching beam between panels, for example, changing operating panel, may require (in the order of) of hundred microseconds to some milliseconds (time from trigger to switch on the panel until the panel is operable). A delay (for example, a two microsecond delay) may be assumed (for example, the system or UE may operate based on an assumption) for the UE being operative again when switching active antenna panel.

[0003] A common Quasi-colocation (QCL) and Transmit Configuration Indication (TCI) framework may be used for defining a “transmit beam” for different downlink physical signals and channels, such as for periodic, semi-persistent and aperiodic CSI-RS, and NR-PDCCH and NR-PDSCH in NR. In these instances, the UE may be configured with a TCI table in which each row/state is associated with one or two RSs that act as a source RS(s) in terms of different QCL parameters (delay spread, average delay, doppler spread, doppler shift, spatial RX, etc.) for the particular downlink signal. In instances in which spatial RX QCL parameter is configured for the particular source RS, the UE may assume that the same RX beam can be applied when receiving the configured/scheduled/triggered physical signal or physical channel as was used for receiving the source RS.

[0004] Certain abbreviations that may be found in the description and/or in the Figures are herewith defined as follows:

BWP	Bandwidth part
CA	Carrier aggregation
CC	Component carrier
CCE	Control channel element
CE	Control Element
CORESET	Control Resource Set
CSI-RS	Channel State Information Resource Set
CSS	Common search space
DCI	Downlink Control Information
DL	Downlink
DMRS	Demodulation Reference Signal
gNB	5G Enhanced Node B (Base station)
HARQ	Hybrid Automatic Repeat Request
LTE	long term evolution
MAC	Medium access control

MEC	multi-access edge computing
MME	mobility management entity
NCE	network control element
NR	New radio
NR-PDCCH	New radio Physical Downlink Control Channel
N/W	Network
PBCH	Physical Broadcast Channel
PDCCH	Physical Downlink Control Channel
PDSCH	Physical Downlink Shared Channel
PUCCH	Physical Uplink Control Channel
PUSCH	Physical Uplink Shared Channel
QCL	Quasi Co-Location
RE	Resource Element
RF	Radio Frequency
RRC	Radio Resource Control
RS	Reference Signal
RSRP	Reference Signal Received Power
SCS	Subcarrier spacing
SS	Synchronization Signal
TCI	Transmission Configuration Indication
TRP	Transmission – reception point
TRS	Tracking Reference Signal
TXRU	Transceiver Unit
UE	User Equipment
UL	Uplink
5G	Fifth generation mobile communication system

BRIEF SUMMARY

[0005] The following summary includes examples and is merely intended to be exemplary. The summary is not intended to limit the scope of the claims.

[0006] In accordance with one aspect, an example method comprises providing, from a user device, at least one beam report to a base station indicating a particular panel tag to use for measuring a particular beam management source reference signal, receiving, by the user device, from the base station, configuration of a transmission configuration indication table for the user device, wherein the configuration is based on the at least one beam report and states are associated to at least one source reference signal measured by at least one receiver panel of the user device, and determining, when activating at least one particular source reference signal for the control resource set, that only transmission configuration indication states sharing a same tag with an activated at least one source reference signal for a control resource set are to be used for physical downlink shared channel beam indication.

[0007] In accordance with another aspect, an example apparatus comprises means for providing, from the apparatus, at least one beam report to a base station indicating a particular panel tag to use for measuring a particular beam management source reference signal, means for receiving, by the apparatus, from the base station, configuration of a transmission configuration indication table for the user device, wherein the configuration is based on the at least one beam report and states are associated to at least one source reference signal measured by at least one receiver panel of the apparatus, and means for determining, when activating at least one particular source reference signal for the control resource set, that only transmission configuration indication states sharing a same tag with an activated at least one source reference signal for a control resource set are to be used for physical downlink shared channel beam indication.

[0008] In accordance with another aspect, an example apparatus comprises at least one processor; and at least one non-transitory memory including computer program code, the at least one memory and the computer program code may be configured to, with the at least one processor, cause the apparatus to:

[0009] In accordance with another aspect, an example apparatus comprises a non-transitory program storage device readable by a machine, tangibly embodying a program of instructions executable by the machine for performing operations, the operations comprising: provide at least one beam report to a base station indicating a particular panel tag to use for measuring a particular beam management source reference signal, receive from the base station, configuration of a transmission configuration indication table for the user device, wherein the configuration is based on the at least one beam report and states are associated to at least one source reference signal measured by at least one receiver panel of the user device, and determine, when activating at least one particular source reference signal for the control resource set, that only transmission configuration indication states sharing a same tag with an activated at least one source reference signal for a control resource set are to be used for physical downlink shared channel beam indication.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0010] The foregoing and other aspects of embodiments of this invention are made more evident in the following Detailed Description, when read in conjunction with the attached Drawing Figures, wherein:

[0011] Fig. 1 is a block diagram of one possible and non-limiting example system in which the example embodiments may be practiced;

[0012] Fig. 2 shows an example illustration of a TCI table configured for a UE;

[0013] Fig. 3 shows an example illustration of two exemplary CORESET configurations showing (only) association to certain TCI state(s);

[0014] Fig. 4 shows an example illustration in which a TX beam for PDSCH is the same as for the PDCCH;

[0015] Fig. 5 shows an example illustration in which a TX beam for PDSCH is indicated by TCI index in DCI;

[0016] Fig. 6 shows an example illustration in which a TX beam for PDSCH corresponds to PDCCH TX beam of the lowest CORESET-ID in the latest slot;

[0017] Fig. 7 shows an example illustration of a TCI table configured for a UE;

[0018] Fig. 8 shows an example illustration of a TCI table configured for a UE;

[0019] Fig. 9 shows a method in accordance with example embodiments which may be performed by an apparatus;

[0020] Fig. 10 shows a method in accordance with example embodiments which may be performed by an apparatus;

[0021] Fig. 11 shows an example illustration of UE beams in the presence of a user;

[0022] Fig. 12 shows an example illustration of DL RS beams and UE beams;

[0023] Fig. 13 shows an example illustration of measured RSRP (a) and PHR (b) accounting the MPR required to meet emission requirements; and

[0024] Fig. 14 shows an example illustration of a DL RS beams and UE beams, where beams are spatially overlapping.

DETAILED DESCRIPTION:

[0025] In the example embodiments as described herein a method and apparatus that provides multi-beam downlink channel control procedures.

[0026] Turning to Fig. 1, this figure shows a block diagram of one possible and non-limiting example system in which the example embodiments may be practiced. In Fig. 1, a user equipment (UE) 110 is in wireless communication with a wireless network 100. A UE is a wireless, typically mobile device that can access a wireless network. The UE 110 includes one or more processors 120, one or more memories 125, and one or more transceivers 130 interconnected through one or more buses 127. Each of the one or more transceivers 130 includes a receiver, Rx, 132 and a transmitter, Tx, 133. The one or more buses 127 may be address, data, or control buses, and may include any interconnection mechanism, such as a series of lines on a motherboard or integrated circuit, fiber optics or other optical communication equipment, and the like. The one or more transceivers 130 are connected to one or more antennas 128. The one or more memories 125 include computer program code 123. The UE 110 includes a report module 140, comprising one of or both parts 140-1 and/or 140-2, which may be implemented in a number of ways. The report module 140 may be implemented in hardware as report module 140-1, such as being implemented as part of the one or more processors 120. The report module 140-1 may be implemented also as an integrated circuit or through other hardware such as a programmable gate array. In another example, the report module 140 may be implemented as report module 140-2, which is implemented as computer program code 123 and is executed by the one or more processors 120. For instance, the one or more memories 125 and the computer program code 123 may be configured to, with the one or more processors 120, cause the user equipment 110 to perform one or more of the operations as described herein. The UE

110 communicates with eNB 170 via a wireless link 111.

[0027] The gNB (NR/5G Node B but possibly an evolved NodeB) 170 is a base station (e.g., for LTE, long term evolution, or for NR, New Radio) that provides access by wireless devices such as the UE 110 to the wireless network 100. The gNB 170 includes one or more processors 152, one or more memories 155, one or more network interfaces (N/W I/F(s)) 161, and one or more transceivers 160 interconnected through one or more buses 157. Each of the one or more transceivers 160 includes a receiver, Rx, 162 and a transmitter, Tx, 163. The one or more transceivers 160 are connected to one or more antennas 158. The one or more memories 155 include computer program code 153. The gNB 170 includes a signaling module 150, comprising one of or both parts 150-1 and/or 150-2, which may be implemented in a number of ways. The signaling module 150 may be implemented in hardware as signaling module 150-1, such as being implemented as part of the one or more processors 152. The signaling module 150-1 may be implemented also as an integrated circuit or through other hardware such as a programmable gate array. In another example, the signaling module 150 may be implemented as signaling module 150-2, which is implemented as computer program code 153 and is executed by the one or more processors 152. For instance, the one or more memories 155 and the computer program code 153 are configured to, with the one or more processors 152, cause the gNB 170 to perform one or more of the operations as described herein. The one or more network interfaces 161 communicate over a network such as via the links 176 and 131. Two or more gNBs 170 communicate using, e.g., link 176. The link 176 may be wired or wireless or both and may implement, e.g., an X2 interface.

[0028] The one or more buses 157 may be address, data, or control buses, and may include any interconnection mechanism, such as a series of lines on a motherboard or integrated circuit, fiber optics or other optical communication equipment, wireless channels, and the like. For example, the one or more transceivers 160 may be implemented as a remote radio head (RRH) 195, with the other elements of the gNB 170

being physically in a different location from the RRH, and the one or more buses 157 could be implemented in part as fiber optic cable to connect the other elements of the gNB 170 to the RRH 195.

[0029] It is noted that description herein indicates that “cells” perform functions, but it should be clear that the gNB that forms the cell will perform the functions. The cell makes up part of a gNB. That is, there can be multiple cells per gNB. Each cell may contain one or multiple transmission and receiving points (TRPs).

[0030] The wireless network 100 may include a network control element (NCE) 190 that may include MME (Mobility Management Entity)/SGW (Serving Gateway) functionality, and which provides connectivity with a further network, such as a telephone network and/or a data communications network (e.g., the Internet). The gNB 170 is coupled via a link 131 to the NCE 190. The link 131 may be implemented as, for example, an S1 interface. The NCE 190 includes one or more processors 175, one or more memories 171, and one or more network interfaces (N/W I/F(s)) 180, interconnected through one or more buses 185. The one or more memories 171 include computer program code 173. The one or more memories 171 and the computer program code 173 are configured to, with the one or more processors 175, cause the NCE 190 to perform one or more operations.

[0031] The wireless network 100 may implement network virtualization, which is the process of combining hardware and software network resources and network functionality into a single, software-based administrative entity, a virtual network. Network virtualization involves platform virtualization, often combined with resource virtualization. Network virtualization is categorized as either external, combining many networks, or parts of networks, into a virtual unit, or internal, providing network-like functionality to software containers on a single system. Note that the virtualized entities that result from the network virtualization are still implemented, at some level, using hardware such as processors 152 or 175 and memories 155 and 171, and also such

virtualized entities create technical effects.

[0032] The computer readable memories 125, 155, and 171 may be of any type suitable to the local technical environment and may be implemented using any suitable data storage technology, such as semiconductor based memory devices, flash memory, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory. The computer readable memories 125, 155, and 171 may be means for performing storage functions. The processors 120, 152, and 175 may be of any type suitable to the local technical environment, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on a multi-core processor architecture, as non-limiting examples. The processors 120, 152, and 175 may be means for performing functions, such as controlling the UE 110, gNB 170, and other functions as described herein.

[0033] In general, the various embodiments of the user equipment 110 can include, but are not limited to, cellular telephones such as smart phones, tablets, personal digital assistants (PDAs) having wireless communication capabilities, portable computers having wireless communication capabilities, image capture devices such as digital cameras having wireless communication capabilities, gaming devices having wireless communication capabilities, music storage and playback appliances having wireless communication capabilities, Internet appliances permitting wireless Internet access and browsing, tablets with wireless communication capabilities, as well as portable units or terminals that incorporate combinations of such functions.

[0034] Embodiments herein may be implemented in software (executed by one or more processors), hardware (e.g., an application specific integrated circuit), or a combination of software and hardware. In an example of an embodiment, the software (e.g., application logic, an instruction set) is maintained on any one of various conventional computer-readable media. In the context of this document, a “computer-

readable medium” may be any media or means that can contain, store, communicate, propagate or transport the instructions for use by or in connection with an instruction execution system, apparatus, or device, such as a computer, with one example of a computer described and depicted, e.g., in Fig. 1. A computer-readable medium may comprise a computer-readable storage medium or other device that may be any media or means that can contain or store the instructions for use by or in connection with an instruction execution system, apparatus, or device, such as a computer.

[0035] The current architecture in LTE networks is fully distributed in the radio and fully centralized in the core network. The low latency requires bringing the content close to the radio which leads to local break out and multi-access edge computing (MEC). 5G may use edge cloud and local cloud architecture. Edge computing covers a wide range of technologies such as wireless sensor networks, mobile data acquisition, mobile signature analysis, cooperative distributed peer-to-peer ad hoc networking and processing also classifiable as local cloud/fog computing and grid/mesh computing, dew computing, mobile edge computing, cloudlet, distributed data storage and retrieval, autonomic self-healing networks, remote cloud services and augmented reality. In radio communications, using edge cloud may mean node operations to be carried out, at least partly, in a server, host or node operationally coupled to a remote radio head or base station comprising radio parts. It is also possible that node operations will be distributed among a plurality of servers, nodes or hosts. It should also be understood that the distribution of labor between core network operations and base station operations may differ from that of the LTE or even be non-existent. Some other technology advancements probably to be used are Software-Defined Networking (SDN), Big Data, and all-IP, which may change the way networks are being constructed and managed.

[0036] Having thus introduced one suitable but non-limiting technical context for the practice of the example embodiments of this invention, the example embodiments will now be described with greater specificity.

[0037] Fig. 2 illustrates an example TCI table 200 configured for a UE. Table 200 includes columns for a TCI index 210, a source RS set 220, a source RS index 230 and a QCL type 240.

[0038] For determining the transmit beam for the NR-PDCCH, each CORESET may be associated to one or multiple TCI states. In instances in which the CORESET is associated with more than one TCI state, MAC-CE level activation signalling may be used to control which one of the multiple TCI states is active at a time per CORESET. Search space set may define PDCCH monitoring related time domain parameters, such as monitoring periodicity. In other words, search space parameters may provide UE 110 information regarding when to try detecting NR-PDCCH from the particular CORESET. The CORESET defines physical time and frequency resources on which NR-PDCCH can be transmitted. Search space set related parameters associated to the CORESET may define a time domain monitoring pattern from which the UE 110 may determine when to monitor particular (for example, certain) CORESET. The UE may then determine how to set its RX beam from associated (active) TCI state of the CORESET. With regard to PDCCH beam indication, for example, a UE 110 may be configured with up to 3 CORESETs and together 10 search space sets within a configured bandwidth part (BWP).

[0039] Fig. 2 provides an exemplary TCI table 200 configured for the UE 110 in which QCL type 240 A means (for example, corresponds to) Doppler spread, Doppler shift, delay spread, average delay and QCL type 240 D means (for example, corresponds to) spatial RX. Thus, when TCI index 210 0 determines source RS(s) 220 for a particular physical signal or channel, the UE 110 may determine that it can set its RX beam as it set for receiving the SS/PBCH block #n (based on the corresponding source RS index 230). Correspondingly, when TCI index 210 1 determines source RS(s) 220 for a particular physical signal or channel, the UE 110 may determine that it can set its RX beam as it set for receiving the CSI-RS # (of RS set #B) (based on the corresponding source RS index 230).

[0040] Fig. 3 illustrates an instance in which UE 110 has been configured with two CORESETs (320, 330) with one or multiple TCI state associations. For the CORESET #0 320, MAC-CE signalling may be used to activate 350 one TCI state at a time (configured TCU state 340, 0 is active 350, Yes, while the remaining states 340, 1 and 5, are not active (active 350, no)). For CORESET #1 320, the configured TCI state M-1 is active. M-1 is a TCI state index that defines the table size as a variable M.

[0041] For PDSCH beam indication, three implementation options are available as shown with regard to Figs. 4, 5, and 6.

[0042] As described with respect to Fig. 4, a default mode 400 for PDSCH beam indication is shown. The slots 410 may receive PDCCH transmitted 430, PDSCH transmitted 440 and time domain resource allocation for PDSCH 450. PDCCH (particularly, Downlink Control Info (DCI) transmitted in PDCCH) provides resource allocation for PDSCH. One component is time domain resource allocation where PDCCH gives the starting slot index (and symbol index within the slot) where PDSCH allocation starts. Starting slot is counted from the PDCCH. For example, slot allocation may indicate that PDSCH start in slot n+2 where PDCCH (providing slot allocation) is transmitted in slot n.

[0043] PDSCH beam indication method may be controlled by a higher layer parameter (for example, TCI-PresentInDCI) and the offset (threshold-sched-offset 460) between the reception of the DL DCI and the corresponding PDSCH. TCI-PresentInDCI may be configured per CORESET. If TCI-PresentInDCI is set as 'Disabled' for the CORESET scheduling the PDSCH or the PDSCH is scheduled by a DCI format 1_0, TX beam 420 for PDSCH may be the same as for the PDCCH. DCI format 1_0 is a compact or fallback downlink control info (DCI) format to schedule, for example, PDSCH. There is no TCI state index field in format 1_0 that can be found from 1_1 format.

[0044] As described with respect to Fig. 5, a dynamic mode 500 that may allow

different TX beam 510 (for example, more narrow, different TRP, etc.) for PDSCH (than the TX beam 420 for PDCCH) is shown. The slots 410 may receive PDCCH transmitted 430, PDSCH transmitted 440 and time domain resource allocation for PDSCH 450.

[0045] If the TCI-PresentinDCI is set as 'Enabled' and time offset between the reception of the DL DCI and the corresponding PDSCH may be equal to or greater than a threshold Threshold-Sched-Offset 460, TX beam 510 for PDSCH may be indicated by TCI index in DCI. For example, the threshold may include numbers 1 and 2 slots (for example, 120 kHz SCS). There will be a threshold for time between PDCCH and PDSCH. For example, assuming threshold is 2 slots. If PDSCH is coming 1 slot after PDCCH a default TX beam is applied for PDSCH. If PDSCH is coming 3 slots after PDCCH (greater than threshold) the PDSCH is applied the transmit beam which is indicated by TCI index in PDCCH DCI

[0046] As described with respect to Fig. 6, a fallback mode 600 with one CORESET and in case PDSCH follows PDCCH equals to Default mode is shown. The slots 410 may receive PDCCH transmitted 430, PDSCH transmitted 440 and time domain resource allocation for PDSCH 450.

[0047] If the TCI-PresentinDCI is set as 'Enabled'/'Disabled' and time offset between the reception of the DL DCI and the corresponding PDSCH is less than a threshold Threshold-Sched-Offset 460, TX beam 610 for PDSCH may correspond to PDCCH TX beam 420 of the lowest CORESET-ID in the latest slot in which one or more CORESETs are configured for the UE 110.

[0048] The controlling parameter Threshold-Sched-Offset 460 may be a predetermined parameter, for example Threshold-Sched-Offset 460 may be one or two slots assuming 120 kHz SCS. In such instances, the threshold for dynamic beam indication for PDSCH may be around 125-250 microseconds. For example, when PDSCH is scheduled after one or two slots later than PDCCH, the PDSCH may be

transmitted with different transmit beam than the PDCCH.

[0049] Referring to Fig. 7 an example TCI table 700 configured for the UE 110. Table 700 includes columns for a TCI index 210, a source RS set 220, a source RS index 230 and a QCL type 240.

[0050] In one possible implementation, the gNB 170 may configure a TCI table 700 for the UE 110 where the states may be associated to source RSs measured by different UE 110 RX panel (source RS index / panel index 710). Tag may in general mean a set of receive spatial filters the UE 110 may be able to use simultaneously. UE 110 may “earmark” beam reports on certain transmit beams with a certain tag which it can receive simultaneously (or is willing to receive simultaneously). UE 110 may have only one panel at a time and it needs to switch from one panel to another when doing measurements over all the panels. In this case the tag would refer to one panel. UE 110 may be able to use two panels at a time could use the same tag for both panels, for example, tag would refer to what UE 110 may measure simultaneously. UE 110 may determine whether it will report tag per panel or tag per panel group (if UE 110 may be able to use multiple panels at a time).

[0051] Tag may be defined as a set of RX beams among which the beam switch doesn't require any additional delay (can be handled, for example, within a Cyclic prefix in OFDM (CP) in OFDM modulation. CP may be used to account channel delay spread). To build gNB 170 awareness of which panels UE 110 would use to receive certain transmit beams, the UE 110 may have provided gNB 170 beam reports indicating with panel tag which panel is used for measuring certain beam management (BM) source RS. Beam management may provide a framework used for beam indication, beam reporting for downlink and uplink signals and channels, etc. Tag may be omitted by the UEs 110 capable of receiving simultaneously with all the panels. When activating particular source RS for the CORESET, the UE 110 may determine that only TCI states sharing the same tag with the activated source RS for the CORESET can be used for PDSCH beam

indication provided by DCI in PDCCH of the CORESET and, for example, for semi-persistent CSI-RS beam indication. Consequently, UE 110 may deactivate TCI states of which source RSs are not sharing the same tag and the UE 110 may deactivate semi-persistent resource (if such semi-persistent resource exists) if the source RS doesn't share the same tag. This implicit UE 110 behaviour based on reported tag(s) may be configurable. For example, the UE 110 behavior may be implicit without configuration from gNB 170 to use the behavior, or, alternatively, UE 110 behavior may require first configuration from gNB 170.

[0052] Fig. 7 illustrates an example of the configured TCI table 700 in which the proposed panel tag may be provided at the panel indexes 710 corresponding to TCI index 210, 1 for QCL types 240 A, and D (shown, by way of illustration in Fig. 7 as TRS #b (of set #B) | panel#n, and CSI-RS #c (of set #B) | panel#m, respectively.

[0053] Panel tag may be configured, for example, to all TCI states or only to TCI states that have QCL type D configured. Each TCI state (with QCL type D) may have a panel tag/index which may be same or different (for example, same tag may mean that UE 110 can receive transmit beams defined by TCI states having same tag using the same receive panel (tag)). Different tag for TCI states may mean that UE 110 is required to have different panels to receive transmit beams defined by TCI states.

[0054] If the UE 110 is configured with a CSI-ReportConfig with the higher layer parameter ReportQuantity set to 'CRI/RSRP' or SS/PBCH block Resource index (SSBRI)/RSRP.

[0055] if the UE 110 is configured with the higher layer parameter group-based-beam-reporting set to 'OFF', the UE 110 may not be required to update measurements for more than 64 [CSI-RS and or SSB] resources, and the UE 110 may (or alternately may have to) report in a single report nrofReportedRS (number of reported RS, higher layer configured) different [CRI or SSBRI (SSB Resource Indicator)] for each report setting

and the corresponding Rx-panel-tag.

[0056] if the UE 110 is configured with the higher layer parameter group-based-beam-reporting set to 'ON', the UE 110 may not be required to update measurements for more than 64 [CSI-RS and or SSB] resources, and the UE 110 may report in a single reporting instance two different resources [CRI or SSBRI] for each report setting and the corresponding receiver panel tag (Rx-panel-tag.), where [CSI-RS and or SSB] resources may be received simultaneously by the UE 110 either with a single spatial domain receive filter, or with multiple simultaneous spatial domain receive filters. UE 110 may report in a single reporting instance multiple resources which may be both CSI-RS resources indexed using CRI (CSI-RS resource indicator) and SSB resources indexed using SSBRI for each report setting and the corresponding RX panel tag where resources may be received simultaneously.

[0057] Example embodiments may be provided with regard to features of NR, such as x.y.z beam management and UE 110 power saving. UE 110 may be configured to provide group based beam reports where the UE 110 indicates within a beam report on which RX panel the UE 110 has measured the configured beam management RSs (SSB or CSI-RS). Based on the received beam report, the gNB 170 may be able to optimize the TCI configuration and set of activated TCI states so that UE 110 is able to operate with minimum number of panels at a time without sacrificing performance.

[0058] According to example embodiments, specified beam indication and reporting functionality may not support UEs 110 with limited beamforming capabilities, for example as described herein above. For example, limited beamforming capabilities UEs 110 may include UEs 110 that may have less TXRUs than antenna panels or UE 110 that may operate with subset of active TXRUs and panels for power saving reasons. gNB 170 may not be aware of the UE's 110 receive panel per each beam report (beam measurement on configured SSB or CSI-RS resource for beam management measurement). Thus, gNB 170 may be required to operate based on a worst case

assumption always that UE 110 needs to activate/switch to alternative panel. As discussed, this activation may take several milliseconds and taking it into account always delays the beam switch procedure, meaning potentially lower user throughput or disruption in communication. Additionally, from UE 110 perspective, the UE 110 may need to have all the panels active that have been used to measure any source RS configured in the TCI table. Consequently, UE 110 may have low possibility to switch off the panels for power saving without sacrificing the performance.

[0059] The example embodiments provide beam indication and reporting functionality that support UEs 110 with limited beamforming capabilities. For example, as MAC-CE signalling is used to activate TCI states, for example, for PDCCH and PDSCH, and if the assumed latency between the MAC-CE command (or HARQ-ACK sent to PDSCH carrying the command) and time when the command is in effect is at least as long as the lead time at UE to switch on the panel, a TCI framework may be able to provide some level of power saving possibilities for the UE 110. However, there may be a risk that if the latency is agreed to be long, for example a few microseconds to tens of microseconds, dynamic beam switch for PDCCH, PDSCH (for example, a set of source RSs that may be indicated), semi-persistent CSI-RS and PUCCH may not be possible and thus support for mobility even with moderate speed may not be supported.

[0060] Example embodiments may provide efficient power saving possibilities for the UE 110 to compensate for the power consumption of active TXRUs and panels, for example, at the very wide bandwidths above 6 GHz when compared to below 6 GHz operation.

[0061] According to an example embodiment, available source RSs in spatial QCL sense (QCL type-D) for downlink beam indication may be determined by a spatial QCL mask which validates source RSs that may be inherited in spatial QCL sense from activated source RS of the active CORESET.

[0062] In another example embodiment, available source RSs in spatial QCL sense (QCL type-D) for downlink beam indication may be the ones that are reported with the same tag as the activated source RSs of the active CORESET where the tag corresponds to a particular UE 110 panel. Simultaneously without switching delay, for example, tag may be defined as a set of RX beams among which the beam switch doesn't require any additional delay. The active source RS of the active CORESET may determine the set of available TCI states. There may be multiple active CORESETs and thus the available source RSs under each source RS of the CORESET may be disjoint set of source RSs, partially overlapping set of RSs or the same set of RS.

[0063] Referring to Fig. 8, an example TCI table 800 configured for the UE 110. Table 800 includes columns for a TCI index 210, a source RS set 220, a source RS index 230, a QCL type 240, a TCI mask #1 810 and a TCI mask #2 820.

[0064] According to an example embodiment gNB 170 may configure a TCI table 800 for the UE 110 and also corresponding masks (for example, TCI mask #1 810 and a TCI mask #2 820) that indicate to the UE 110 which TCI index maybe applied for PDSCH scheduling (of PDCCH). TCI table may be configured by gNB 170 using RRC level signaling. TCI mask may include a process to "activate" particular TCI states that are associated to particular UE 110 panel tag / index. Where the TCI masking process is applied, other TCI states in the TCI table UE 110 maybe assumed to be deactivated. UE 110 may be configured with multiple masks, such as illustrated in Fig. 8, which may be set to be active. For a given mask sub-set of the TCI index may be set to 'inactive' (=0) so that UE 110 can assume it will not be scheduled using those TCI signals (and hence UE 110 may, in instances in which UE 110 selects a particular option, for example for power saving purposes, deactivate those antenna panels or other hardware required to reception of corresponding (reference) signals.). Network 110 may, either via MAC-CE or RRC signalling activate/deactivate selected TCI Mask(s). Alternatively the activation may be done, implicitly based on PDCCH scheduling, by using TCI index associated to a given mask.

[0065] In one example implementation aspect, UE 110 may indicate a subset of panels that UE 110 may be able to activate at the same time, for example, in instances UE 110 has panels #1, 2, 3, 4 it may indicate the combination of active panels for example, 1, and 2 or 3, and 4 or in any combination. This signaling may provide an additional indication to panel tag. In one alternative example, if UE 110 is configured to always activate the same subset of panels for measurement, UE 110 may indicate the subset of panels, for example, 2 panels under the same panel tag. In other words, the UE 110 may be configured to determine how (for example, in a particular arrangement) to group beam reports.

[0066] Further, UE 110 may be provided with information for example, in a form of masks (for example, TCI mask #1 810 and a TCI mask #2 820) on the configured TCI indexes, which UE 110 may be prepared to receive. For example, a set of possible TCI indexes that UE 110 is to expect (for example, is configured to receive) may be indicated, for example, in DCI. The TCI mask may be based on the UE 110 selected grouping of receive spatial filters where the spatial filter may be one panel or multiple panels, for example, two panels.

[0067] In an example dependent embodiment for the above example embodiments, based on grouped beam reports, the gNB 170 may transmit to UE 110 a triggering signal for preparation of change of TCI applicable TCI states from one tag to another tag, or for preparation of update of set of tags defining the available source RSs / TCI states for beam indication.

[0068] The triggering signal may provide a direction to switch on UE 110 panel that is to be used to receive downlink signals after certain time. This may be implemented using MAC-CE activation command and there may be two application delays defined. One application delay may be defined for the case when activated source RS belongs to a set of source RSs currently active. This application delay may be shorter.

The other application delay may be defined for the case when an activated source RS doesn't belong to a set of source RSs currently active. This application delay may be longer than the application delay for the case when activated source RS belongs to a set of source RSs currently active. This application delay may be used for UEs 110 that are able to run simultaneously multiple panels but for power saving purpose keep some of the panels switched off when possible.

[0069] Fig. 9 is an example flow diagram 900 illustrating a method in accordance with example embodiments which may be performed by an apparatus.

[0070] At block 910, UE 110 may provide beam reports to gNB 170 indicating with panel tag which panel is used for measuring particular BM source RS. Tag can be omitted by the UEs 110 capable of receiving simultaneously with all the panels.

[0071] At block 920, UE 110 may be configured, for example by gNB 170, with a TCI table for the UE 110 in which the states may be associated to source RSs measured by different UE 110 RX panel, such as table 700, described with respect to Fig. 7 herein above.

[0072] At block 930, when activating certain source RS for the CORESET, UE 110 may determine that only TCI states sharing the same tag with the activated source RS for the CORESET can be used for PDSCH beam indication provided by DCI in PDCCH of the CORESET and, for example, for semi-persistent CSI-RS beam indication. .

[0073] At block 940, UE 110 may de-activate TCI states of which source RSs are not sharing the same tag and the UE 110 may de-activate semi-persistent resource (if such exists) if the source RS doesn't share the same tag.

[0074] Fig. 10 is an example flow diagram 1000 illustrating a method in accordance with example embodiments which may be performed by an apparatus.

[0075] At block 1010, UE 110 may be configured, for example by gNB 170, with a TCI table for the UE 110 in which corresponding masks indicate to the UE 110 which TCI index maybe applied for PDSCH scheduling (of PDCCH), such as table 800, illustrated in Fig. 8. UE 110 may be configured with multiple masks that may be set to be active.

[0076] At block 1020, UE 110 may receive signalling to set to 'inactive' (=0) a given mask sub-set of the TCI index can be so that UE 110 may assume that it will not be scheduled using those TCI signals.

[0077] At block 1030, UE 110 may, if it so chooses, for example for power saving purposes, deactivate those antenna panels or other hardware required to reception of corresponding (reference) signals.

[0078] At block 1040, UE 110 may receive from the network 100, either via MAC-CE or RRC signalling, instructions to activate/deactivate selected TCI Mask(s). Alternatively the activation may be done, implicitly based on PDCCH scheduling, by using TCI index associated to a given mask.

[0079] Figs. 9 and 10 provide example embodiment of UE panel aware active TCI state determination based on UE panel based beam reporting.

[0080] Fig. 11 shows an example illustration 1100 of UE beams in the presence of a user 1110.

[0081] As shown in Fig. 11, there is a maximum radiated power allowed by safety emission limit 1120 may be determined based on the Equivalent Isotropically Radiated Power (EIRP). The safe EIRPO level (for a user 11100 is a function of UE 110 position relative to the user 1110, UE 110 beam direction and side-lobe levels and user proximity.

UE beams may radiate in all directions 1130 (in the presence of the user).

[0082] According to an example embodiment, a separate beam reporting may be considered for determining feasible transmit beams at gNB 170 for downlink transmission between gNB 170 and UE 110 and feasible transmit beams at UE 110 for uplink transmission between UE 110 and gNB 170 where determining is based on downlink reference signals corresponding to transmit beams and receive beams at gNB 170. That is assuming that UE 110 is able to determine transmit beam from receive beam. The reason for separate beam reporting for determining feasible “downlink beam pair links” and feasible “uplink beam pair links”, where downlink beam pair link consist of transmit beam at gNB and receive beam at UE and uplink beam pair link consist of transmit beam at UE 110 and receive beam at gNB 170, is a possible issue related to emission safety at UE 110 when UE 110 transmitter uses beam forming.

[0083] The basic problem as illustrated in Fig. 11, is that certain UE 110 beams may be directed towards the head/body of the user 1110, resulting risk of exceeding the said emission limits. That may lead to a problem that the same beam pair link may not be always available for downlink and uplink. In other words, some downlink beam pair link may provide very strong connection while using the same beam pair link for uplink may not provide strong connection because the UE 110 may be forced to limit its transmission power due to emission limit to the direction of beam pair link in uplink.

[0084] Fig. 12 shows an example illustration 1200 of DL RS beams and UE beams.

[0085] As illustrated in Fig. 12, certain gNB 170 TX beams (for example, from TRP1 1210-1 and TRP2 1210-2) represented as DL RSs beams 1220 may have human body 1110 as a blocker between the gNB 170 TX and corresponding (UE) 110 RX beam 1230. Depending on the propagation conditions, these beams could still have good observed RSRP (for example, even when assuming body loss of 3dB) resulting low

pathloss (PL) estimate. Due to UE 110 requiring additional maximum power reduction (MPR), P-MPR, to meet the emission related requirements (for example, electromagnetic energy absorption requirements), the actual achievable PL for a given UL resource allocation will be reduced compared to the level that could be estimated based on the DL RSRP.

[0086] Figs. 13(a) and (b) show example illustrations 1300 of measured RSRP (a) 1310 and PHR (b) 1320 accounting the MPR required to meet emission requirements.

[0087] Hence, as illustrated in Fig. 13 (a) (following from the discussion regarding Fig. 12, herein above), the measured RSRP of RS set A and F would be the best ($F > A$), even when accounting for human body loss (for example, 3 to 5dB) while the RSRP obtained based on other RS sets would be lower due to non-optimal beam alignment (for example, beam gain to the direction of the RS).

[0088] However, as illustrated by Fig. 13 (b) the power headroom (PHR) accounting both the PL estimate (based on RSRP) and the UE 110 determined configured maximum output power (including the effect of P-MPR), the order of superiority of the beams may be changed. For example, assuming that for RS set A and F UE 110 may be required to restrict the maximum transmit power significantly (apply P-MPR) to comply with electromagnetic energy absorption requirements (emission limits), the RS set E would be best from UL perspective.

[0089] Fig. 14 shows an example illustration of a DL RS beams and UE beams, where beams are spatially overlapping. For example, RS beams may be heard in multiple RX beams.

[0090] In Fig. 14 illustrate an example scenario in which a same DL RS can be heard through multiple UE 110 RX beams, resulting possibly different RSRP and PHR value pairs.

[0091] In a certain sense this may be seen as a problem of reciprocity introduced in dynamic manner by 'non-reciprocal' blocker. In other words, a problem of reciprocity introduced is separate from transmit and receive beam correspondence (means that UE 110 can determine TX beam from its RX beam) / non-beam-correspondence at the UE 110 in the sense that now UE's 110 TX beam can be determined still from DL RS (beam correspondence at UE 110) but the best / possible UE 110 TX beams may not be corresponding to RX beams used to receive best DL TX beams.

[0092] One possible way to determine suitable UL transmit (TX) beams (and uplink beam pair links), which would be required for UEs 110 not able to determine transmit (TX) beams from receive (RX) beams, would be to configure UE 110 with multiple uplink sounding reference signals (SRS) resources for which the UE 110 can try different TX beams and the gNB 170 based on measurements from SRS transmissions would determine the best SRS resources and thus best TX beams to be used in UL. However, from system operation point of the view, the use of SRSs for beam management is seen as a significant overhead. Thus, it's considered that beam management related operations for both DL and UL directions at both gNB 170 and UE 110 should be performed only based on DL RSs (thus requiring UEs 110 to have beam correspondence capability as well).

[0093] Additional example embodiments may be used to determine separately downlink and uplink beam pair links. The UE 110 may be configured to provide beam reports separately to indicate which downlink RSs are good to determine feasible downlink beam pair links and which downlink RSs are good to determine feasible uplink beam pair links:

[0094] According to an example embodiment, for determining which downlink RSs are good to determine feasible downlink beam pair links, the UE may be configured normal L1-RSRP reporting calculated on configured SS/PBCH and/or CSI-RS resources.

[0095] According to an example embodiment, for determining which downlink RSs are good to determine feasible uplink beam pair links, the UE may be configured to provide L1-RSRP reports for the configured SS/PBCH and/or CSI-RS resources which are best from uplink beam pair link determination point of view.

[0096] According to an example embodiment, the UE may be configured for determining which downlink RSs are good to determine feasible uplink beam pair links can be based on, for example, UE's 110 calculation of power headroom for each configured downlink RS for measurement (where power headroom indicates how much transmission power is left for a UE 110 to use in addition to the power being used by the transmission in UL and where power headroom calculation is expected to take into account also reduction in transmission power due to regulated emission limits among other power reductions). UE 110 may be configured with (and/or, in some instances to determine) parameters such as a reference transmission bandwidth and target transmit power for a bandwidth unit based on which the UE 110 may calculate the power headroom.

[0097] The UE may rank the DL RSs conditioned on virtual power headroom per DL RS, for example, the best ones may be the ones which have the highest power headroom calculated.

[0098] In addition, the UE 110 may provide together with the best RSRP values ranked using power headroom calculations the UE's RX panel index to indicate the gNB 170 which UE's 110 antenna panel has been used to measure reported best RSRP values in power headroom sense. That may assist gNB 170 to optimize beam indication for both DL and UL in a way that UE 110 is needed to use always minimum number of panels at a time to save power at the UE 110.

[0099] In another example embodiment to determine possible different beam pair

links to downlink and uplink, in case the UE 110 is not able to transmit on the UL TX beam associated with the best DL RS based on calculated L1-RSRP value, the UE 110 may indicate to the gNB 170 the existence of the UL beam (for example, DL RSs having good L1-RSRP value and thus being good downlink beam pair link) which cannot be used. This may trigger gNB 170 to allocate UE 110 with multiple UL resources to provide UE 110 with more opportunities for UL transmission to the direction allowing enough high TX power. Resource allocation may include downlink RSs as source RSs for the UE 110 to determine possible TX beams and similarly the gNB 170 is able to determine its RX beam for the reception on each UL resource.

[00100] Without in any way limiting the scope, interpretation, or application of the claims appearing below, a technical effect of one or more of the example embodiments disclosed herein is that to enable controlled means for gNB 170 to enable power saving at UE 110 in terms of which panels UE 110 may be required to have active at a time. Another technical effect is that the gNB 170 is able to make transmit beam selection so that UE 110 power consumption may be improved compared to functionality that is not aware how many panels need to keep active at a time, for example, pure Rel15 preceding functionality. Another technical effect is that gNB 170 may optimize use of UE's 110 panels by, for example, aiming at activating TCI states that require minimum number of UE 110 panels active at a time.

[00101] An example embodiment may provide a method comprising providing, from a user device, at least one beam report to a base station indicating a particular panel tag to use for measuring a particular beam management source reference signal, receiving, by the user device, from the base station, configuration of a transmission configuration indication table for the user device, wherein the configuration is based on the at least one beam report and states are associated to at least one source reference signal measured by at least one receiver panel of the user device, and determining, when activating at least one particular source reference signal for the control resource set, that only transmission configuration indication states sharing a same tag with an activated at least one source reference signal for a control resource set are to be used for physical

downlink shared channel beam indication.

[00102] In accordance with the example embodiments as described in the paragraphs above, deactivating at least one transmission configuration indication state of which the at least one source reference signal do not share the same tag.

[00103] In accordance with the example embodiments as described in the paragraphs above, wherein each tag includes an indication of a set of spatial filters that the user device is able to use simultaneously.

[00104] In accordance with the example embodiments as described in the paragraphs above, omitting, by the user device, the particular panel tag, wherein the user device is capable of receiving simultaneously with all at least one receiver panel of the user device.

[00105] In accordance with the example embodiments as described in the paragraphs above, deactivating at least one semi-persistent resource if the at least one source reference signal does not share the same tag.

[00106] In accordance with the example embodiments as described in the paragraphs above, determining whether the user device is configured with a higher layer parameter group-based-beam-reporting set to off; and providing a configuration that the user device is only required to update measurements for a predetermined number of different resources for each report setting in response to a determination that the user device is configured with the higher layer parameter group-based-beam-reporting set to off.

[00107] In accordance with the example embodiments as described in the paragraphs above, determining whether the user device is configured with a higher layer parameter group-based-beam-reporting set to on; and providing a configuration that the user device is only required to update measurements for a predetermined number of resources.

[00108] In accordance with the example embodiments as described in the paragraphs above, wherein the user device is configured to report in a single reporting instance two different resources for each report setting and corresponding receiver panel.

[00109] In accordance with the example embodiments as described in the paragraphs above, wherein the user device is configured to receive resources simultaneously by at least one of a single spatial domain receive filter, and multiple simultaneous spatial domain receive filters.

[00110] In accordance with the example embodiments as described in the paragraphs above, wherein the user device is configured provide group based beam reports that indicate on which receiver panel the user device has measured a configured beam management reference signals.

[00111] An example embodiment may provide a method comprising receiving configuration of a transmission configuration indication table, receiving configuration of transmission configuration indication at least one corresponding mask, wherein the at least one corresponding transmission configuration indication mask indicates which transmission configuration indication index is applicable for physical downlink shared channel scheduling of a physical downlink control channel; and deactivating at least one antenna panels required for reception of at least one corresponding reference signal.

[00112] In accordance with the example embodiments as described in the paragraphs above, receiving a signal deactivating at least one selected transmission configuration indication mask.

[00113] In accordance with the example embodiments as described in the paragraphs above, determining activation based on physical downlink control channel scheduling, by using a particular transmission configuration indication index associated to a particular at least one transmission configuration indication mask.

[00114] In accordance with the example embodiments as described in the paragraphs above, indicating a subset of panels that the user device is capable of activating at a same time.

[00115] An example embodiment may be provided in an apparatus comprising at least one processor; and at least one non-transitory memory including computer program code, the at least one memory and the computer program code may be configured to, with the at least one processor, cause the apparatus to: provide at least one beam report to a base station indicating a particular panel tag to use for measuring a particular beam management source reference signal, receive from the base station, configuration of a transmission configuration indication table for the user device, wherein the configuration is based on the at least one beam report and states are associated to at least one source reference signal measured by at least one receiver panel of the user device, and determine, when activating at least one particular source reference signal for the control resource set, that only transmission configuration indication states sharing a same tag with an activated at least one source reference signal for a control resource set are to be used for physical downlink shared channel beam indication.

[00116] In accordance with the example embodiments as described in the paragraphs above, deactivating at least one semi-persistent resource if the at least one source reference signal does not share the same tag.

[00117] In accordance with the example embodiments as described in the paragraphs above, deactivating at least one transmission configuration indication state of which the at least one source reference signal do not share the same tag.

[00118] In accordance with the example embodiments as described in the paragraphs above, wherein each tag includes an indication of a set of spatial filters that the apparatus is able to use simultaneously.

[00119] In accordance with the example embodiments as described in the paragraphs above, omitting the particular panel tag, wherein the apparatus is capable of receiving simultaneously with all at least one receiver panel of the apparatus.

[00120] In accordance with another example, an example apparatus comprises: means for providing at least one beam report to a base station indicating a particular panel tag to use for measuring a particular beam management source reference signal, means for receiving configuration of transmission configuration indication at least one corresponding mask, wherein the at least one corresponding transmission configuration indication mask indicates which transmission configuration indication index is applicable for physical downlink shared channel scheduling of a physical downlink control channel; and means for deactivating at least one antenna panels required for reception of at least one corresponding reference signal.

[00121] Embodiments herein may be implemented in software (executed by one or more processors), hardware (e.g., an application specific integrated circuit), or a combination of software and hardware. In an example embodiment, the software (e.g., application logic, an instruction set) is maintained on any one of various conventional computer-readable media. In the context of this document, a “computer-readable medium” may be any media or means that can contain, store, communicate, propagate or transport the instructions for use by or in connection with an instruction execution system, apparatus, or device, such as a computer, with one example of a computer described and depicted, e.g., in Fig. 1. A computer-readable medium may comprise a computer-readable storage medium (e.g., memories 125, 155, 171 or other device) that may be any media or means that can contain, store, and/or transport the instructions for use by or in connection with an instruction execution system, apparatus, or device, such as a computer. A computer-readable storage medium does not comprise propagating signals.

[00122] If desired, the different functions discussed herein may be performed in a different order and/or concurrently with each other. Furthermore, if desired, one or more of the above-described functions may be optional or may be combined.

[00123] Although various aspects are set out above, other aspects comprise other combinations of features from the described embodiments, and not 'solely the combinations described above.

[00124] It is also noted herein that while the above describes example embodiments, these descriptions should not be viewed in a limiting sense. Rather, there are several variations and modifications which may be made without departing from the scope of the present invention.

[00125] Although various aspects of the invention are set out in the independent claims, other aspects of the invention comprise other combinations of features from the described embodiments and/or the dependent claims with the features of the independent claims, and not solely the combinations explicitly set out in the claims.

[00126] It is also noted herein that while the above describes example embodiments, these descriptions should not be viewed in a limiting sense. Rather, there are several variations and modifications which may be made without departing from the scope of the present invention as defined in the appended claims.

[00127] In general, the various embodiments may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. For example, some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device, although the invention is not limited thereto. While various aspects of the invention may be illustrated and described as block diagrams, flow charts, or using some other pictorial representation, it is well understood that these blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting

examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[00128] Embodiments may be practiced in various components such as integrated circuit modules. The design of integrated circuits is by and large a highly automated process. Complex and powerful software tools are available for converting a logic level design into a semiconductor circuit design ready to be etched and formed on a semiconductor substrate.

[00129] The word "exemplary" is used herein to mean "serving as an example, instance, or illustration." Any embodiment described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments. All of the embodiments described in this Detailed Description are exemplary embodiments provided to enable persons skilled in the art to make or use the invention and not to limit the scope of the invention which is defined by the claims.

[00130] The foregoing description has provided by way of example and non-limiting examples a full and informative description of the best method and apparatus presently contemplated by the inventors for carrying out the invention. However, various modifications and adaptations may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings and the appended claims. However, all such and similar modifications of the teachings of this invention will still fall within the scope of this invention.

[00131] It should be noted that the terms "connected," "coupled," or any variant thereof, mean any connection or coupling, either direct or indirect, between two or more elements, and may encompass the presence of one or more intermediate elements between two elements that are "connected" or "coupled" together. The coupling or connection between the elements can be physical, logical, or a combination thereof. As employed herein two elements may be considered to be "connected" or "coupled"

together by the use of one or more wires, cables and/or printed electrical connections, as well as by the use of electromagnetic energy, such as electromagnetic energy having wavelengths in the radio frequency region, the microwave region and the optical (both visible and invisible) region, as several non-limiting and non-exhaustive examples.

[00132] Furthermore, some of the features of the preferred embodiments of this invention could be used to advantage without the corresponding use of other features. As such, the foregoing description should be considered as merely illustrative of the principles of the invention, and not in limitation thereof.

CLAIMS

What is claimed is:

1. A method, comprising:
 - providing, from a user device, at least one beam report to a base station indicating a particular panel tag to use for measuring a particular beam management source reference signal;
 - receiving, by the user device, from the base station, configuration of a transmission configuration indication table for the user device, wherein the configuration is based on the at least one beam report and states are associated to at least one source reference signal measured by at least one receiver panel of the user device; and
 - determining, when activating at least one particular source reference signal for the control resource set, that only transmission configuration indication states sharing a same tag with an activated at least one source reference signal for a control resource set are to be used for physical downlink shared channel beam indication.
2. The method of claim 1, further comprising:
 - deactivating at least one transmission configuration indication state of which the at least one source reference signal do not share the same tag.
3. The method according to any of claims 1 to 2, wherein each tag includes an indication of a set of spatial filters that the user device is able to use simultaneously.
4. The method according to any of claims 1 to 3, further comprising:
 - omitting, by the user device, the particular panel tag, wherein the user device is capable of receiving simultaneously with all at least one receiver panel of the user device.

5. The method according to any of claims 1 to 4, further comprising:
deactivating at least one semi-persistent resource if the at least one source reference signal does not share the same tag.
6. The method according to any of claims 1 to 5, further comprising:
determining whether the user device is configured with a higher layer parameter group-based-beam-reporting set to off; and
providing a configuration that the user device is only required to update measurements for a predetermined number of different resources for each report setting in response to a determination that the user device is configured with the higher layer parameter group-based-beam-reporting set to off.
7. The method according to any of claims 1 to 6, further comprising:
determining whether the user device is configured with a higher layer parameter group-based-beam-reporting set to on; and
providing a configuration that the user device is only required to update measurements for a predetermined number of resources.
8. The method of claim 7, wherein the user device is configured to report in a single reporting instance two different resources for each report setting and corresponding receiver panel.
9. The method of claim 7, wherein the user device is configured to receive resources simultaneously by at least one of a single spatial domain receive filter, and multiple simultaneous spatial domain receive filters.
10. The method according to any of claims 1 to 9, wherein the user device is configured provide group based beam reports that indicate on which receiver panel the user device has measured a configured beam management reference signals.

11. A method, comprising:
 - receiving configuration of a transmission configuration indication table;
 - receiving configuration of transmission configuration indication at least one corresponding mask, wherein the at least one corresponding transmission configuration indication mask indicates which transmission configuration indication index is applicable for physical downlink shared channel scheduling of a physical downlink control channel; and
 - deactivating at least one antenna panels required for reception of at least one corresponding reference signal.
12. The method of claim 11, further comprising:
 - receiving a signal deactivating at least one selected transmission configuration indication mask.
13. The method according to any of claims 11 to 12, further comprising:
 - determining activation based on physical downlink control channel scheduling, by using a particular transmission configuration indication index associated to a particular at least one transmission configuration indication mask.
14. The method according to any of claims 11 to 13, further comprising:
 - indicating a subset of panels that the user device is capable of activating at a same time.
15. An apparatus, comprising:
 - means for providing at least one beam report to a base station indicating a particular panel tag to use for measuring a particular beam management source reference signal;
 - means for receiving from the base station, configuration of a transmission configuration indication table for the apparatus, wherein the configuration is based on the at least one beam report and states are associated to at least one source reference

signal measured by at least one receiver panel of the apparatus; and

means for determining, when activating at least one particular source reference signal for the control resource set, that only transmission configuration indication states sharing a same tag with an activated at least one source reference signal for a control resource set are to be used for physical downlink shared channel beam indication.

16. The apparatus of claim 15, further comprising:

deactivating at least one transmission configuration indication state of which the at least one source reference signal do not share the same tag.

17. The apparatus according to any of claims 15 to 16, wherein each tag includes an indication of a set of spatial filters that the apparatus is able to use simultaneously.

18. The apparatus according to any of claims 15 to 17, further comprising:

means for omitting the particular panel tag, wherein the apparatus is capable of receiving simultaneously with all at least one receiver panel of the apparatus.

19. The apparatus according to any of claims 15 to 17, further comprising:

deactivating at least one semi-persistent resource if the at least one source reference signal does not share the same tag.

20. An apparatus, comprising:

means for receiving configuration of a transmission configuration indication table;

means for receiving configuration of transmission configuration indication at least one corresponding mask, wherein the at least one corresponding transmission configuration indication mask indicates which transmission configuration indication index is applicable for physical downlink shared channel scheduling of a physical downlink control channel; and

means for deactivating at least one antenna panels required for reception of at least one corresponding reference signal.

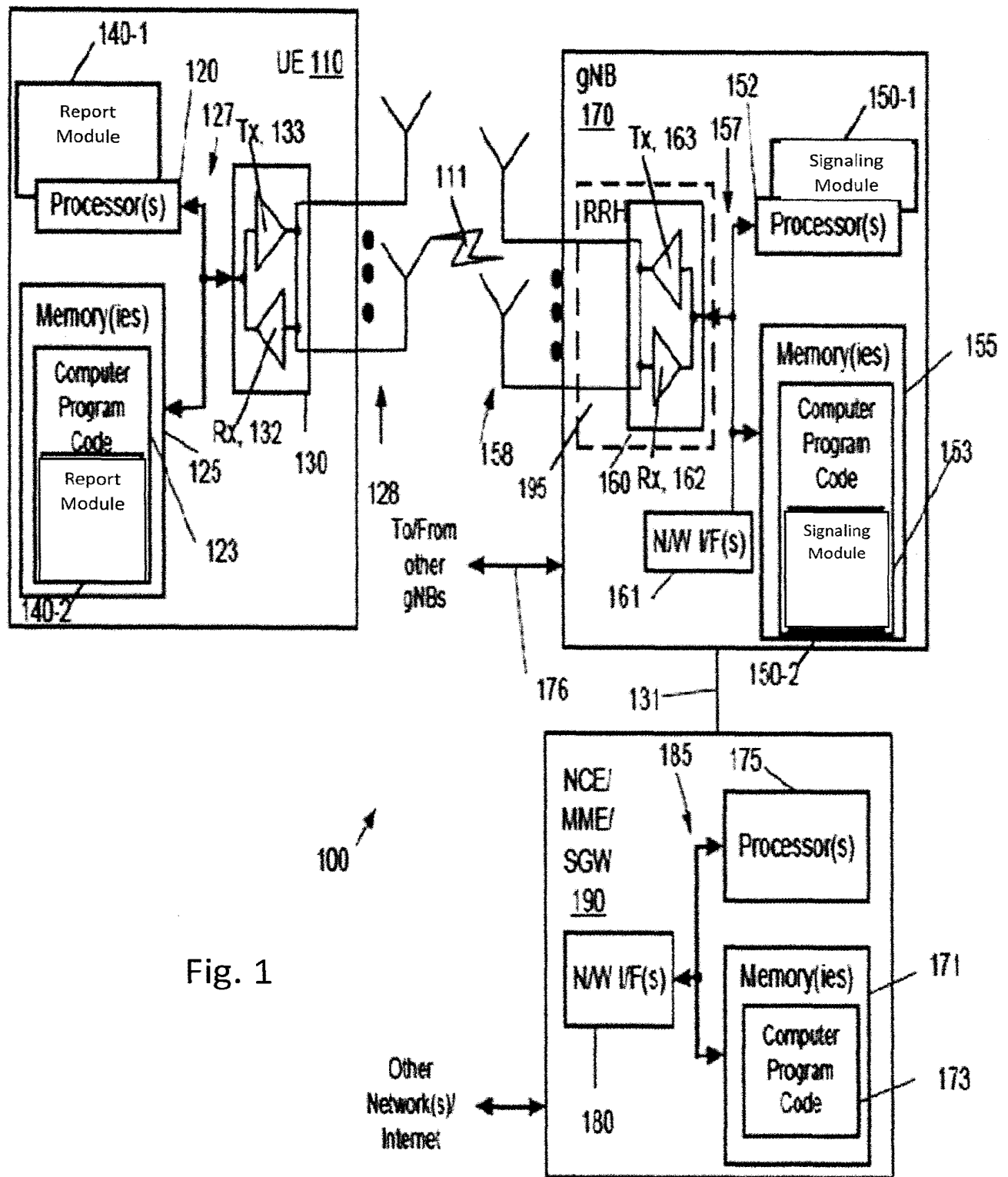


Fig. 1

200

210 TCI index	220 Source RS set	230 Source RS index	240 QCL type
0	RS set #A	SS/PBCH block #n (of set #A)	A+D
1	RS set #B	TRS #b (of set (#B)	A
		CSI-RS #c (of set #B)	D
...	...	...	...
M-1	RS set #E	CSI-RS #b (of the set #E)	A+D

Fig. 2

300

310

MAC-CE to activate/deactivate in case of more than one TCI state configured per CORESET

320

Example: UE configured with 2 CORESETs

340

CORESET #0	
Configured TCI state	Active
0	Yes
1	No
5	No
CORESET #1	
Configured TCI state	Active
M-1	Yes

350

330

Fig. 3

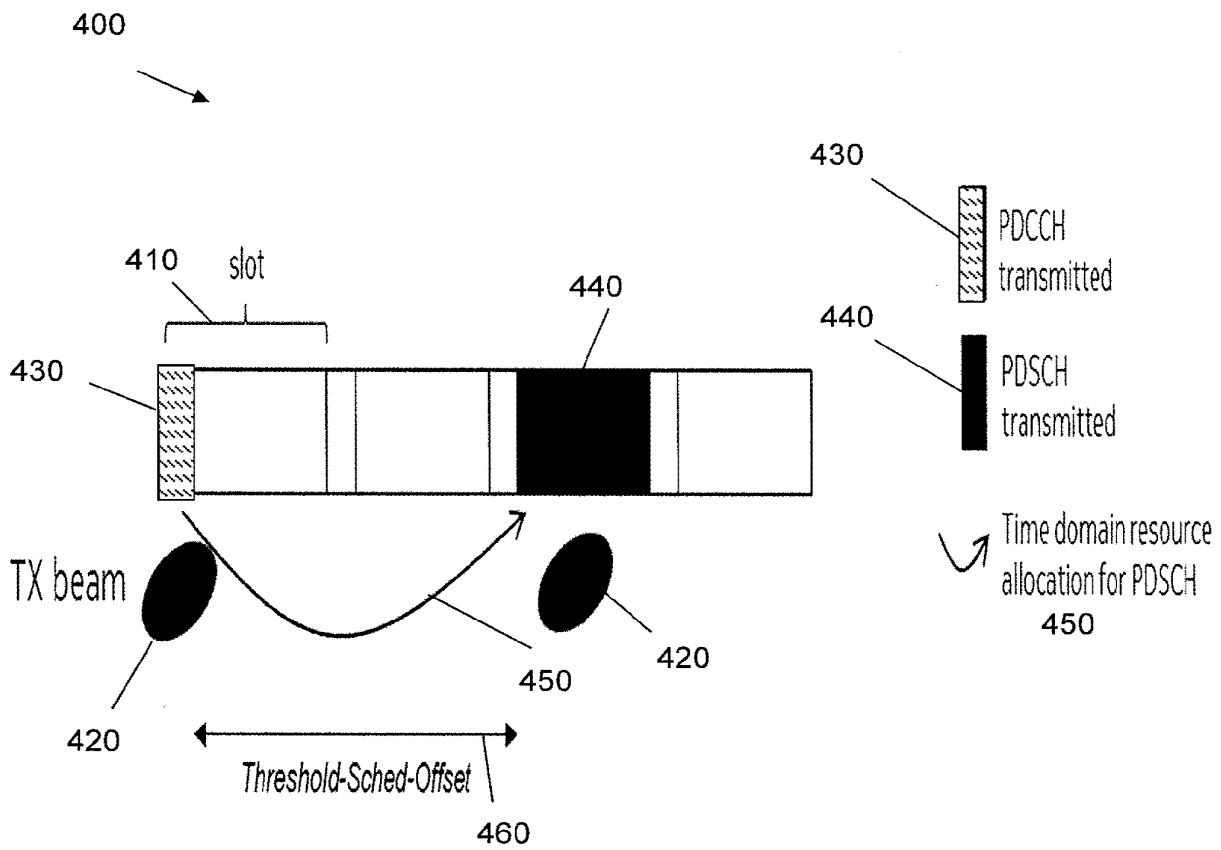


Fig. 4

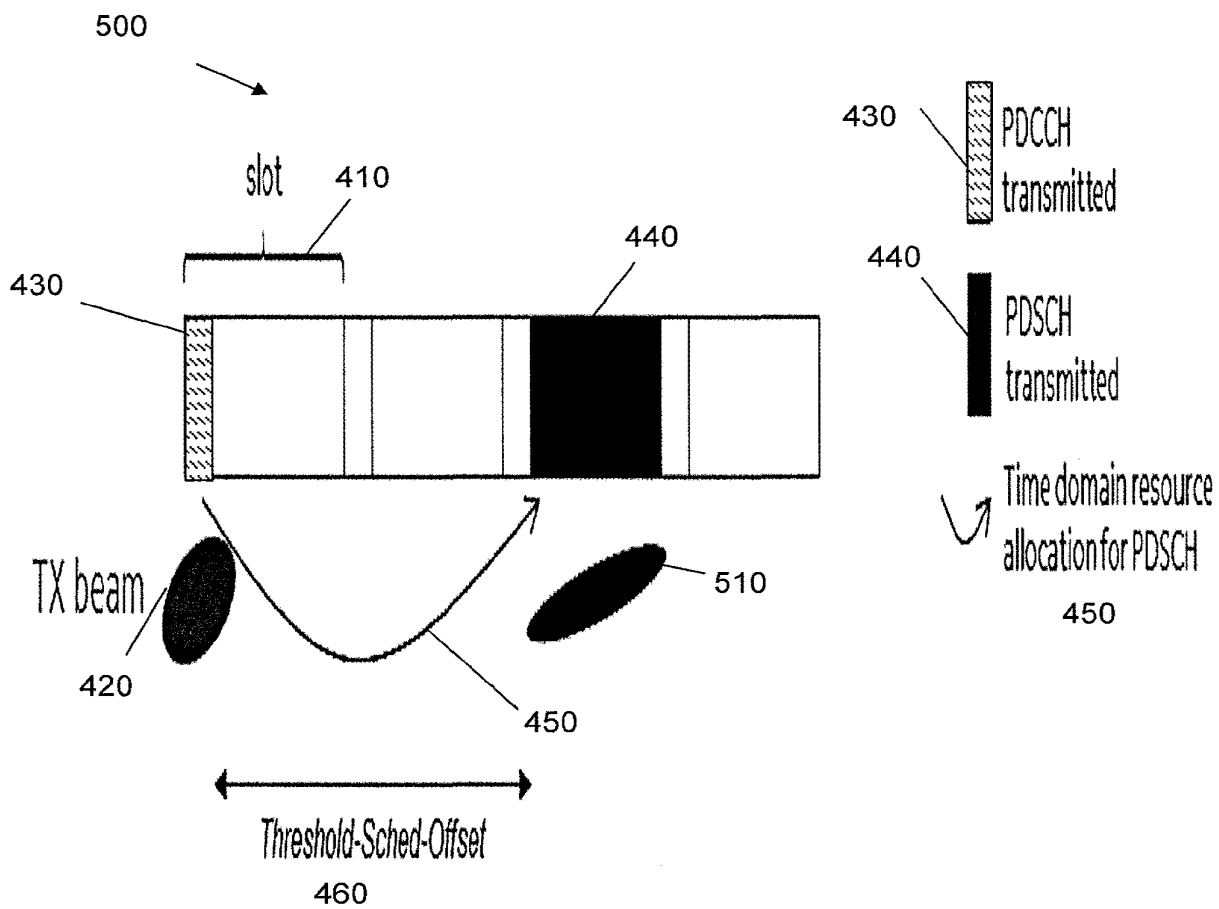


Fig. 5

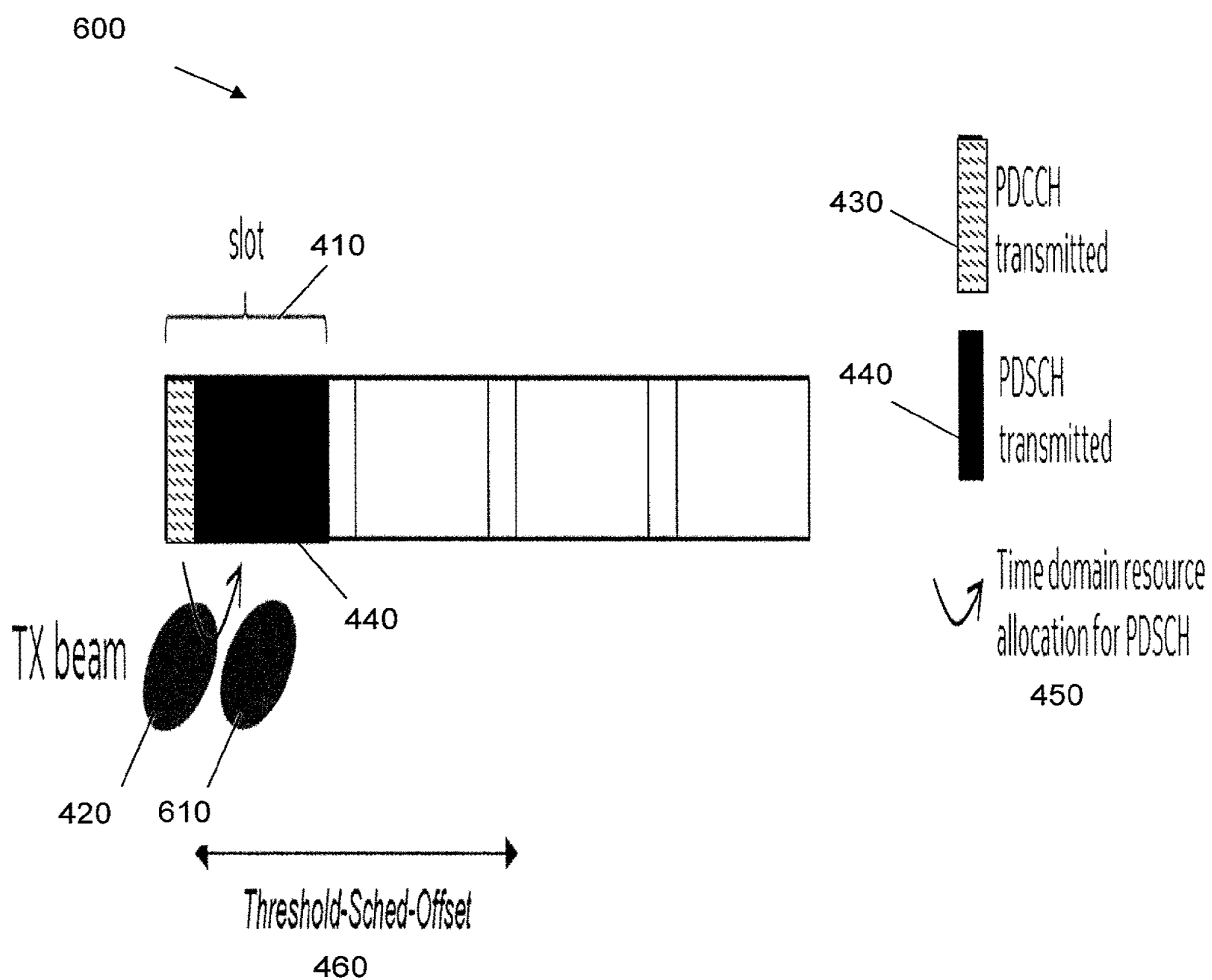


Fig. 6

700

210	220	710	240
TCI index	Source RS set	Source RS index panel index	QCL type
0	RS set #A	SS/PBCH block #n (of set #A) panel#n	A+D
1	RS set #B	TRS #b (of set #B) panel#n	A
		CSI-RS #c (of set #B) panel#m	D
...	...	...	...
M-1	RS set #E	CSI-RS #b (of the set #E) panel#n	A+D

Fig. 7

800

210	220	230	240	810	820
TCI index	Source RS set	Source RS index	QCL type	TCI Mask #1	TCI Mask #2
0	RS set #A	SS/PBCH block #n (of set #A)	A+D	1	1
1	RS set #B	TRS #b (of set #B)	A	1	0
		CSI-RS #c (of set #B)	D	1	0
...	...	...	...	...	...
M-1	RS set #E	CSI-RS #b (of the set #E)	A+D	0	0

Fig. 8

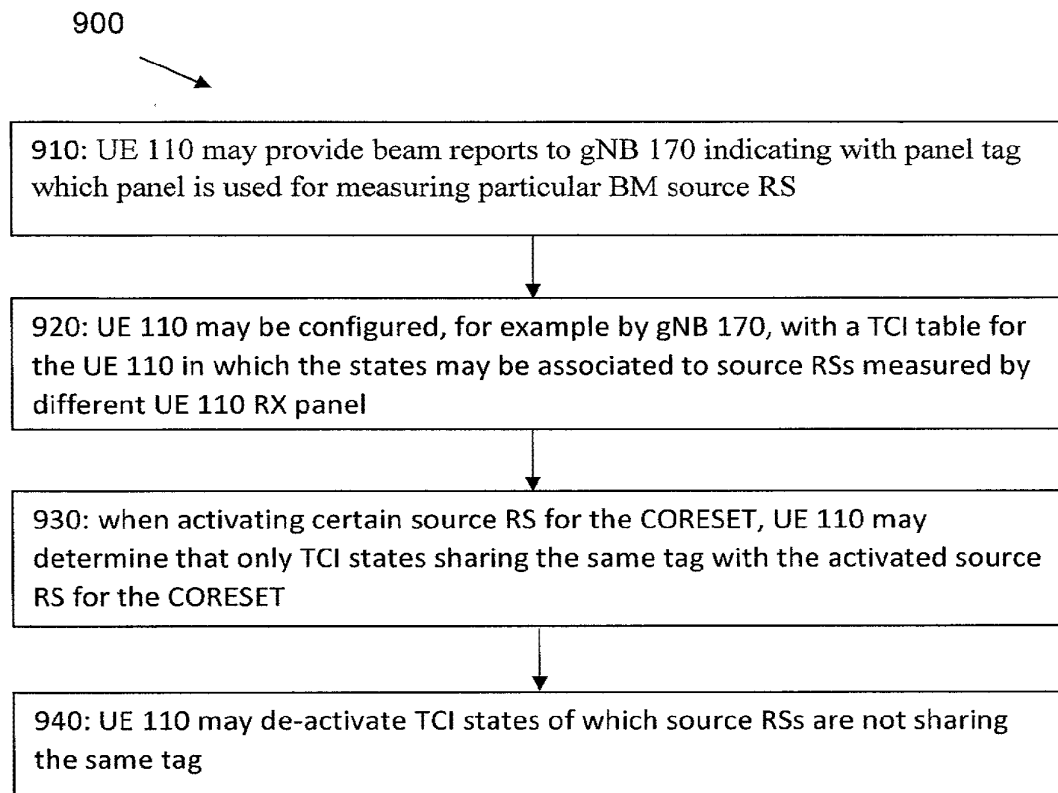


Fig. 9

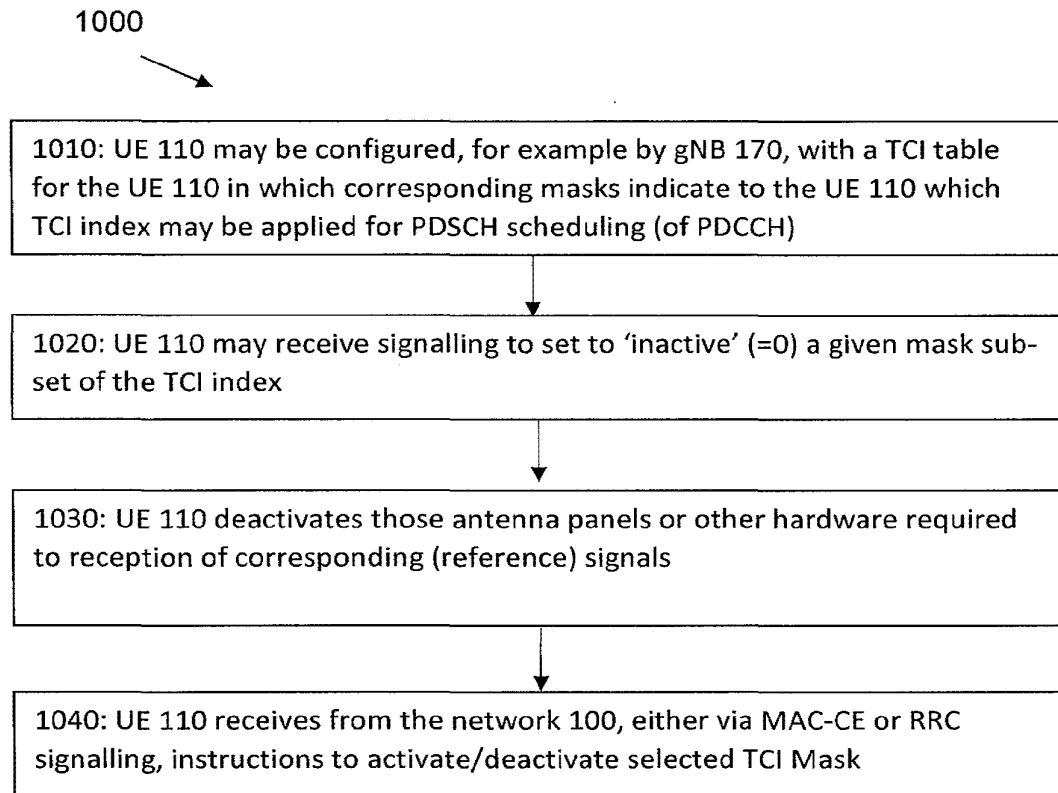


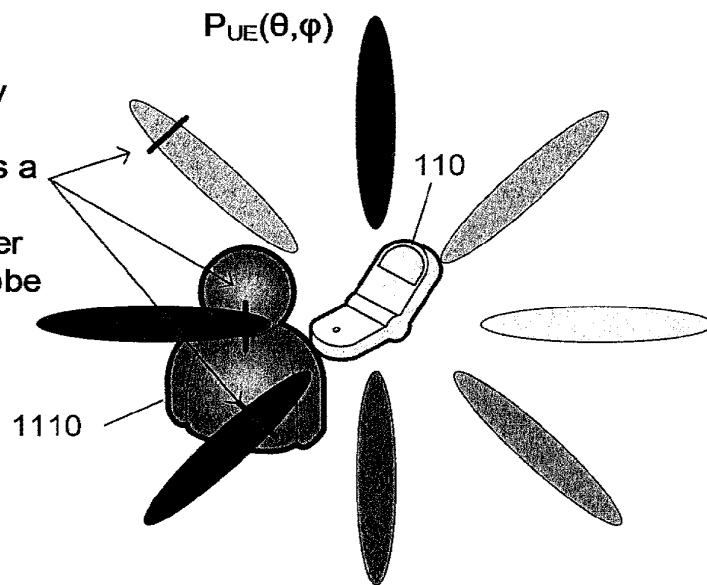
Fig. 10

1100

Max radiated power allowed by
safety emission limit
Note that the safe EIRP level is a
function of:

- UE position relative to the user
- UE beam direction and sidelobe levels
- User proximity

1120



Spherical coverage: conceptual illustration in 2D
of possible UE beams in all directions
(in the presence of the user)

1130

Fig. 11

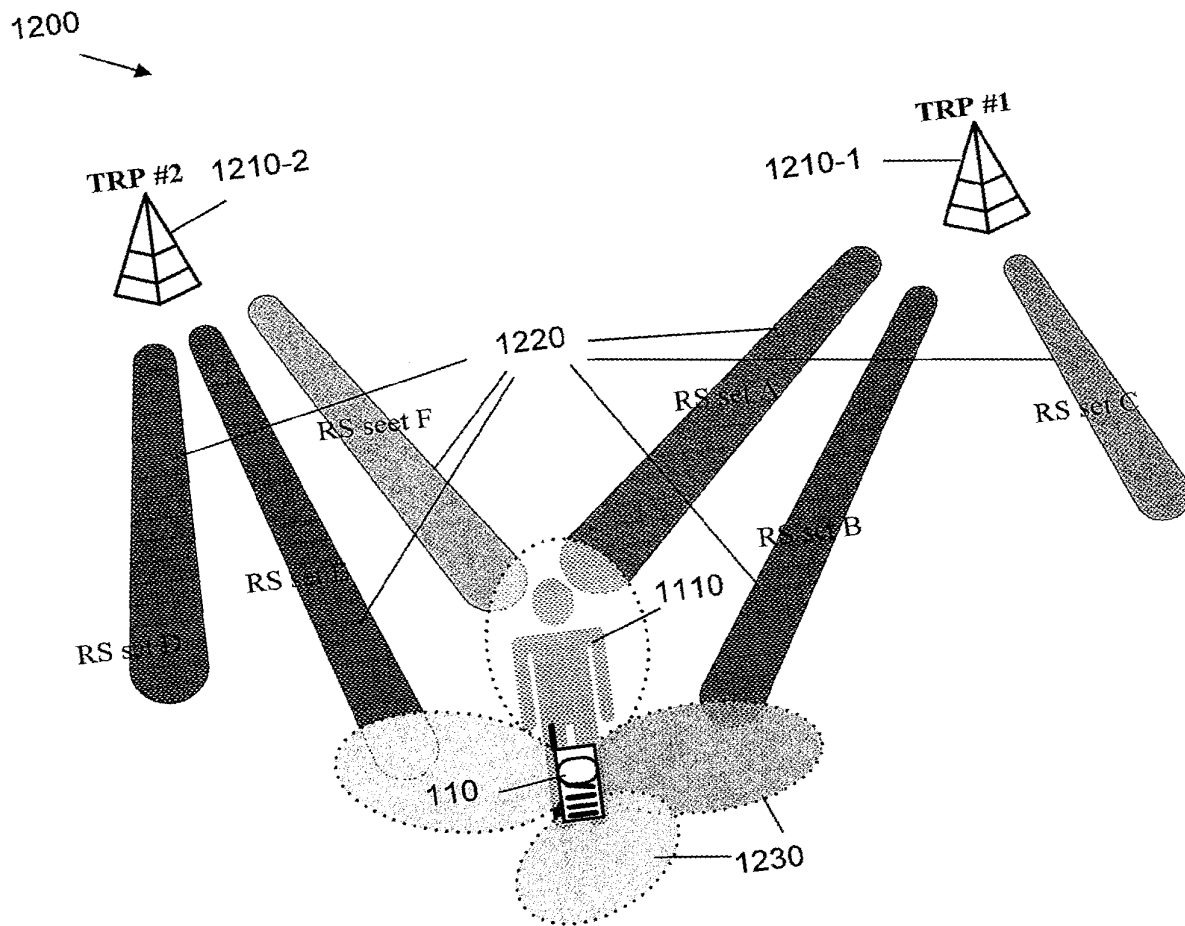
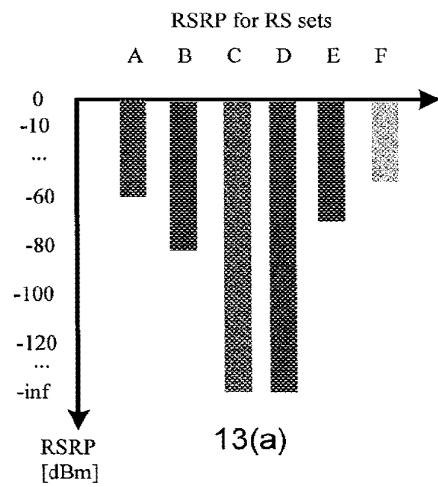


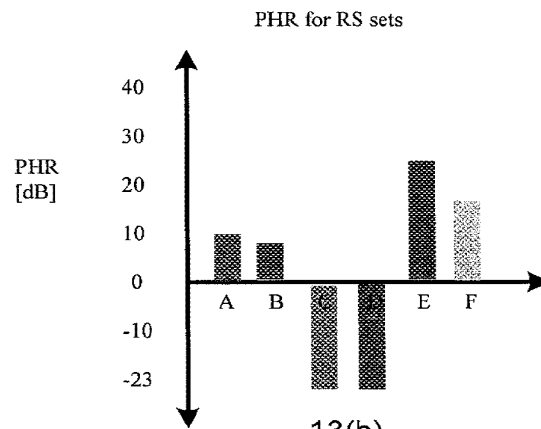
Fig. 12

1300



13(a)

1310



13(b)

1320

Fig. 13

1400

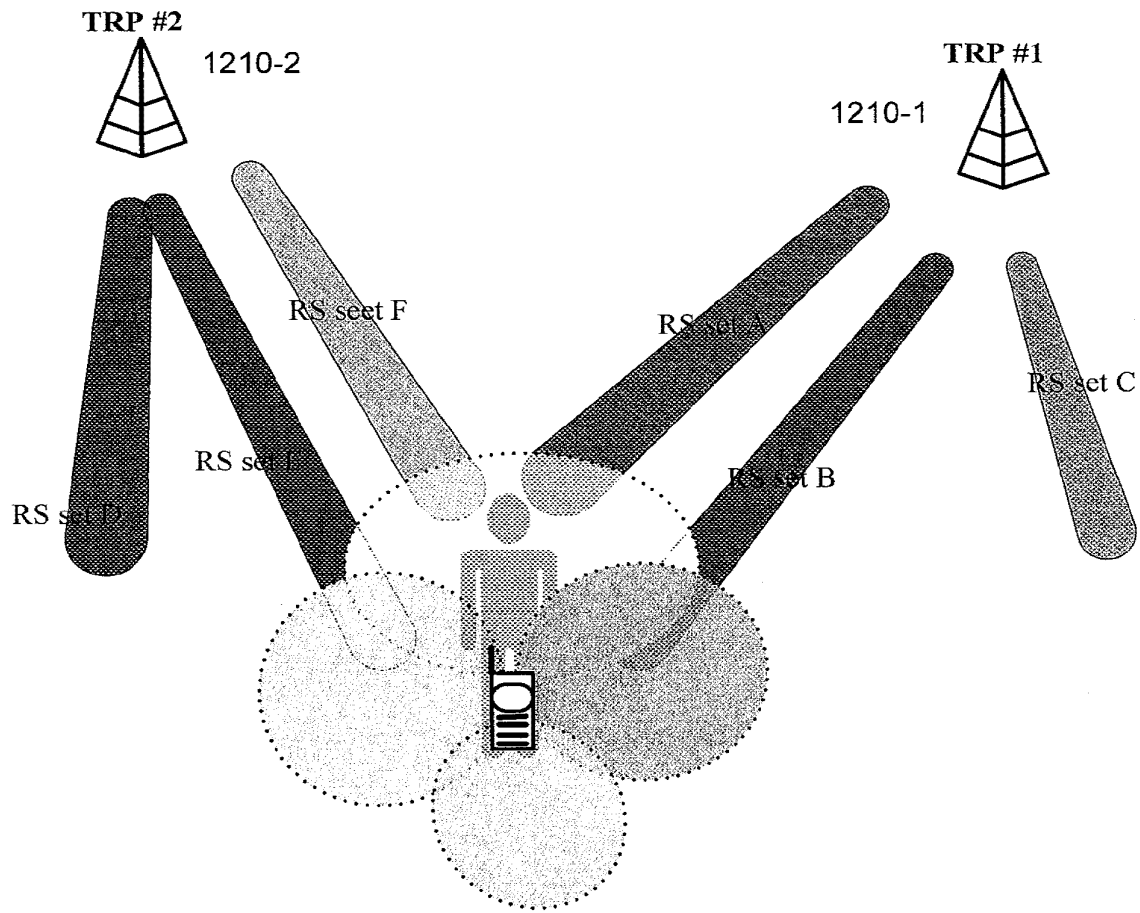


Fig. 14

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	800.2366.P1(US)
		Application Number	
Title of Invention	BEAM INDICATION FOR MULTI-PANEL UE		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	800.2366.P1(US)
		Application Number	
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	800.2366.P1(US)
		Application Number	
Title of Invention	BEAM INDICATION FOR MULTI-PANEL UE		

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All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button. Add				

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).	
☐ An Address is being provided for the correspondence information of this application.	
Customer Number	10948
Email Address	patent@hspatent.com Add Email Remove Email

Application Information:

Title of the Invention	BEAM INDICATION FOR MULTI-PANEL UE		
Attorney Docket Number	800.2366.P1(US)	Small Entity Status Claimed ☐	
Application Type	Provisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	14	Suggested Figure for Publication (if any)	

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	800.2366.P1(US)
		Application Number	
Title of Invention	BEAM INDICATION FOR MULTI-PANEL UE		

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	☒ Customer Number	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	10948		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	800.2366.P1(US)
		Application Number	
Title of Invention	BEAM INDICATION FOR MULTI-PANEL UE		

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)ⁱ the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country ^j	Filing Date (YYYY-MM-DD)	Access Code ^j (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	800.2366.P1(US)
		Application Number	
Title of Invention	BEAM INDICATION FOR MULTI-PANEL UE		

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	800.2366.P1(US)
		Application Number	
Title of Invention	BEAM INDICATION FOR MULTI-PANEL UE		

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.			
Applicant 1			
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.			
			
☒ Assignee		☐ Legal Representative under 35 U.S.C. 117	
☐ Person to whom the inventor is obligated to assign.		☐ Person who shows sufficient proprietary interest	
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:			
Name of the Deceased or Legally Incapacitated Inventor:			
If the Applicant is an Organization check here. ☒			
Organization Name		Nokia Technologies Oy	
Mailing Address Information For Applicant:			
Address 1		Karaportti 3	
Address 2			
City		Espoo	State/Province
Country	FI	Postal Code	02610
Phone Number		Fax Number	
Email Address			
Additional Applicant Data may be generated within this form by selecting the Add button.			

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	800.2366.P1(US)
		Application Number	
Title of Invention	BEAM INDICATION FOR MULTI-PANEL UE		

Assignee 1				
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.				
If the Assignee or Non-Applicant Assignee is an Organization check here. ☐				
Prefix	Given Name	Middle Name	Family Name	Suffix
Mailing Address Information For Assignee including Non-Applicant Assignee:				
Address 1				
Address 2				
City		State/Province		
Country ¹			Postal Code	
Phone Number		Fax Number		
Email Address				
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.				

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).				
This Application Data Sheet must be signed by a patent practitioner if one or more of the applicants is a juristic entity (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, all joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of all joint inventor-applicants.				
See 37 CFR 1.4(d) for the manner of making signatures and certifications.				
Signature			Date (YYYY-MM-DD)	2018-04-06
First Name	Garth	Last Name	Clarke	Registration Number
60,292				
Additional Signature may be generated within this form by selecting the Add button.				

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	800.2366.P1(US)
		Application Number	
Title of Invention	BEAM INDICATION FOR MULTI-PANEL UE		

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

DOCUMENT MADE AVAILABLE UNDER THE PATENT COOPERATION TREATY (PCT)

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International filing date:	05 April 2019 (05.04.2019)
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Date of receipt at the International Bureau:	06 April 2019 (06.04.2019)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a),(b) or (b-bis)