**3GPP TSG RAN WG1 #103-e R1-2009499**

**e-Meeting, October 26th – November 13th, 2020**

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator summary#2 for multi-beam enhancement

**Document for:** Discussion and Decision

**{Only including proposals and conclusions – clean version}**

* 1. Issue 1 (unified TCI framework)

**Proposal 1.A**: On Rel.17 unified TCI framework, support common TCI state update and activation to provide common QCL information and/or common UL TX spatial filter(s) across a set of configured CCs:

* The above applies to intra-band CA
* The above applies to joint DL/UL and separate DL/UL beam indications
* FFS: The above also applies to inter-band CA
* FFS: sharing a single RRC TCI state pool for the set of configured CCs

**Proposal 1.B**: On Rel.17 unified TCI framework, to accommodate the case of separate beam indication for UL and DL:

* Utilize two separate TCI states, one for DL and one for UL.
	+ FFS: Contents of separate UL TCI state
* For the separate DL TCI (note: taken straight from the joint TCI definition agreed in RAN1#102-e):
	+ The source reference signal(s) in M TCIs provide common QCL information at least for UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC
		- FFS: decide between “all”, “subset”, or “all or subset”
* For the separate UL TCI (note: taken straight from the joint TCI definition agreed in RAN1#102-e):
	+ The source reference signal(s) in N TCIs provide a reference for determining common UL TX spatial filter(s) at least for dynamic-grant/configured-grant based PUSCH, all or subset of dedicated PUCCH resources in a CC
		- FFS: decide between “all”, “subset”, or “all or subset”
	+ Optionally, this UL TX spatial filter can also apply to all SRS resources in resource set(s) configured for antenna switching/codebook-based/non-codebook-based UL transmissions
* FFS: Whether the UL TCI state is taken from a common or separate TCI state pool from DL TCI state
* FFS: Whether Rel.17 supports TCI configured for single channel (e.g. PDSCH only, single CORESET)
* Note: This does not preclude the type of UE supporting only 1 beam tracking loop, i.e. UE reports value of 1 in UE FG 2-62.

**Proposal 1.C**: On Rel.17 unified TCI framework, based on theRAN1#102-e agreement the following is supported for both joint DL/UL TCI and separate DL/UL TCI:

* For single-TRP scenarios:
	+ The source reference signal(s) in one TCI provide common QCL information at least for UE-dedicated reception on PDSCH and for UE-dedicated reception on all or subset of CORESETs in a CC (i.e. M=1 in this case)
		- FFS: decide between “all”, “subset”, or “all or subset”
	+ The source reference signal in one TCI provides a reference for determining common UL TX spatial filter at least for dynamic-grant/configured-grant based PUSCH, all or subset of dedicated PUCCH resources in a CC (i.e. N=1 in this case)
		- FFS: decide between “all”, “subset”, or “all or subset”
	+ FFS: The support for M>1 and/or N>1 for single-TRP
* FFS: the support for mTRP
* Note: This does not preclude that the source reference signal(s) in one TCI can provide common QCL/spatial filter info for both DL and UL signals.

**Proposal 1.D**:

* On Rel.17 unified TCI framework, based on the RAN1#102-e agreement the following is supported for both joint DL/UL TCI and separate DL TCI:
	+ The source reference signal(s) in M TCIs can also provide common QCL information for one or more CSI-RS resources for CSI, some CSI-RS resource for BM with repetition ‘ON’, and aperiodic CSI-RS for tracking, where the target CSI-RS resource(s) are determined by NW configuration
		- FFS: Support for some aperiodic CSI-RS resource for BM with repetition ‘OFF’
* FFS (RAN1#104-e): select a scheme to provide the QCL information or the UL TX spatial filter for other channels, signals, or CORESETs not included in the Rel.17 unified TCI framework

**Conclusion 1**: On Rel.17 unified TCI framework, in RAN1#103-e, there is no consensus on supporting:

* the use of SRS for BM as a source RS to represent a DL RX spatial filter, whether configured together with a DL RS (either a CSI-RS for BM, SSB, or DL TRS) or not,
* the use of CSI-RS for tracking as source RS to determine a UL TX spatial filter
	1. Issue 2 (L1/L2-centric inter-cell mobility)

**Proposal 2.A**: On Rel.17 enhancements to enable L1/L2-centric inter-cell mobility:

* The following use cases are assumed:
	+ Network architecture:
		- NSA, i.e. LTE PCell and NR-PSCell
		- SA
	+ Intra-band CA
		- FFS: If inter-band CA is also included
	+ Intra- RAT (excluding inter-RAT)
	+ Intra-frequency scenario:
		- The SSBs of non-serving cells have the same center frequency and SCS as the SSBs of the serving cell
		- An SSB of a non-serving cell is associated with a PCI different from the PCI of the serving cell
		- FFS: Support for inter-frequency scenario
	+ Support scenarios where all CORESETs are configured without CORESETPoolIndex.
		- FFS: other scenarios
	+ Intra-DU operation
		- FFS: If inter-DU operation is also included
* The following enhancement scope is assumed:
	+ No RRC reconfiguration signaling is needed after handover when a TCI associated with non-serving cell RS is indicated
		- A non-serving cell RS is an RS that is or has an SSB of a non-serving cell as direct or indirect QCL source
		- This implies no C-RNTI update during inter-cell mobility after handover
		- The reception of signals/channels associated with non-serving cell RS follows Rel.15/16 synchronization assumption between different cells
	+ Facilitating L1/L2 measurement and reporting of non-serving RSs via associating non-serving cell info with some TCI(s) and/or Reporting/Resource Setting(s), along with the necessary measurement and reporting scheme(s)
		- FFS: Detailed/exact method(s)
		- FFS: Whether this also implies the support of beam indication (TCI state update along with the necessary TCI state activation) for TCI(s) associated with non-serving cell RS(s)
		- FFS: Metric for the measurement and reporting, e.g. L1-RSRP or L3-RSRP or time- or spatial-domain-filtered L1-RSRP
	+ Facilitate serving cell to provide configurations for non-serving cell SSBs and/or other DL RS (e.g. CSI-RS for mobility) via RRC
		- FFS: details for the configurations of other DL RSs, e.g. time/frequency location, transmission power, etc.
		- FFS: other information needed for inter-cell mobility
	+ Note: In RAN1's understanding, non-serving cell SSB and non-serving cell RS can be part of the serving cell configuration
	1. Issue 3 (beam indication signaling medium)

The following agreement was made during the first GTW.

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| **Agreement**On beam indication signaling medium to support joint or separate DL/UL beam indication in Rel.17 unified TCI framework:* Support L1-based beam indication using at least UE-specific (unicast) DCI to indicate joint or separate DL/UL beam indication from the active TCI states
	+ The existing DCI formats 1\_1 and 1\_2 are reused for joint beam indication
		- FFS: If additional DCI format(s) are supported, e.g. existing DCI formats 0\_0, 0\_1, 0\_2, 1\_0 as well as new DCI format(s) dedicated for beam indication
	+ Support a mechanism for UE to acknowledge successful decoding of beam indication
		- The ACK/NAK of the PDSCH scheduled by the DCI carrying the beam indication can be used as an ACK also for the DCI
		- FFS: Whether any additional specification support is needed
	+ FFS beam indication for the TCI state assumption/update for the following cases:
		- The beam indication UE-specific DCI (i.e. the CORESETs with the DCI received by UE), the scheduled PDSCH by the DCI and the associated PUCCH for the acknowledgment of the beam indication DCI
		- Non-UE-specific CORESETs and PUSCH/PDSCH scheduled/activated and PUCCH transmission triggered by non-UE-specific CORESETs
* Support activation of one or more TCI states via MAC CE analogous to Rel.15/16:
	+ At least for the single activated TCI state, the activated TCI state is applied
	+ The content for the MAC CE is determined based on the outcome of issue 1
	+ FFS: If supported, default TCI state when more than one TCI states are activated by MAC CE
	+ Note: There is no implications on the support of single TRP or multi-TRP
* Support a UE capability for the minimum beam indication delay
	+ FFS: Whether to measure beam indication delay from DCI reception or from acknowledgment of DCI
	+ FFS: The exact supported values e.g. {0.5ms, 2ms, 3ms}
* FFS: Additional enhancement such as L1-based beam indication with group-common DCI
* FFS: Whether the Rel.17 beam indication can also apply to beam indication for single channel (e.g. PDSCH only, single CORESET) or a subset of channels
* FFS: Additional details on extending the support of L1-based beam indication when separate UL (from DL) common beam indication is configured

**Continue email discussion on the yellow part.** |

**Proposal 3:**

* Yellow 3.1: “for joint beam indication” text. This can be addressed as follows:
	+ The existing DCI formats 1\_1 and 1\_2 are reused for joint DL/UL beam indication
		- ~~FFS: If additional DCI format(s) are supported, e.g. existing DCI formats 0\_0, 0\_1, 0\_2, 1\_0 as well as new DCI format(s) dedicated for beam indication~~
		- FFS: support new DCI format(s) dedicated for beam indication for joint or separate DL/UL beam indication
		- FFS: support for reusing the existing UL-related DCI format(s) (e.g. 0\_0, 0\_1, 0\_2) for joint or separate DL/UL beam indication
		- FFS: support for reusing DCI format 1\_0, 1\_1, and 1\_2 for separate UL beam indication
* Yellow 3.2: vivo FFS
	+ Summary of companies’ views:
		- Support (keep): Apple, Intel, NTT Docomo, vivo, ZTE (with addition)
		- Not support (remove): APT, Ericsson, Fraunhofer IIS/HHI, Futurewei, MediaTek, Nokia/NSB, OPPO, Samsung, Sony, Xiaomi
	+ **Conclusion**: There is no consensus in including the two FFS points proposed by vivo in the agreement made in the 1st GTW session
* Yellow 3.3: UE capability text, revised as follows (per inputs from interested companies, based on where we left off during the GTW discussion):
	+ Application time of the beam indication: down-select from the following:
		- Alt1: the first slot that is at least X ms after the DCI with the joint or separate DL/UL beam indication
		- Alt2: the first slot that is at least X ms after the acknowledgment of the joint or separate DL/UL beam indication
	+ FFS: When and how to apply the minimum beam indication delay
	+ Support a UE capability for the minimum value of X
		- FFS: the beam application time X is configured by the gNB via higher-layer (RRC) signaling based the UE capability
		- FFS: the exact minimum values of X (e.g., 0.5ms, 2ms, 3ms) supported by UE
	1. Issue 4 (MP-UE)

**Proposal 4.A**: In Rel.17 enhancement for facilitating fast uplink panel selection, the following use cases are assumed:

* MPE mitigation
* UE power saving
* UL interference management
* Support different configurations across panels
* FFS: UL mTRP (whether to handle this issue in mTRP or MB)

**Proposal 4.B**: In Rel.17 enhancement on MP-UE to facilitate fast UL panel selection and MPE mitigation, UL Tx panel(s) is a same set or subset of DL Rx panel(s)

**Proposal 4.C**: In Rel.17 enhancement for facilitating fast uplink panel selection, UE-initiated UL panel selection/activation are supported:

* FFS: Whether NW-initiated panel selection/activation is also supported
	1. Issue 5 (MPE mitigation)

**Proposal 5.A**: On UE reporting for MPE mitigation for Rel.17, investigate and, if needed, specify the following:

* Reporting of panel level P-MPR report based on Rel.16 framework.
* Reporting SSBRI(s)/CRI(s) for the purpose of indicating:
	+ Alt1: alternative UE panel(s) or TX beam(s) for UL transmission
	+ Alt2: feasible UE panel(s) or TX beam(s) for UL transmission taking the MPE effect into account
* Any additional reporting: down-select from the following in RAN1#104-e
	+ Alt0: no additional reporting content
	+ Alt1: P-MPR + L1-RSRP
	+ Alt2: virtual PHR + L1-RSRP
	+ Alt3: L1-RSRP/SINR with and without MPE effect
	+ Alt4: virtual PHR
		- Note that PHR including PH and Pcmax is calculated based on P-MPR and the L1-RSRP
	1. Issue 6 (beam refinement/tracking)

**Proposal 6.A**: Investigate and, if needed, specify *at least* the following enhancements for beam refinement/tracking in Rel.17:

* Beam measurement and reporting enhancement via RACH during initial access (e.g. RO for measurement and MSG3 for reporting)
* Improving efficiency (latency and/or overhead) of beam refinement assuming the unified TCI framework (issue 1):
	+ Enabling joint DL TX and RX beam refinement/tracking (P2+P3)
	+ Additional UE report to aid P1/P2/P3 related measurement/report configuration (triggering frequency or periodicity)
* Beam management with reduced DL signaling assuming the unified TCI framework (issue 1):
	+ Dynamic beam update based on beam report (without beam indication)
	+ Dynamic beam measurement and report triggered by beam indication (without CSI-RS/CSI triggering)
	+ Configuring/indicating to UE multiple SSBs for beam tracking
	+ Semi-static/pre-planned (RRC based) beam transition (for, e.g. isolated HST deployment)
	+ Reducing activation delay of TCI states (e.g. via storing QCL properties of a subset of source RSs for a time period)