**3GPP TSG RAN WG1 #102-e R1-200xxxx**

**e-Meeting, August 17th – 28th, 2020**

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator summary for multi-beam enhancement: advanced beam acquisition

**Document for:** Discussion and Decision

1. Introduction

In this summary, the term “item 1” refers to the first item in the Rel.17 NR FeMIMO WID, i.e. multi-beam enhancement:

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| 1. Enhancement on multi-beam operation, mainly targeting FR2 while also applicable to FR1:
	1. Identify and specify features to facilitate more efficient (lower latency and overhead) DL/UL beam management to support higher intra- and L1/L2-centric inter-cell mobility and/or a larger number of configured TCI states:
		1. Common beam for data and control transmission/reception for DL and UL, especially for intra-band CA
		2. Unified TCI framework for DL and UL beam indication
		3. Enhancement on signaling mechanisms for the above features to improve latency and efficiency with more usage of dynamic control signaling (as opposed to RRC)
	2. Identify and specify features to facilitate UL beam selection for UEs equipped with multiple panels, considering UL coverage loss mitigation due to MPE, based on UL beam indication with the unified TCI framework for UL fast panel selection
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One of the agreements made in RAN1#102-e is as follows:

* [Issue 6] For Rel.17 NR FeMIMO,
	1. Add another category on performing study and, if needed, specifying feature(s) for beam acquisition (including beam tracking and refinement) latency reduction, especially for scenarios with high-speed UEs and large number of configured TCI states

During the email discussion leading to the agreement, a number of example proposals were provided by companies. It was later understood that further sub-categorization of this issue can facilitate more structured investigation and discussion.

1. Categorization of issues

With the above agreement and inputs from companies ([1][2]), the category of issues can be refined as follows.

Table 1 Category of issues

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| 1. **Unified TCI framework** – by means of extending the Rel.15/16 DL TCI framework (e.g. TCI state definition)
	1. Design for UL common TCI
		1. Goal: utilize same unified design as DL TCI, specify UL TCI framework to facilitate common TCI state update for UL (data, PUCCH, SRS)
		2. Including UL PC, timing control, PL RS, and/or default UL common beam
	2. Design for DL common TCI
		1. Goal: identify and, if needed, specify potential refinement on Rel.15/16 DL TCI framework to facilitate common TCI state update for DL (data and DL assignment of the same UE)
		2. Including default DL common beam
	3. Additional QCL Type-D relations for TCI state definition
		1. Goal: if supported, facilitate extended use of DL RS (e.g. SSB, CSI-RS) for UL and UL RS (e.g. SRS) for DL
	4. Facilitating combined/joint and separate TCI for DL and UL:
		1. Goal 1: when beam correspondence is assumed (common scenario), specify TCI framework to facilitate common TCI state update for DL and UL
		2. Goal 2: when beam correspondence is not assumed (e.g. MPE event), facilitate separate TCI state updates for DL and UL

*Note: the following factors should be considered in the above design aspects** + - *CA and cross-carrier scheduling operation (e.g. inter- and intra-band CA, FR1/FR2 CCS)*
		- *Beam correspondence assumption*
		- *When applicable, performance assessment based on the agreed EVM*
1. **L1/L2-centric inter-cell mobility**
	1. The need for and/or the applicability and scope of L1-/L2-centric inter-cell mobility:
		1. Goal: assess the need for and/or the applicability (use cases) and scope of L1/L2-centric inter-cell mobility (as an enhancement on the Rel.15/16 L3-based approach)
	2. Method of enabling L1/L2-based inter-cell mobility:
		1. Goal: select the type of information pertinent to non-serving cell(s) in TCI state to facilitate inter-cell mobility operation, e.g. PCI, SSB/TRS indicator,TAGs, L1-RSRP report for RS in a neighboring cell

*Note: the following factors should be considered in the above design aspects** + - *CA and cross-carrier scheduling operation (e.g. inter- and intra-band CA, FR1/FR2 CCS)*
		- *Beam correspondence assumption*
		- *When applicable, performance assessment based on the agreed EVM*
1. **Dynamic TCI state update signaling medium** for common TCI state update operation
	1. Signaling medium: L1 control signaling (DCI-based on PDCCH) and/or MAC CE
		1. Goal: select the medium and the associated detailed design used for signaling TCI state update
		2. This includes DCI format when applicable, reliability (HARQ-ACK and/or repetition), UE-specific vs. UE-group, 1-part vs. 2-part signaling, timing aspect
	2. Exact content:
		1. Goal: define list of parameters included in the TCI state update (supporting multiple formats is possible)
		2. This includes (a) separate DL and UL (DL-only and UL-only), (b) Combined joint DL and UL

*Note: the following factors should be considered in the above design aspects** + - *CA and cross-carrier scheduling operation (e.g. inter- and intra-band CA, FR1/FR2 CCS)*
		- *Beam correspondence assumption*
		- *When applicable, performance assessment based on the agreed EVM at high-speed scenarios*
1. **Extension of UL TCI for UE with (capable of) multiple panels** to facilitate UL fast panel selection, given the unified TCI framework design (cf. the above aspect 1 and 3)
	1. Mechanism to identify a UE panel:
		1. Goal: Assess whether resource ID or resource set ID (SRS, CSI-RS, ...) is sufficient or an explicit (new) panel ID is needed
	2. Signaling mechanism to enable UL fast panel selection,
		1. Goal 1: assess needed signaling from UE to NW, e.g. to indicate multi-panel capability, UE reporting
		2. Goal 2: extending UL TCI state update mechanism for various scenarios for UL fast panel selection, e.g. if supported, DL and UL TCI state update are (a) common, (b) separate;
	3. The need for panel-specific timing and power control enhancements in relation to panel indication and unified TCI framework design
		1. Goal: assess the need for panel-specific timing and power control and, if needed, the associated specification features

*Note: the following factors should be considered in the above design aspects** + - *CA and cross-carrier scheduling operation (e.g. inter- and intra-band CA, FR1/FR2 CCS)*
		- *The use of UE panels for both DL reception and UL transmission, including the need for UE reporting and NW signaling*
		- *Beam correspondence assumption*
1. **MPE mitigation -** given the unified TCI framework design and multi-panel UE support (cf. the above aspect 1, 3, and 4)
	1. The need for enhancement(s) to reduce UL coverage loss due to meeting MPE regulation
		1. Goal: assess the need based on a list of candidate schemes
	2. Method of enabling MPE mitigation:
		1. Goal: scheme selection for MPE mitigation

*Note: the following factors should be considered in the above design aspects** + - *Beam correspondence assumption*
		- *Performance assessment based on the agreed EVM*
		- *Support for fast panel selection on MP-UE*
1. **Advanced beam acquisition** targeting high-mobility and large number of configured TCI states **-** given the unified TCI framework design for intra- and L1/L2-centric inter-cell mobility, and multi-panel UE support (cf. the above aspect 1, 2, 3, and 4)
	1. Overhead and latency reduction of beam refinement (P2/P3)
		1. Goal: evaluate and select schemes (including NW signaling and configuration as well as UE signaling) to enable faster TX/RX beam refinement (P2/P3)
		2. Refinement is understood as selecting narrower (more spatially precise) beam from a set of candidate beams (TX and/or RX beams, jointly or separately) which also includes beam sweeping
	2. Overhead and latency reduction of beam tracking
		1. Goal: evaluate and select schemes (including NW signaling and configuration as well as UE signaling) to enable faster TX and/or RX beam tracking
		2. Tracking is understood as prompt/predictive response to the change in propagation link

*Note: the following factors should be considered in the above design aspects** + - *CA and cross-carrier scheduling operation (e.g. inter- and intra-band CA, FR1/FR2 CCS)*
		- *Beam correspondence assumption*
		- *Performance assessment based on the agreed EVM*
1. **Miscellaneous enhancements**
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# References

1. R1-2006985 Moderator summary for multi-beam enhancement: proposal categorization Moderator (Samsung)
2. R1-2007189 Moderator summary#2 for multi-beam enhancement: proposal categorization Moderator (Samsung)