**3GPP TSG-RAN** **WG2 Meeting #114 electronic R2-210xxxx**

**Online, 19 – 27 May, 2021**

**Title:** LS Reply on TCI State Update for L1/L2-Centric Inter-Cell Mobility

**Response to:** R2-2102627/R1-2102248

**Release:** Rel-17

**Work Item:** NR\_feMIMO-Core

**Source:** RAN2

**To:** RAN1

**Cc:** RAN3, RAN4, RAN

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# **1. Overall Description**

RAN2 would like to thank RAN1 for the LS on TCI State Update for L1/L2-Centric Inter-Cell Mobility. In RAN2#114-e meeting, RAN2 has started discussion on the L1/L2 centric inter-cell mobility, especially the expected scenarios and RAN2 impacts, and made the following agreements.

* RRC provides the configuration for “the cells for L1/L2 centric mobility”, and L1/L2 signaling can be used/feasible for the dynamic usage/switching of the configured value.
* R2 didn’t see a problem with using different C-RNTIs for different cells. Different C-RNTI seems more natural in a mobility scenario. No conclusion in R2 for mTRP scenario.
* RRC configurations of the cells for L1/L2 centric mobility, including C-RNTI, are configured by RRC.
* RAN2 prefer to restrict the scope of the deployment only for intra-DU case in Rel-17.
* RAN2 assumes to prioritize intra-frequency case in Rel-17, but RAN2 follows the RAN4 decision to support inter-frequency case.
* RAN2 confirm the simplified procedures on the inter-cell multi-TRP-like model as a baseline RAN2 understanding:

 Scenario 1: Inter-cell multi-TRP-like model

 1. UE receives from serving cell, configuration of SSBs of the TRP with different PCI for beam measurement, and configurations needed to use radio resources for data transmission/reception incl resources for differet PCI.

 2. UE performs beam measurement for the TRP with different PCI and report it to serving cell.

 3. Based on the above reports, TCI state(s) associated to the TRP with different PCI is activated from the serving cell (by L1/L2 signaling).

 4. UE receives and transmits using UE-dedicated channel on TRP with different PCI.

 5. UE should be in coverage of a serving cell always, also for multi-TRP case, e.g. UE should use common channels BCCH PCH etc. from the serving cell (as in legacy).

* RAN2 confirm the simplified procedures on the L1L2 mobility model as a baseline RAN2 understanding:

 Scenario 2: L1L2 mobility model (i.e. with serving cell change)

 1. UE receives from serving cell, configuration of SSBs of the cell with different PCI for beam measurement/ serving cell change.

 2. UE performs beam measurement for the cell with different PCI and report it to serving cell.

 3. Serving cell configuration for cell with other PCI is provided to the UE by RRC (pre-configuration for serving cell change, FFS if this step is same as 1).

 4. Based on the above reports, TCI states for cell with different PCI is activated along with the serving cell change (by L1/L2 signaling). FFS if this is multiple steps.

 5. UE changes the serving cell and starts receiving/transmitting using the pre-configured UE-dedicated channel and TCI states.

* Ask R1 to confirm that L1L2 mobility is assumed to be based on L1 measurements (not in R2 scope)
* R2 assumes for now that L1L2 mobility model includes Pcell mobility and possibly also Scell mobility (FFS).
* R2 assumes that for both multi-TRP and mobility scenarios, single protocol stack can be assumed (intra-DU)
* Continue discussion [036] to converge on a reply LS, can include all R2 agreements and explicitly formulated replies to R1 questions (to the extent needed/possible)

RAN2 summarized two expected scenarios and corresponding models (Inter-cell multi-TRP-like model and L1L2 mobility model) with simplified procedures regarding L1/L2 centric inter-cell mobility (see above agreements).

RAN2 would also like to note that the replies in this LS are based on the initial analysis in RAN2 but it's clear that substantial amount of RAN2 work is needed in this WI.

RAN2 believes this RAN2 understanding is helpful for RAN1 to take into account for future work. In addition, RAN2 has a question on measurements used for triggering L1/L2 centric inter-cell mobility.

**Question: Does RAN1 assume L1 measurements (i.e. measurements not using L3 filtering) are used for triggering L1/L2 centric inter-cell mobility for Scenario 1 and/or Scenario 2?**

# **2. Answers on questions from RAN1**

RAN2 first would like to clarify the term ‘non-serving cell’ which RAN1 has used in their LS and agreements. Serving cell definition in RAN2 pertains to a single PCI, and UE is only allowed to perform data transmission and reception in serving cell(s). Data transmission and reception in a "non-serving cell" seems contradictory with respect to legacy serving cell definition. So, the ‘non-serving cell’ term could be replaced with something clearer (which can be further discussed in RAN2). In this LS, we use the terms “cell having TRP with different PCI” (i.e. Scenario 1) or “cell for L1/L2 centric mobility” (i.e. Scenario 2) to differentiate the use cases and corresponding models being discussed.

**Question 1**: In regard of serving cell,

1. Is there a need for a UE to change a serving cell for DL reception from or UL transmission to another (non-serving) cell, at least on UE-dedicated PDSCH, PDCCH, PUSCH, and PUCCH?

**[Answer 1-1]** For PUCCH/PUSCH/PDCCH/PDSCH transmission/reception on a " cell having TRP with different PCI" or on a "cell for L1/L2 centric mobility", the UE needs to know the corresponding configurations. In the inter-cell mTRP like model (Scenario-1 of RAN2 agreements), the serving cell change is not useful hence not required whereas in the L1/L2 mobility model (Scenario-2 of RAN2 agreements), the serving cell change is required.

1. If so, how can the addition, release or change of a non-serving cell for DL reception and/or UL transmission be done? For example, would any of such actions require L3 handover and/or selection/activation among pre-configured candidate cells from RAN2 perspective?

**[Answer 1-2]** For Scenario 2, RRC provides the pre-configuration (i.e. addition, release or change) for the “cells for L1/L2 centric mobility”, and L1/L2 signaling can be used for switching between pre-configured cells. For Scenario 1, the UE should be in coverage of a serving cell always (i.e. without serving cell change).

1. If so, how can the TCI states associated with the previous serving cell be handled?
* **[Answer 1-3]** For Scenario 2, the L1/L2 signalling would trigger UE to change serving cell based on the indicated preconfiguration. After the serving cell change, RAN2 assumes the UE if needed could keep the configuration of previous serving cell including TCI state related information but it is not clear how to handle TCI state.
1. If so, what is the impact on the system information reception by the UE?

**[Answer 1-4]** The UE is only required to monitor system information on current PCell: for all other cells, common configuration (as in system information) is provided by dedicated signalling.

* For Scenario 2, after PCell changes via L1/L2 signalling, the UE starts monitoring system information on the new PCell (and stops monitoring it on the previous PCell).
1. If so, what is the impact on the RACH and PUCCH-related procedures and configurations?

**[Answer 1-5]** if random access is required, network configures the corresponding parameters by dedicated signalling in each scenario.

1. If not, what is the impact on the applicable use cases? That is, in what scenarios can the UE be configured for DL reception from or UL transmission to another (non-serving) cell, at least on UE-dedicated PDSCH, PDCCH, PUSCH, and PUCCH, if the serving cell does not change?

**[Answer 1-6]** At least in Scenario 1 (Inter-cell multi-TRP-like model), RRC provides the configuration (i.e. addition, release or change) for each “cells having TRP with different PCI” as part of another serving cell (please see the simplified procedure in above RAN2 agreement).

**Question 2**: In regard of RRC configuration, RAN1 is discussing whether to allow a UE to be configured for DL reception from or UL transmission to a non-serving cell on UE-dedicated PDSCH, PDCCH, PUSCH, and PUCCH. From RAN2 perspective

1. Depending on the answer to question 1-1, what would be the impact of allowing the UE to transmit and/or receive on some or all of those channels and which RRC parameter(s) would need to be reconfigured for the UE?

**[Answer 2-1]** RRC requires the (pre-)configuration (i.e. addition/release/modification) of the additional cell(s) for this type of L1/L2 mobility operation. This configuration includes the dedicated configuration (e.g. PxxCH configurations, signaling of QCL source in each TCI state) and/or the common configuration (e.g. SSB, SI, paging, RACH, etc.) only for Scenario 2. RAN2 assumes a single protocol stack for both Scenario 1 and Scenario 2.

1. Is it feasible to update some of the above RRC parameter(s) via dynamic signaling (e.g. MAC CE and/or DCI, potentially selecting pre-configured values) without any additional RRC reconfiguration signaling?

**[Answer 2-2]** RRC parameters can only be updated via RRC but L1/L2 signaling can be used to change which configuration is used. This approach would be applied for both Scenario 1 and 2.

**Question 3**: In regard of C-RNTI:

1. Is there a need to assign a UE a separate C-RNTI for DL reception from and UL transmission to a non-serving cell, or can the same C-RNTI from the serving cell be reused, at least for transmission and reception on UE-dedicated PDSCH, PDCCH, PUSCH, and PUCCH?

**[Answer 3-1]** In general, C-RNTI identifies a UE among all UEs connected to the same PCell and a new C-RNTI value is provided at PCell change, which may be the same or different, so RAN2 would like to support changing the C-RNTI for the L1/L2 mobility scenario. For the mTRP scenario, no conclusion is achieved in RAN2 on the C-RNTI allocation.

1. In restricting the use of the same C-RNTI for serving and non-serving cells, what would be the impact in applicable use cases and/or required specification support, if any?

**[Answer 3-2]** For L1/L2 mobility scenario, this restricts network implementation as one PCell would need to use the C-RNTI allocated by the previous PCell, which is different from normal RAN2 assumption (as indicated by Answer 3-1).

1. If separate C-RNTIs are considered necessary in some cases, for serving and non-serving cells, how would this be configured for UE, i.e. is RRC reconfiguration signaling or some other (dynamic) signaling needed for configuring the separate C-RNTI(s)?

**[Answer 3-3]** RRC configurations of the cells for L1/L2 centric mobility, including C-RNTI, are configured by RRC.

**Question 4**: In regard of CU-DU split, from RAN2/3 perspective, is there any difference between supporting intra-DU only and supporting inter- in addition to intra-DU, in terms of the following?

1. The associated RAN2 specification impact,

**[Answer 4-1]** When RLC/MAC configuration is contained within the same DU, MAC reset and RLC reestablishment may be avoided. Supporting inter-DU might also imply different CU-UP, which would complicate CU handling, such as PDCP reestablishment to update security context. In addition, even if we restrict to only one CU-UP and CU-CP, that would require extra inter-node signaling and additional changes in RAN2 configuration.

1. Applicable use cases (e.g. deployment scenarios), and

**[Answer 4-2]** To reduce the user plane impacts, RAN2 prefer to limit the applicable use case to intra-DU case in Rel-17.

1. Network inter-operability (e.g. across different gNB vendors)

**[Answer 4-3]** This is more RAN3 matter than RAN2.

**Question 5**: In regard of CA issues, RAN1 is discussing whether the operation is supported only for intra-band CA scenario (i.e. UE is configured to operate with serving and non-serving cells that belong to the same frequency band) or for both intra-band CA and inter-band CA scenarios. Note that one common TCI state ID associated with a non-serving cell, if supported, may be optionally applied for CCs in a band.

1. Are there specific RAN2/4 issues (including higher-layer impact) that need to be considered for deciding between the two alternatives?

**[Answer 5]** RAN2 signaling/configuration can support both inter-band and intra-band scenarios, which is unrelated to whether CA is configured, but RAN2 assumes intra-band CA scenario (i.e. UE is configured to operate with serving and non-serving cells that belong to the same frequency band) is more relevant for Rel-17.

**Question 6**: In regard of inter-frequency issues, from RAN2/4 perspective, what would be the higher-layer and RRM impact assuming inter-frequency scenarios as opposed to intra-frequency scenarios? For intra-frequency scenario, it is assumed that SSBs of non-serving cells have the same center frequency and SCS as the SSBs of the serving cell.

* Note: RAN1 has agreed to support intra-frequency scenarios, whereas the support for inter-frequency scenarios is still for further study.

**[Answer 6]** RAN2 prefer to prioritize intra-frequency case in Rel-17, but RAN2 will follow the RAN4 decision on whether to support inter-frequency case.

# **3. Actions:**

**To: RAN1**

RAN2 respectfully asks RAN1 to take the above information into account for future work.

RAN2 also respectfully requests RAN1 answer to the following question:

**Question: Does RAN1 assume L1 measurements (i.e. measurements not using L3 filtering) are used for triggering L1/L2 centric inter-cell mobility for Scenario 1 and/or Scenario 2?**

# **4. Date of Next RAN2 Meetings:**

TSG RAN WG2 Meeting #115-e Aug. 16 – 27, 2021 Online

TSG RAN WG2 Meeting #116-e Nov. 1 – 12, 2021 Online