**3GPP TSG-RAN WG2 Meeting #130 R2-250xxxx**

**St. Julian’s, Malta, May 19th – 23rd, 2023**

**Agenda item: x.x.x**

**Source: Samsung**

**Title: MAC open issues for MIMO**

**WID/SID: NR\_MIMO\_Ph5**

**Document for: Discussion and Decision**

# Introduction

This document includes a list of open issues according to the following email discussion:

* [Post129bis][215][ MIMO\_Ph5] Running CR for 38.321 (Samsung)

Intended outcome:

1. Updated running CR based on new agreements for endorsement
2. Open issue list

Deadline: Long

Companies are invited to provide feedback on open issue list by: **2nd May 1000 UTC**

# Discussion

## MAC-1: UL skipping for event-triggered beam reporting

**Issue description:**

In RAN2#129bis, the following agreements are made.

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| * Confirm the following RAN2 understandings:
	+ - * **The CG type-1 PUSCH carrying the beam report of Mode-B does not carry MAC PDU (i.e. UL-SCH).**
			* **The DG PUSCH carrying the beam report of Mode-A carries MAC PDU (i.e. UL-SCH) as legacy.**
* FFS if any other MAC impact for UL skipping
 |

Based on the understanding, for mode-B event-triggered beam reporting the type-1 CG is not used in MAC procedure to generate MAC PDU, thus UL skipping in the MAC procedure is not applicable. The issue is whether UL skipping is applied to mode-A DG-based event-triggered beam reporting.

**Discussion:**

Note for both mode-A and mode-B event-triggered beam reporting, the actual report is transmitted as UCI in PUSCH, according to the following RAN1 agreement.

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| **Agreement RAN1#116bis**On beam report transmission procedure for UE-initiated/event-driven beam reporting, following modes are supported:* Mode A (dynamically scheduling UCI by gNB):
	+ Step 1: UE transmits a first PUCCH (one-bit/multi-bit) to request a resource for a second UL channel to carry beam report
		- FFS: Request format, e.g., SR or a new UCI type.
	+ Step 2: UE detects the DCI format to indicate a resource for a second UL channel to carry beam report.
	+ Step 3: Beam report is transmitted in second UL channel.
		- FFS: Details on the second UL channel, e.g., whether the second UL channel is PUCCH, PUSCH or both
	+ This mode is basic UE capability (i.e. all UE supporting UE-initiated/event-driven beam reporting should support this feature).
	+ No new DCI format is introduced.
* Mode B (UCI in pre-configured resource(s) for second UL channel):
	+ Step 1: UE transmits a first PUCCH (one-bit/multi-bit) notifying a second UL channel to carry beam report
		- FFS: Notification format, e.g., SR or a new UCI type.
	+ Step 2: UE transmits the beam report in the second UL channel.
		- FFS: Details on the second UL channel, e.g., whether the second UL channel is PUCCH, PUSCH or both
	+ The notification in Step1 is in a separate reporting instance from the beam report in Step 2.

FFS: Whether UE receives acknowledge information with response to each step for all modesFor above procedures, cross-CC beam reporting is supported for both modes.* FFS: Details.
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In the current procedure of UL skipping, it is specified that Rel-16 enhanced UL skipping is not applied to UCI multiplexed on the PUSCH, as highlighted below.

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| TS 38.321 clause 5.7…The MAC entity shall:1> if the MAC entity is configured with *enhancedSkipUplinkTxDynamic* with value *true* and the grant indicated to the HARQ entity was addressed to a C-RNTI, or if the MAC entity is configured with *enhancedSkipUplinkTxConfigured* with value *true* and the grant indicated to the HARQ entity is a configured uplink grant:2> if there is no UCI to be multiplexed on this PUSCH transmission as specified in TS 38.213 [6]; and2> if there is no aperiodic CSI requested for this PUSCH transmission as specified in TS 38.212 [9]; and2> if the MAC PDU includes zero MAC SDUs; and2> if the MAC PDU includes only the periodic BSR and there is no data available for any LCG, or the MAC PDU includes only the padding BSR:3> not generate a MAC PDU for the HARQ entity.1> else if the MAC entity is configured with *skipUplinkTxDynamic* with value *true* and the grant indicated to the HARQ entity was addressed to a C-RNTI, or the grant indicated to the HARQ entity is a configured uplink grant:2> if there is no aperiodic CSI requested for this PUSCH transmission as specified in TS 38.212 [9]; and2> if the MAC PDU includes zero MAC SDUs; and2> if the MAC PDU includes only the periodic BSR and there is no data available for any LCG, or the MAC PDU includes only the padding BSR:3> not generate a MAC PDU for the HARQ entity. |

Therefore, the UCI for mode-A DG-based event-triggered beam report multiplexed on PUSCH can follow the existing enhanced UL skipping procedure (i.e., MAC PDU is generated for the UCI for mode-A DG-based event-triggered beam report multiplexed on PUSCH regardless of Rel-16 UL skipping configuration). For Rel-15 UL skipping (*skipUplinkTxDynamic*), whether to enhance for event-triggered beam report can be discussed.

**Q1: Do you agree the following view?**

**1-1: UL skipping is not applicable to mode-A type-1 CG event-triggered beam report.**

**1-2: For Rel-16 UL skipping (enhancedSkipUplinkTxDynamic), the UCI for mode-A DG-based event-triggered beam report follows the existing procedure (i.e., MAC PDU is generated for the UCI for mode-A DG-based event-triggered beam report multiplexed on PUSCH regardless of Rel-16 UL skipping configuration), there is no MAC impact.**

**1-3: For Rel-15 UL skipping (skipUplinkTxDynamic), discuss whether to enhance for mode-A DG-based event-triggered beam report.**

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| **Company** | **Y/N** | **Comments** |
| CATT | Yes |  |
| Sharp | Yes |  |
| LGE | Comment | Agree with the intention. However, we think that the same principle should be applied to Rel-15 UL skipping. In our understanding, aperiodic CSI reporting is a kine of UCI, so if "mode-A DG-based event-triggered beam report" is aligned with aperiodic CSI reporting case, the same principle can be applied to Rel-15 UL skipping. |
| ZTE | Yes |  |
| Huawei | Yes | According to the RAN1 agreement, for mode-A event-triggered beam reports, the DCI format of the CSI request should be the same as that of the aperiodic CSI report. Therefore, at the MAC layer, it will be treated as an aperiodic CSI report for the UL skipping issue.

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| **Agreement**On beam report transmission procedure for UE-initiated/event-driven beam reporting, regarding the triggering procedure in Step-2 of Mode-A aperioid* Reuse CSI request field in DCI format 0\_1/0\_2 to trigger the transmission of the UEI beam report
	+ If a CSI trigger state associated with UEI beam report configuration(s) is indicated by the CSI request field in DCI format 0\_1/0\_2, the UE transmits the corresponding UEI beam report(s) in the second PUSCH scheduled by the DCI format 0\_1/0\_2
	+ FFS: DCI format 0\_3
* FFS: Whether a CSI trigger state should be dedicated to UE-initiated/event-driven beam reporting, i.e., not associated with legacy AP-CSI report configuration.
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| Ofinno | Yes, with comments | For 1-1, there seems to be a typo “UL skipping is not applicable to mode-B~~A~~ type-1 CG event-triggered beam report”For 1-2: Yes. For 1-3: Support to enhance for Mode-A DG-based event-triggered beam report for Rel-15 UL skipping. We agree with LG and Huawei that the UE-initiated CSI report in mode A should be treated as aperiodic CSI reporting.  |
| Qualcomm | Yes w. comment | Mode B with Type 1 CG |
| Nokia | Yes, with comment  | * 1. – Yes (UL skipping is not applicable to mode-~~A~~ B type-1 CG event-triggered beam report.)
	2. Yes
	3. Yes, and we share same view a LGE, Huawei, and Ofinno
 |
| Samsung | Yes | For 1-3, okay to enhance. |

Summary:

All companies (9/9) agree with 1-1 (with typo fixed), 1-2, and 1-3. For 1-3, 5 companies support to enhance Rel-15 UL skipping for mode-A UE-initiated report.

**Proposal 1: UL skipping is not applicable to mode-B type-1 CG event-triggered beam report.**

**Proposal 2: For Rel-16 UL skipping (enhancedSkipUplinkTxDynamic), the UCI for mode-A DG-based UE-initiated report follows the existing procedure (i.e., MAC PDU is generated), there is no MAC impact.**

**Proposal 3: For Rel-15 UL skipping (skipUplinkTxDynamic is configured), discuss whether to generate MAC PDU for multiplexing UCI of mode-A DG-based UE-initiated report in PUSCH.**

## MAC-2: overlapping rule for mode-A beam report in PUSCH

**Issue description:**

For mode-B event-triggered beam reporting the type-1 CG is not used in MAC procedure to generate MAC PDU, thus the overlapping rule in MAC procedure is not applicable. The issue is whether the existing overlapping rule is impacted to handle overlapping between the PUSCH of mode-A beam report and SR/other PUSCH [1].

**Discussion:**

Based on the understanding agreed above, the DG for mode-A beam report is a UL grant as legacy that can carry MAC PDU. The existing rule to handle the overlapping/prioritization between the PUSCH of mode-A beam report and SR/other PUSCH should be applied.

**Q2: Do you agree the following view?**

**The existing rule to handle the overlapping/prioritization between the PUSCH of mode-A beam report and SR/other PUSCH is applied.**

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| **Company** | **Y/N** | **Comments** |
| CATT | Yes |  |
| Sharp | Wait for RAN1 input | RAN1 has some discussion and make agrees as below. Maybe we could wait for further input from RAN 1.**Agreement**On beam report transmission procedure for UE-initiated/event-driven beam reporting, regarding the multiplexing/dropping rule(s) of 1-bit first PUCCH, down-select one of the following rules for the Case-2: the 1-bit first PUCCH is collided/overlapped with a PUSCH, in RAN1#121* Option-1: Prioritize first PUCCH over PUSCH, i.e., PUSCH is dropped.
	+ FFS: If the PUSCH should be with UL-SCH or not for UEI beam report
* Option-3: Piggyback 1-bit indication of first PUCCH into the PUSCH.
	+ FFS: The 1-bit indication is always multiplexed in the PUSCH, regardless that UEI beam report procedure is triggered.
	+ FFS: If the PUSCH should be with UL-SCH or not for UEI beam report
* Option-4: Reuse the SR dropping rules.
* FFS: whether/how to handle the case of different PHY priorities.
 |
| LGE | Yes |  |
| ZTE | Yes | RAN1 has conclusion on the mode B for the similar issue, while for the mode A, the DG would not be skipped, so it should be a RAN2 issue and we prefer to adopt the existing rule. |
| Huawei | Wait for RAN1 input | Since RAN1 will further discuss this issue in the current meeting, we may need to wait for their progress before proceeding. |
| Ofinno | Yes | RAN1 is discussing the overlapping of first PUCCH with a PUSCH (FFS: with a UE-initiated CSI report), which we believe is different from the overlapping of a PUSCH with a UE-initiated CSI report in Mode A and SR/PUSCH, which is a RAN2 issue. So, the existing rule can be adopted.  |
| Qualcomm | Yes | RAN1 agreed to reuse the current DCI for Mode A. |
| Nokia | Yes | The existing rule can be applied |
| Samsung | Yes | Share same view as Ofinno.Regarding the RAN1 ongoing discussion, it handles the overlapping in PHY. The discussion here is to handle the overlapping in MAC. |

Summary:

7 companies out of 9 agree that the existing rule is applied to handle the overlapping/prioritization between the PUSCH of mode-A beam report and SR/other PUSCH in MAC.

2 companies mentioned RAN1 is discussing relevant issue and wanted to wait for RAN1 progress. However, it is clarified by companies that RAN1 ongoing discussing is dealing with overlapping between first step notification in PUCCH and PUSCH in PHY, while RAN2 discussion is to handle overlapping between mode-A UE-initiated report in PUSCH and SR/other PUSCH in MAC, which are separate issues.

Based on majority view, the propose is made.

**Proposal 4: The existing rule is applied to handle the overlapping/prioritization between the PUSCH of mode-A UE-initiated report and SR/other PUSCH in MAC.**

## MAC-3: asymmetric UL mTRP in LTM cell switch

**Issue description:**

To discuss whether/how asymmetric UL mTRP is applied in LTM cell switch [2].

**Discussion:**

Rel-18 2TA (mDCI mTRP) is supported for LTM cell switch, where the TA included in the LTM cell switch command is applied to the TAG configured for the indicated TCI state in LTM cell switch command. Rel-19 2TA (sDCI mTRP) can be naturally applied in the same way.

In addition, PL offset is applied for asymmetric UL mTRP. Since the PL offset is configured per TCI state, the PL offset configured for the indicated TCI state in the LTM cell switch command can be directly applied for the first PUSCH transmission in RACH-less LTM cell switch for the target cell.

**Q3: Do you agree the following view?**

**3-1: For asymmetric UL mTRP, Rel-19 2TA (sDCI mTRP) is supported for LTM cell switch in the same way as Rel-18 2TA (mDCI mTRP), i.e., the TA included in the LTM cell switch command is applied to the TAG configured for the indicated TCI state in LTM cell switch command.**

**3-2: The PL offset, if configured, for the indicated TCI state in the LTM cell switch command is applied for the first PUSCH transmission in RACH-less LTM cell switch.**

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| **Company** | **Y/N** | **Comments** |
| CATT | Yes |  |
| Sharp | Yes with comments | We are ok with 3-1.Regarding to 3-2, it is not sure if PL offset could be configured in advance before LTM cell twitch. If yes, it is ok, otherwise, it should be indicated in the LTM cell switch command explicitly. |
| LGE | Yes |  |
| ZTE | See comments | For the 3-2, we need to check whether it’s possible to get the PL offset in advance first, we think for the FR1 intra-DU, maybe it’s possible, but for the FR1 or inter-DU, it’s not clear.For the 3-1, we think if 3-2 is not supported, we are not sure whether LTM to the asymmetric TRP can work, if can’t, we are not sure whether it’s necessary to support 2 TA feature.Thus we prefer to have more time to check or to confirm with RAN1 on 3-2 first. |
| Huawei | See comments | In Rel-18, LTM with 2TA was designed in the LTM session, we prefer to do the same here. |
| Ofinno  | Yes | Agree with Sharp |
| Qualcomm | Comment | Asymmetric UL mTRP is scoped as intra-DU in WI. So the LTM discussed here is for intra-DU LTM in Rel 18.For 3-1, **if PL offset is not configured** (i.e. the UL mTRP may transmit SSB), the Rel-18 2TA (mDCI mTRP) may be applied but with only one DCI not mDCI; otherwise, don’t see it’ll work without changing the pre-sync procedure for LTM.For 3-2, following the operations of configuration with LTM, pre-DL/UL synchronization and then LTM cell switch using CG, it’s not clear how PL offset can be obtained without changing the current LTM spec. |
| Nokia | See comments |  We agree with ZTE.  |
| Samsung | Yes | Agree with QC that the scope here is intra-DU LTM. RAN1 and RAN4 consider also the scenario asymmetric DL sTRL/UL mTRP with no PL offset, and UE may expect to receive SSB from UL TRP(s) in this scenario. RAN1 has made agreements regarding this scenario. Therefore Rel-19 2TA for sDCI mTRP is for both with and without PL offset, and all Rel-18 2TA procedure can be applied except some changes in RRC configuration. 2TA for sDCI mTRP should be supported for LTM with no difference to Rel-18 2TA. Regarding whether it is possible for NW to pre-configure PL offset in LTM configuration, it is totally up to NW implementation and the scenario of LTM. For example, PL offset can be pre-configured if the UL-only TRP is from the additional PCI in ICBM or inter-cell mTRP and the additional PCI is the LTM target cell. If PL offset is not configured, then the current LTM cell switch procedure is applied. There is no need to introduce PL offset in the LTM cell switch MAC CE since UE can always transmit to the anchor TRP. If PL is not pre-configured, it implies NW may not know the PL offset for the target cell. NW may first need to estimate PL offset based on UL transmission to the anchor TRP.  |

Summary:

One company mentioned the issue should be discussed in mobility session similar as in Rel-18. The issue was discussed in mobility session in Rel-18 because it was raised by companied during the maintenance of LTM. In rapporteur’s view, since Rel-19 scenario of asymmetric DL sTRP/UL mTRP has been discussed in MIMO session, we can discuss the co-existence with other features.

Based on the comments, first we need to build common understanding on the scenario asymmetric DL sTRL/UL mTRP with no PL offset (i.e. UE may expect to receive SSB from UL TRP(s)). Discussion is expected based on contribution.

**Proposal 5: discuss the scenario asymmetric DL sTRL/UL mTRP with no PL offset (i.e. the UL TRP may transmit SSB) based on RAN1/RAN4 LS (R1-2503091) and spec. impact regarding 2TA for sDCI mTRP.**

5 companies agree with 3-1, and the concern for 3-2 is whether NW can pre-configure PL offset in LTM configuration. Based on the comments, the following aspects regarding asymmetric TRP in intra-DU LTM are to be discussed based on contribution.

**Proposal 6: discuss to support sDCI mTRP 2TA for intra-DU LTM, in the same way as Rel-18 mDCI mTRP 2TA, i.e., the TA included in the LTM cell switch command is applied to the TAG configured for the indicated TCI state in LTM cell switch command.**

**Proposal 7: Regarding PL offset in LTM, discuss**

1. **how to apply the PL offset in intra-DU LTM when PL offset is provided in LTM configuration (e.g., the PL offset for the indicated TCI state in the LTM cell switch command is applied for the first PUSCH transmission in RACH-less LTM cell switch);**
2. **whether to support PL offset in intra-DU LTM when PL offset is not provided in LTM configuration for the target cell.**

## MAC-4: TCI state activation MAC CE for asymmetric DL sTRP/UL mTRP

**Issue description:**

To discuss whether/how Rel-18 TCI state activation MAC CEs for sDCI mTRP can be applied for asymmetric DL sTRP/UL mTRP [3][4][5][6].

**Discussion:**

RAN1 has made a conclusion for asymmetric DL sTRP/UL mTRP.

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| **Conclusion RAN1#117**For the asymmetric DL sTRP/UL mTRP deployment scenario, reuse the rel-17 unified TCI/ICBM and rel-18 unified TCI framework:* When rel-17 unified TCI/ICBM is configured:
	+ For FR1: one joint TCI state or {one DL TCI state + one UL TCI state} can be applied.
	+ For FR2: {one DL TCI state + one UL TCI state} can be applied.
* When rel-18 unified TCI is configured:
	+ For FR1: up to two joint TCI states or {one DL TCI state + up to two UL TCI state} can be applied.
	+ For FR2: {one DL TCI state + up to two UL TCI states} can be applied.
 |

Based on this conclusion, there are so-far different views related to the Rel-18 TCI state activation MAC CEs for sDCI mTRP.

* [3] Rel-18 TCI state activation MAC CEs for sDCI mTRP cannot work for asymmetric DL sTRP/UL mTRP. Send an LS to RAN1 to ask whether the Rel-18 MAC CEs can be applied or enhancement is needed.
* [4] The Rel-18 MAC CEs can work for asymmetric DL sTRP/UL mTRP with no enhancement, e.g., NW always activates one joint/DL TCI state for each codepoint (by setting a Fi,j field as 0), or provides same QCL information for the two indicated DL TCI states so that from UE perspective it is DL sTRP operation.
* [5][6] Reuse the Rel-18 MAC CEs, for separate mode the Fi,j field for the DL TCI state for the UL-only TRP is set to 0 and the UE ignores this Fi,j field.

In Rapporteur’s understanding, the Rel-18 MAC CEs can support the TCI state activation for the cases in the above RAN1 conclusion. How to indicate one/two activated TCI state(s) to be applied in the asymmetric scenario based on the existing RRC/MAC signaling may be specified/enhanced by RAN1 if needed. Companies are welcome to internally check with RAN1. So far RAN1 has not informed any need of signaling enhancement, LS can be sent to RAN1 if needed. This issue is expected to be discussed in contribution.

# Other identified open issues

Companies are invited to describe any other identified open issues.

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| **Company** | **Other identified open issues? (please describe)** |
| Samsung | Issue-1:At the time UE initiated beam reporting is triggered, UE may not be UL synchronized (e.g. TAT is expired). If UE is not UL synchronized, PUCCH/PUSCH cannot be transmitted. When TAT is expired, there is no valid PUCCH/PUSCH resource to transmit UEI report (i.e., PUCCH resource is released by RRC and type-1 CG is cleared in MAC). For pending SR, UE triggers RACH if UE is not UL synchronized. Similar for UEI report, UE behavior should be discussed and specified.Issue-2: The current MAC specifies whether to transmit CSI report for activated/deactivated SCell/SCG (clause 5.9), handling of measurement gaps, FR2 UL gaps, BWP operation, cell DRX operation (clause 5.9, 5.14, 5.15.1, 5.29 5.30, 5.34.3). Whether the same rule is applied to UEI report should be discussed. |
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Summary:

Two more issues are identified and expected to be discussed based on contribution.

**Proposal 8: Discuss UE behavior when UE-initiated report is triggered but there is no valid PUCCH/PUSCH resource to transmit UE-initiated report (e.g., PUCCH resource is released by RRC and type-1 CG is cleared in MAC due to TAT expired).**

**Proposal 9: Discuss whether the same rule of CSI report transmission is applied to UEI report (e.g., for activated/deactivated SCell/SCG, handling of measurement gaps, handling of FR2 UL gaps, BWP operation, cell DRX operation).**

# Conclusions

The following proposals have been provided based on feedback to the above document:

Proposals for easy agreement:

**Proposal 1: (9/9) UL skipping is not applicable to mode-B type-1 CG event-triggered beam report.**

**Proposal 2: (9/9) For Rel-16 UL skipping (enhancedSkipUplinkTxDynamic), the UCI for mode-A DG-based UE-initiated report follows the existing procedure (i.e., MAC PDU is generated), there is no MAC impact.**

**Proposal 4: (7/9) The existing rule is applied to handle the overlapping/prioritization between the PUSCH of mode-A UE-initiated report and SR/other PUSCH in MAC.**

Issues for discussion:

**Proposal 3: For Rel-15 UL skipping (skipUplinkTxDynamic is configured), discuss whether to generate MAC PDU for multiplexing UCI of mode-A DG-based UE-initiated report in PUSCH.**

**Proposal 5: discuss the scenario asymmetric DL sTRL/UL mTRP with no PL offset (i.e. the UL TRP may transmit SSB) based on RAN1/RAN4 LS (R1-2503091) and spec. impact regarding 2TA for sDCI mTRP.**

**Proposal 6: discuss to support sDCI mTRP 2TA for intra-DU LTM, in the same way as Rel-18 mDCI mTRP 2TA, i.e., the TA included in the LTM cell switch command is applied to the TAG configured for the indicated TCI state in LTM cell switch command.**

**Proposal 7: Regarding PL offset in LTM, discuss**

1. **how to apply the PL offset in intra-DU LTM when PL offset is provided in LTM configuration (e.g., the PL offset for the indicated TCI state in the LTM cell switch command is applied for the first PUSCH transmission in RACH-less LTM cell switch);**
2. **whether to support PL offset in intra-DU LTM when PL offset is not provided in LTM configuration for the target cell.**

**Proposal 8: Discuss UE behavior when UE-initiated report is triggered but there is no valid PUCCH/PUSCH resource to transmit UE-initiated report (e.g., PUCCH resource is released by RRC and type-1 CG is cleared in MAC due to TAT expired).**

**Proposal 9: Discuss whether the same rule of CSI report transmission is applied to UEI report (e.g., for activated/deactivated SCell/SCG, handling of measurement gaps, handling of FR2 UL gaps, BWP operation, cell DRX operation).**

# References

1. R2-2502065 Further discussion on UE-initiated/event-driven beam management SHARP Corporation discussion NR\_MIMO\_Ph5-Core
2. R2-2502374 Discussion on UEIBR Lenovo discussion Rel-19
3. R2-2502167 Discussion on MAC CE impact for asymmetric DL sTRP/UL mTRP scenarios vivo discussion Rel-19 NR\_MIMO\_Ph5-Core
4. R2-2502665 Discussion on Asymmetric DL sTRP/UL mTRP Samsung discussion Rel-19 NR\_MIMO\_Ph5
5. R2-2502713 Discussion on Asymmetric DL sTRP/UL mTRP CMCC discussion Rel-19 NR\_MIMO\_Ph5-Core
6. R2-2502834 Discussion on remaining issues on Asymmetric DL sTRP/UL mTRP Huawei, HiSilicon discussion Rel-19 NR\_MIMO\_Ph5-Core