**3GPP TSG RAN WG1 #107-e R1-210xxxx**

**e-Meeting, November 11th – 19th, 2021**

Source: moderator (vivo)

Title: Feature lead summary on Enhancements on Multi-TRP inter-cell operation

Agenda Item: 8.1.2.2

Document for: Discussion and Decision

1. Introduction

In this contribution, contributions submitted in AI 8.1.2.2 are summarized. In section 2, the points raised in the contributions are listed.

1. 1. Item 1: Rate matching

Proposal 1:

* PDSCH/PDCCH from serving cell is rate matched around SSB (associated with activated TCI states) with PCI different from serving cell PCI
	+ Introduce a UE capability indicating above behavior

|  |  |
| --- | --- |
| Company | comments |
| QC | Not support. We do not think additional mechanisms for rate matching is needed, which increase the overhead. |
| Apple | Support.  |
| ZTE | Do NOT support, we think such additional rules will negatively impact resource efficiency and cause performance loss.Besides, note that the previous agreement on rate matching specify non-serving cell PDSCH/PDCCH need to be rate matched around **all the RRC-configured non-serving cell SSBs** with the same PCI, we think it is too handling. Given that TCI states of non-serving cell SSBs can be determined/activated by MAC CE, we think it is more reasonable to rate match **the SSBs in activated TCI states, instead of all activated and inactivated TCI states**, for PDSCH/PDCCH. Hence, we suggest the following modification (highlighted as red):***Proposal 1：****PDSCH/PDCCH from cell with PCI different from serving cell PCI associated with TCI state and/or QCL-info is rate matched around non-serving cell SSB (only in activated TCI states) with the same PCI* |
| OPPO | Not support. RAN1 has discussed this issue without conclusion. |
| Spreadtrum | Not support.  |
| LG | Support.  |
| Xiaomi | We prefer to support proposal 1. For inter-cell mTRP, the beam measurement based on non-serving cell SSB is needed. To measure the SSB with different PCI correctly, additional rate matching behavior may be needed. If not, how to perform beam measurement on neighboring cell SSB because UE may not be able to receive from serving cells and measure non-serving cell SSB at the same time. |
| Lenovo/MotM | Don’t support considering the resource efficiency. |
| Ericsson | Not support. To reply to Xiaomi, the UE is already today performing such inter-cell measurements in L3 mobility. We don’t see why this case would be different.  |
| Huawei, HiSilicon | Not support, similar view as Qualcomm.  |
| MediaTek | Don’t support |
| NTT DOCOMO | Not support. Agree with QC. |
| CATT | Support, to avoid interference between SSB and PDSCH from different cells. |
| Nokia/NSB | Not support.  |

* 1. Item 2: switching between intra-cell and inter-cell mTRP

Proposal 2:

* For switching, between intra-cell MTRP and inter-cell MTRP, support one PCI associated with activated TCI states can be associated with more than one CORESETPoolIndex and one CORESETPoolIndex can be associated with only one PCI associated with activated TCI states

|  |  |
| --- | --- |
| Company | comments |
| QC | Not needed. Switching between intra-cell and inter-cell mTRP is already possible by MAC-CE. We do not see the need for this proposal.  |
| Apple | We also think this is already supported by MAC CE. |
| ZTE | Already supported by MAC CE. |
| OPPO | Not needed. |
| Spreadtrum | Not needed. Already supported by MAC CE. |
| LG | Already supported by MAC CE. |
| Xiaomi | Support proposal 2.I think this issue is all about the association between PCI and CORESETPoolIndex when switching between intra-cell mTRP and inter-cell mTRP, not the way to perform switching between intra-cell mTRP and inter-cell mTRP. There is agreement about the association between PCI and CORESETPoolIndex as shown below:**Agreement*** For inter-cell mTRP , one PCI associated with one or more of activated TCI states for PDSCH/PDCCH is associated with one *CORESETPoolIndex* , another PCI associated with one or more of activated TCI states for PDSCH/PDCCH is associated with another *CORESETPoolIndex*
* FFS : The association between PCI and *CORESETPoolIndex* when switching between intra-cell mTRP and inter-cell mTRP

However, the first bullet is not appropriate anymore considering the switching between inter-cell mTRP and intra-cell mTRP. Because for intra-cell mTRP, there are two CORESETPoolIndex that associated with one PCI. From our understanding, what this proposal is trying to do is clarifying the association between PCI and CORESETPoolIndex when switching between intra-cell mTRP and inter-cell mTRP. Therefore, we do not agree that this proposal is not needed just because the switching between intra-cell and inter-cell mTRP is already possible by MAC-CE. |
| Lenovo/MotM | Not needed. Already supported by MAC CE. |
| Huawei, HiSilicon | Is the proposal to increase the maximum number of CORESET pools that can be configured to UE? |
| MediaTek | Not needed |
| NTT DOCOMO | We think it is allowed to switch between intra-cell mTRP and inter-cell mTRP operation by MAC CE based on current spec.. Then, the question is, whether to support DCI based switching between intra-cell mTRP and inter-cell mTRP operation. We do not support DCI based switching. To make such restriction clearer, we should limit at most one PCI is associated with the activated TCI states with one CORESETPoolIndex. Because, to support DCI based switching, the activated TCI states for PDSCH/PDCCH associated with one CORESETPoolIndex need to include TCI states with two different PCIs. This should be avoided.Hence, we suggest following revision to avoid DCI based switching between intra-cell mTRP and inter-cell mTRP.Proposal 2: * At most one PCI is associated with the activated TCI states for PDSCH/PDCCH associated with one CORESETPoolIndex.
 |
| CATT | Not needed. This is already supported by MAC CE |
| Nokia/NSB | Not fully sure the wording used in the proposal is correctly capture switching between intra-cell and inter-cell multi-TRP operation. In any case, we think switching is already supported based on latest spec draft. There may be one open issue when switching from inter-cell to intra-cell operation: CORESETs under the same CORESETpoolindex can be associated with different PCIs during the intermediate state (during switching) due to MAC-CE commands for different CORESETs of same CORESETPoolIndex may not be received at given time. Unless some explicit behavior defined for current MAC-CE signaling framework, it allows one CORESETPoolIndex to have two different PCIs (specially in this kind of intermediate stages). From our view, the UE is not required to monitor two different PCIs under same CORESETpoolindex, and it may follow one PCI per CORESETPollindex where PCI could be the latest indicated PCI).  |

* 1. Item 3: Type0/0A/1/2 CSS in a CORESET

Proposal 3:

* CORESETs associated with Type 0/0A/1/2 SS should not be configured/activated with TCI states associated with SSB of PCI different from the serving cell PCI.

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| --- | --- |
| Company | comments |
| QC | Ok.  |
| Apple | Support in principle, but suggest we add a bracket for Type2 CSS, since this is under discussion in 8.1.1. In addition, it seems in the proposal “SS” should be changed into “CSS”. |
| ZTE | Agree with Apple. |
| OPPO |  Support. |
| Spreadtrum | Support |
| LG | Support |
| Xiaomi | Support proposal 3.For this issue, the LS reply to RAN2 as follows can be good reference.

|  |
| --- |
| **Question 2:** The WI states that "*For inter-cell beam management, a UE can transmit to or receive from only a single cell (i.e. serving cell does not change when beam selection is done)*". Then, when the UE is configured to use both *serving cell TRP* and *TRP with different PCI*, RAN2 would like to understand the corresponding behaviour for: a) …b) **System information and short message (e.g. paging):** If UE is receiving DL data from TRP with different PCI on dedicated channels, is the UE still able to receive short message (e.g. paging) and system information from serving cell TRP at the same time?**Answer 2.b**: The system information for inter-cell beam management can be only received from the serving cell TRP. With respect to the paging/short messages for inter-cell beam management, RAN1 is currently discussing this issue.**Question 3:** RAN2 would like to understand the impacts to MAC operation, in particular:a) …b) **RACH:** Are there any impacts to RACH operation with inter-cell beam management? That is, is it necessary to perform RACH toward TRP with different PCI e.g. for TA, BFR, etc?**Answer 3.b**: Currently, RAN1 has not identified any impact on RACH operation, i.e., RACH transmission should be performed by the UE using the serving cell configuration. |

For inter-cell beam management, CORESETs associated with at least Type 0/0A/1 SS should not be configured/activated with TCI states associated with SSB of PCI different from the serving cell PCI. This can be used as reference for inter-cell mTRP. |
| Lenovo/MotM | Support |
| Ericsson | Support |
| Huawei, HiSilicon | Similar to previous meeting, we prefer to say that the UE is not required to monitor those CSS if configured as above. With above formulation, we are not sure if the editor of 38.213 will refuse to capture above proposal if it is agreed.  |
| MediaTek | Support |
| NTT DOCOMO | Support |
| ASUSTeK | Similar view as Apple. |
| CATT | Support |
| Nokia/NSB | Not support the current wording. Similar view as HW, we discussed this last meeting and this is putting extra restriction on the network side. Since the intra/inter cell switching is supported we propose not to restrict the SS configuration on particular CORESET. Propose to change the proposal to:***Proposal 3: UE is not expected to monitor a Type0/0A/1/2 CSS in a CORESET when the active TCI state is associated with a PCI different from serving cell PCI.*** |

* 1. Item 4: On additional PCI value X

Proposal 4:

For the number of additional PCIs configured per CC:

* Support at least adding X = 5

On UE capability reporting,

* Support per-band capability reporting,
	+ For default X1 and X2 values selection one of the following options.
		- Option1: By default Case 1 with X1=1 and Case 2 with X2=1 are supported.
		- Option2: By default Case 1 with X1=1 (and Case2 with X2=0) is supported.

|  |  |
| --- | --- |
| Company | comments |
| QC | These are being discussed as part of UE features. There is no need for parallel discussions. |
| Apple | We are fine to add X=5, but we think the second part on default behavior is not needed, which can be part of UE feature discussion. |
| ZTE | For the first part, the motivation of X=5 is unclear, we do NOT support it.For the second part, we share the similar view with QC and Apple. |
| OPPO | Suggest to discuss it in UE feature. |
| Spreadtrum | It can be discussed in UE feature session. |
| LG | It can be discussed in UE feature session. |
| Xiaomi | Agree with QC. |
| Lenovo/MotM | It can be discussed in UE feature.  |
| Ericsson | Ok to support X2=5 (Case 2), but for X1 (Case 1), there should be no complexity difference between 5 and 7 so adding 5 is not neccessary. About UE capability reporting and per-band discussion, this needs to be taken in the UE feature agenda item. |
| Huawei, HiSilicon | Fine to add X = 5. Default values may not be needed.  |
| MediaTek | Can be discussed in UE feature. |
| NTT DOCOMO | Okay to add X=5.Default case for UE capability is needed. Okay to discuss it here or in UE feature. |
| ASUSTeK | Agree with QC. |
| CATT | Prefer to discuss in UE feature |
| Nokia/NSB | Ok to discuss in UE feature sessions.  |

* 1. Item 5: Others

**Proposal 5-1 :** Clarify that ‘PDSCH/PDCCH from non-serving cell’ or ‘PDSCH/PDCCH from cell with PCI different from serving cell PCI’ refer to PDSCH/PDCCH from the serving cell but has a SSB/CSI-RS from cell with PCI different from serving cell PCI as indirect QCL source.

**Proposal 5-2:** The UE can assume that non-serving-cell use the same Point A as the serving-cell when receiving from the non-serving-cell. Hence, no specification impact is

**Proposal 5-3:** At most one PCI is associated with the activated TCI states for PDSCH/PDCCH associated with one CORESETPoolIndex.

**Proposal 5-4:** PDSCH/PDCCH associated with one CORESETPoolIndex can be associated with only one PCI at a time, and at least one of the two CORESETPoolIndexes should be associated with PCI of serving cell.

**Proposal 5-5:** Support inter-cell multi-DCI based multi-TRP operation, for both cases of CORESETPoolIndex is configured and not configured

**Proposal 5-6:** Configuration framework of Rel-17 unified TCI and inter-cell mTRP can be further discussed, at least for CORESETPoolIndex associated with PCI of the serving cell, it seems Rel-17 unified TCI framework can be applied.

**Proposal 5-7:** Define a new/independent IE for cells with additional PCIs for MTRP inter-cell operation.

* + At least PhysCellId is included in the IE.
	+ A new RRC indicator/signaling (e.g., re-index the non-serving cells) is needed in the IE to indicate each cell with different PCI.

**Proposal 5-8:** The information related to “SSB time domain position” for SSB with PCI different from the serving cell consists of halfFrameIndex.

**Proposal 5-9:** Support indication of ss-PBCH-BlockPower associated with the non-serving cell to the UE.

**Proposal 5-10:** For inter-cell multi-TRP, SSB associated with a physical cell ID different from that of the serving cell can only be used as an indirect QCL reference for PDSCH.

**Proposal 5-11:** UE is not expected to track a SSB with additional PCI which is not associated with any activated TCI state unless the SSB is configured for L1 measurement.

**Proposal 5-12:** If SSB and PDSCH associated with the same PCI are transmitted on the same symbol, the PDSCH and SSB should be QCLed with QCL-TypeD and should not overlap.

**Proposal 5-13:** In an inter-cell mTRP operation, UE can receive at least one PDCCH configuration that is related to at least one of its neighboring cells, e.g., PDCCH-config\_neighbor.

**Proposal 5-14:** Indication of an additional PCI for same/cross-carrier scheduling is not needed.

**Proposal 5-15:** SSB from a non-serving cell can be directly configured in QCL-info and SSB-InfoNcell-r16/SSB-Configuration-r16 are used to provide the non-serving cell’s information for the UE to obtain the correct SSB information.

**Proposal 5-16:** The non-serving PCID configured in SSB-InfoNcell-r16/SSB-Configuration-r16 is associated with a neighboring cell configured that is configured in a CSI-ReportConfig containging RS resources associated with one or more non-serving cells.

**Proposal 5-17:** The configured non-serving cell’s SSB is within the SMTC configured for this cell.

**Proposal 5-18:** When SSB is used as reference signal in *SRS-SpatialRelationInfo, PUCCH-SpatialRelationInfo, PUCCH-PathlossReferenceRS, PUSCH-PathlossReferenceRS,* and *pathlossReferenceRS* under *SRS-ResourceSet*, the configuration indicates whether the *SSB-Index* is associated with the serving cell PCI or the other PCI.

**Proposal 5-19:** Any UL channels/signals (no matter associated with serving cell PCI or non-serving cell PCI) should NOT be transmitted in the symbols of non-serving cell SSB in TDD operation.

**Proposal 5-20:** Clarify that “PDSCH from non-serving cell (PCI)” are those PDCH/PDCCH that use SSB associated with a physical cell ID different from that of the serving cell as an indirect QCL reference.

* Note: When RS X is an indirect QCL reference of a target channel, there exists at least one other source signal on the QCL chain between RS X and the target channel

**Proposal 5-21:** Additional info for non-serving cell should include rate matching pattern as well as LTE-CRS rate matching pattern.

**Proposal 5-22:** For downlink signals associated with a non-serving cell, if virtual cell ID is not configured, the default ID should be PCI for the non-serving cell.

**Proposal 5-23:** With regard to minimal delay for L1-RSRP measurement from overlapped SSBs, additional delay should be introduced with Z=Z3+d and Z’=Z3’+d, where d indicates the number of symbols for the overlapped SSBs

**Proposal 5-24:**

* Apply Rel-17 BFR enhancement for mTRP also for inter-cell mTRP
* Confirm that TRP-specific BFD counter and timer in the MAC procedure is supported on both Serving Cell and non-Serving Cell in inter-Cell multi-TRP operation.
* Confirm that BFRQ framework based on Rel.16 SCell BFR BFRQ is supported on both Serving Cell and non-Serving Cell in inter-Cell multi-TRP operation.

**Proposal 5-25:**

* For multi-DCI based MTRP inter-cell operation,
	+ For per-cell BFR, SSB associated with additional PCI can be configured as BFD-RS explicitly/implicitly.
	+ For per-TRP BFR, SSB associated with additional PCI can be configured as BFD-RS in the BFD-RS set associated with corresponding CORESETPoolIndex.

**Proposal 5-26:** If one PUCCH-SR resource is supported for inter-cell mTRP operation, adopt table 1 for initiating BFR procedure for inter-cell mTRP SpCell regarding different scenarios of beam failure detection.

**Proposal 5-27:** If two dedicated PUCCH-SR resources is supported for inter-cell mTRP operation, a dedicated PUCCH-SR resource in a cell group should be associated with a non-Serving Cell, where the UE performs inter-Cell multi-TRP operation on the non-Serving Cell and a Serving Cell in the cell group.

**Proposal 5-28:** Use the received indication for operating in inter-cell mode to determine the PCI associated to the CORESETPoolIndex.

**Proposal 5-29:** During the intermediate state (during the switching) between serving cell and different PCI, the UE is not required to monitor scheduling from a CORESET with associated with different PCI if the TCI state is associated with different PCI than the latest activated TCI state under the same CORESETpoolindex

**Proposal 5-30:** In the set of symbols indicated to a UE by non-serving cell *ssb-PositionsInBurst*,

* Option 1: The UE does not transmit any UL signal/channel.
* Option 2: The UE can only transmit UL signal/channel associated with the serving cell PCI.
* Further study the impact on the following Rel. 15/16 procedures based on a selected option from Option 1 or 2 above:
	+ Procedure 1: When SSB overlaps with UL channel/RS, UE does not transmit the UL channels/RS [38.213, Section 11.1].
	+ Procedure 2: UE does not expect the set of SSB symbols to indicated as uplink symbols either semi-statically or dynamically (by SFI) [38.213, Section 11.1 and Section 11.1.1].
	+ Procedure 3: SSB symbols are assumed to be invalid symbols in a nominal repetition for PUSCH repetition Type B [38.214, Section 6.1.2.1].
	+ Procedure 4: For determination of the $N\_{PUCCH}^{Repeat}$ slots in the case of PUCCH repetition, i.e., a slot is not counted toward the $N\_{PUCCH}^{Repeat}$ slots if the PUCCH resource in that slot overlaps with a SSB [38.213, Section 9.2.6].

Please indicate in the table below which proposals do you think are essential and your priority for handling in RAN1#107-e.

|  |  |
| --- | --- |
| Company | comments |
| QC | We are not sure how to comment on this section with 30 proposals. Some proposals are on the same issue. Some proposals have been discussed before multiple times, and some proposals are unclear.It would be helpful if the moderator can categorize the proposals and provide FL proposals based on essentiality / importance of the issues. |
| Apple | We suggest we prioritize proposals with potential RRC impact, for example, the following proposal:**Proposal 5-8:** The information related to “SSB time domain position” for SSB with PCI different from the serving cell consists of halfFrameIndex. **Proposal 5-21:** Additional info for non-serving cell should include rate matching pattern as well as LTE-CRS rate matching pattern. |
| ZTE | We have similar feeling with QC, it will be helpful and better to classify and rate these 30 proposals according to FL’s assessment.For reference, we suggest to discuss the following aspects of inter-cell MTRP at first:1. UL channels/signals QCL enhancements, i.e. proposal 5-18.
2. collision handling between UL channels/signals and non-serving cell SSB, i.e. proposal 5-19, proposal 5-30.
3. collision handling between PDSCH and non-serving cell SSB, i.e. proposal 5-12.
4. Additional non-serving cell SSB information, i.e. proposal 5-8, proposal 5-21.
5. Default virtual cell ID, i.e. proposal 5-8, proposal 5-22.
 |
| OPPO | We suggest to discuss the collision between non-serving cell SSB and signal from serving cell firstly, e.g. which signal is prioritized.  |
| Xiaomi | According to the revised WID, the QCL/TCI-related enhancements to support the inter-cell mTRP operation is based on the Rel-15/16 TCI framework, in which the UL beam management is quite different from DL beam management. We think that enhancements of spatial relation for UL beam management should further discussed. In addition, ZTE’s comments seem acceptable. |
| Ericsson | Support P5-2, P5-9, P5-24On P5-8, we would like to know why this needs to be signalled ?On P5.17: measurements are handled in AI 8.1.1 |
| Huawei, HiSilicon | Support 5-1 and 5-20. |
| NTT DOCOMO | First, Proposal 5-8 is highly related to our agreement and FFS in last meeting.Second, suggest discussing following aspects.* UL of non-serving cell : Proposal 5-18.
* Clarification of MTRP BFR in MTRP inter-cell : Proposal 5-24, 5-25.
 |
| ASUSTeK | We share similar view with ZTE, and would like to add (vi) Rel-17 BFR enhancement for inter-cell mTRP, i.e., proposal 5-24, 25, 26. We suggest to confirm that per-TRP BFR could be applied for intra-cell and inter-cell mTRP. Further consider BFR for the scenario that beam failure is detected on one TRP in SpCell while no beam failure on the other TRP in non-serving cell associated to SpCell. We’d like to clarify table 1 mentioned in Proposal 5-26 is to discuss whether RACH-based BFR or PUCCH-based BFR should be performed for different scenarios in inter-Cell mTRP operation:

|  |  |  |
| --- | --- | --- |
|  | Beam failure on TRP of non-serving cell associated with SpCell | No beam failure on TRP of non-serving cell associated with SpCell |
| Beam failure on TRP of SpCell  | RACH-based BFR  | RACH-based BFR |
| No beam failure on TRP of SpCell | PUCCH-based BFR | - |

 |
| Nokia/NSB | Proposal 5-5 and 5-7 are discussing similar thing where CORESETPoolindex is not configured. We suggest to discuss it such that switching between multi-DCI and s-DCI can be easily supported without RRC reconfiguration. Proposal 5-24, 25, 26 are discussing also an important issue, where extending per TRP BFR is useful by using a similar framework as Rel-17 mTRP BFR. |

1. Previous agreements

RAN1 #102-e:

**Agreement**

Study the following aspects of QCL /TCI-related enhancement to enable inter-cell multi-DCI based multi-TRP operation.

* Details on configuration of non-serving cell RS;
* Allowed source and target RS types for RS transmitted from the non-serving cell TRP ;
* Allowed QCL types for RS transmitted from the non-serving cell TRP ;
* Measurement and reporting related to QCL /TCI enhancement except for that in 8.1.1, if any;
* Clarification on potential UE behavior for associating/multiplexing non-serving cell RS with other RS/channels;

Other details not precluded.

RAN1#103-e:

**Agreement**

For QCL /TCI related enhancement for enhanced inter-cell multi-TRP operations, support RRC configuration of non-serving cell information

* Non-serving cell information can be associated with the TCI state and/or QCL -info at least when “neighbor cell SSB” is used as “QCL referenceSignal ”
	+ FFS : Whether beam indication enhancement is needed in addition to QCL -info enhancement
	+ FFS : Whether the association is explicit or implicit

**Agreement**

The information provided by SSB-Configuration-r16/ssb-InfoNcell-r16 and/or MeasObject can be starting point for providing non-serving cell information

**For future meetings**

Consider rate matching behavior related to non-serving cell SSB.

RAN1#104-e:

 **Agreement**

Non-serving cell information at least includes non-serving cell PCI to support inter-cell multi-DCI multi-TRP operation

* FFS: Whether the indication of PCI is implicit or explicit

**Conclusion**

Reuse Rel-15/16 QCL rule between the source and target RS/channel for non-serving cell RS/channel.

**Agreement**

At least following non-serving cell SSB information are needed in inter-cell MTRP operation

* SSB time domain position
* SSB transmission periodicity
* SSB transmission power

FFS: Other non-serving cell information

FFS: Whether indication of these information is implicit or explicit

**Agreement**

For inter-cell MTRP operation, further discuss following options and down select in RAN1#104bis-e

* Option1: Indicate/associate non-serving cell PCI in the TCI state
	+ FFS other non-serving cell information
* Option2: Introduce a flag to indicate whether a TCI state/QCL information is associated with non-serving cell information or serving cell
	+ FFS: how the flag is linked to non-serving cell
* Option3: Explicit or implicit grouping of TCI states associated with non-serving cell information corresponding to the serving cell and the non-serving cell respectively.
	+ FFS: Each group is associated with a CORESETPoolIndex value.
	+ FFS: how to link the group of TCI states to non-serving cell.
* Option4: Re-index the non-serving cell RS, e.g., in the TCI state/QCL-Info, so that the UE can differentiate between a serving cell RS and a non-serving cell RS
	+ Example: serving cell RSs are indexed from #0, #1, …, #N-1, while non-serving cell RSs are re-indexed from #N, #N+1, …
	+ FFS: detailed re-indexing rule(s) of non-serving cell RSs
* Option5: Introduce a new indicator (e.g., re-index the non-serving cell) to indicate the non-serving cell information that a TCI state/QCL information is associated with
	+ FFS: how the indicator is linked to non-serving cell
	+ Note: when there is only one non-serving cell, it means the same as Option2.

**Agreement**

Agree on scheme1

* Scheme1: PDSCH/PDCCH from non-serving cell (PCI) associated with TCI state and/or QCL-info is rate matched around non-serving cell SSB with the same PCI
* FFS: whether PDSCH /PDCCH from serving cell (PCI) is rate matched around non-serving cell SSB
* FFS: whether PDSCH/PDCCH from non-serving cell (PCI) associated with TCI state and/or QCL-info is rate matched around serving cell SSB

**Conclusion**

The UE may assume received DL transmission from multiple TRP within a CP in FR1 and FR2.

* Note: This does not imply that RAN1 intends to ask RAN4 to tighten network synchronization requirements.

RAN1#104b-e:

**Agreement**

* For intercell MTRP operation, 1 additional PCI different from the serving cell PCI is supported per CC
	+ The additional PCI is the one associated with one or more TCI states that are activated for [CSI-RS for CSI]/PDSCH/PDCCH, per CC.
	+ Applicable at least for non-cross carrier QCL indication
		- FFS: Cross carrier scheduling QCL indication
* RAN1 to decide on the maximum number of PCIs different from the serving cell PCI per CC and/or across all CCs that can be RRC-configured for multi-DCI based inter-cell multi-TRP
* Above should be specified by reusing R15 QCL rules as concluded in RAN1#104-e

**Conclusion**

Configuration of CSI-RS for mobility as QCL source for intercell MTRP operation is not supported from Rel-17 specification point of view

**Agreement**

For intercell MTRP operation, downselect one or more of the following alternatives in RAN1#105-e

* Alt1: one PCI associated with one or more of activated TCI states for [PDSCH]/PDCCH can be associated with only one CORESETPoolIndex
* Alt2: one PCI associated with one or more of activated TCI states for [PDSCH]/PDCCH can be associated with more than one CORESETPoolIndex
* Alt3: one PCI associated with TCI states for [PDSCH]/PDCCH via QCL relationship without association with CORESETPoolIndex

Note: This agreement is not related to the down-selection of one of the 5 options from RAN1#104-e

Note: Above should be specified by reusing Rel-15/Rel-16 QCL rules as concluded in RAN1#104-e

RAN1#106-e

**Agreement**

Introduce a new RRC indicator/signalling (e.g., re-index the non-serving cell) to indicate the non-serving cell information that a TCI state/QCL information is associated with, where the new indicator/signaling is not the exact PCI value

* Detailed signalling design is up to RAN2

**Agreement**

Rel. 17 inter-cell MTRP, the maximum number of additional RRC -configured PCIs per CC is denoted X and can be reported as a UE capability

* For the report value of X, multiple candidate values including 1 is supported.
	+ FFS : Which values to support other than 1.
	+ Values larger than 7 are precluded
	+ RAN1 needs to agree on value(s) of X other than 1
* Down-select one of the following alternatives:
	+ Alt 1: A single value of X is reported as UE capability for any possible SSB time domain position and periodicity
	+ Alt 3: At least Two independent X values (X1, X2) are reported as a UE capability for at least two different assumptions on SSB time domain position and periodicity with respect to serving cell SSB
* The serving cell PCI is always associated with active TCI states, only 1 additional PCI can be associated with the active TCI States

**Agreement**

* For inter-cell mTRP , one PCI associated with one or more of activated TCI states for PDSCH/PDCCH is associated with one *CORESETPoolIndex* , another PCI associated with one or more of activated TCI states for PDSCH/PDCCH is associated with another *CORESETPoolIndex*
* FFS : The association between PCI and *CORESETPoolIndex* when switching between intra-cell mTRP and inter-cell mTRP

**Agreement**

For a CSI-RS QCLed with a neighboring cell SSB, the CSI-RS EPRE is calculated based on *powerControlOffsetSS* and the SSB transmission power in the neighboring cell information.

**Agreement**

LS to RAN2 on multi-TRP inter-cell is endorsed in R1-2108633.

RAN1#106b-e

**Agreement**

* Center frequency, SCS, SFN offset are assumed to be the same for SSBs from the serving cell and the configured  SSBs with PCI different from the serving cell for inter-cell multi TRP operation.
* The information related to “SSB time domain position” for  SSB with PCI different from the serving cell consists of [halfFrameIndex and] ssb-PositionsInBurst

**Agreement**

Support two independent X values (X1, X2) are reported as a UE capability for two different assumptions on additional SSB time domain position and periodicity with respect to serving cell SSB.

* X1 (Case 1)= The maximum number of configured additional PCIs when each configuration of SSB time domain positions and periodicity of the additional PCIs is the same as SSB time domain positions and periodicity of the serving cell PCI
* X2 (Case 2)= The maximum number of configured additional PCIs when the configurations of SSB time domain positions and periodicity of the additional PCIs is not according to Case 1
* Note: By definition, Case 1 and Case 2 cannot be enabled simultaneously
* Supported values for X1 and X2 include~~s~~ at least 0,1,2,3 and 7. FFS on other values
* This UE capability has FR1 and FR2 differentiation (FFS : Whether this UE capability is per UE or per band)
1. Reference

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| [**R1-2110763**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2110763.zip) | Details on M-TRP Inter-cell Operation | InterDigital, Inc. |
| **Observation 1:** Simultaneous configuration of intra- and inter-cell mTRP may be beneficial. **Observation 2:** There may be an ambiguity in interpretation of CORESETPoolIndex = 1 when switching between intra- and inter-cell mTRP operation.**Observation 3:** For switching between inter- and intra-cell operation, using RRC re-configuration to switch between intra- and inter-cell mTRP operation introduces an unnecessary overhead and latency.**Observation 4:** For dynamic switching between intra- and inter-cell mTRP operation, TCI states activation at the MAC level can be used to determine the association of CORESETPoolIndex = 1.**Observation 5:** A UE configured with two different values of CORESETPoolIndex in ControlResourceSet expects to receive multiple PDCCHs in the corresponding configured CORESETs.**Proposal 1:** Support simultaneously configured intra- and inter-cell mTRP operation. **Proposal 2:** Use the received indication for operating in inter-cell mode to determine the PCI associated to the CORESETPoolIndex.**Proposal 3:** Support dynamic switching between intra- and inter-cell mTRP operation.**Proposal 4:** Consider MAC CE activation of TCI states for switching between intra- and inter-cell mTRP operation.**Proposal 5:** In an inter-cell mTRP operation, UE can receive at least one PDCCH configuration that is related to at least one of its neighboring cells, e.g., PDCCH-config\_neighbor. |
| [**R1-2110783**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2110783.zip) | Enhancements on inter-cell multi-TRP operation in Rel-17 | Huawei, HiSilicon |
| Proposal 1: Clarify that ‘PDSCH/PDCCH from non-serving cell’ or ‘PDSCH/PDCCH from cell with PCI different from serving cell PCI’ refer to PDSCH/PDCCH from the serving cell but has a SSB/CSI-RS from cell with PCI different from serving cell PCI as indirect QCL source.Proposal 2: Do not support additional rate matching behaviour for inter-cell multi-TRP operation.  |
| [**R1-2110880**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2110880.zip) | Inter-cell multi-TRP operation | FUTUREWEI |
| Proposal 1: For the number of additional PCIs configured per CC:* Support per-band capability reporting
* Support at least adding X = 5

Proposal 2: For the scenario of a mixture of intra-cell M-TRP and inter-cell M-TRP, intra-cell resources can be differentiated by CORESET pool indexes as in Rel-16, and inter-cell resources can be differentiated by association/grouping via QCL/TCI association to corresponding PCIs.Proposal 3: CORESET pool index is useful for the scenario of switching between intra-cell M-TRP and inter-cell M-TRP.Proposal 4: Indication of an additional PCI for same/cross-carrier scheduling is not needed. |
| [**R1-2110934**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2110934.zip) | Enhancements on Multi-TRP inter-cell operation | Lenovo, Motorola Mobility |
| Proposal 1: SSB from a non-serving cell can be directly configured in QCL-info and SSB-InfoNcell-r16/SSB-Configuration-r16 are used to provide the non-serving cell’s information for the UE to obtain the correct SSB information.Proposal 2: The non-serving PCID configured in SSB-InfoNcell-r16/SSB-Configuration-r16 is associated with a neighboring cell configured that is configured in a CSI-ReportConfig containging RS resources associated with one or more non-serving cells.Proposal 3: The configured non-serving cell’s SSB is within the SMTC configured for this cell.Proposal 4: SSB from a non-serving cell can be configured as the spatial relation and PL-RS for PUCCH resources and SRS resources. |
| [**R1-2110946**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2110946.zip) | Finalizing Multi-TRP inter-cell operation | Ericsson |
| Proposal 1 The UE can assume that non-serving-cell use the same Point A as the serving-cell when receiving from the non-serving-cell. Hence, no specification impact is |
| [**R1-2110950**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2110950.zip) | Discussion on Multi-TRP inter-cell operation | ZTE |
| **Proposal 1:** Support that PDSCH/PDCCH from cell with PCI different from serving cell PCI associated with TCI state and/or QCL-info is rate matched around non-serving cell SSB (only in activated TCI states) with the same PCI.**Proposal 2:** PDSCH/PDCCH from the serving cell should not be rate-matched around any SSB (including activated and non-activated TCI states) from cell with PCI different from serving cell PCI, and vice versa.**Proposal 3:** Support to use non-serving cell SSB for mobility measurement as the PL-RS for uplink transmission.**Proposal 4:** Any UL channels/signals (no matter associated with serving cell PCI or non-serving cell PCI) should NOT be transmitted in the symbols of non-serving cell SSB in TDD operation. |
| [**R1-2110992**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2110992.zip) | Remaining issues on inter-cell MTRP operation | vivo |
| Proposal 1: Clarify that it is not expected for CORESETs associated with type 0/1/2 SS to be configured/activated with TCI states associated with SSB of PCI different from the serving cell PCI.Proposal 2: PDSCH in non-serving cell is not rate matched around SSB from serving cell and PDSCH in serving cell is not rate matched around SSB from non-serving cell.Proposal 3: Clarify that “PDSCH from non-serving cell (PCI)” are those PDCH/PDCCH that use SSB associated with a physical cell ID different from that of the serving cell as an indirect QCL reference.* Note: When RS X is an indirect QCL reference of a target channel, there exists at least one other source signal on the QCL chain between RS X and the target channel

Proposal 4: Update previous agreement on rate matching as following:* PDSCH that uses SSB associated with a physical cell ID as an indirect QCL reference is rate matched around SSB with the same PCI as the indirect QCL reference of the PDSCH.
	+ Note: When RS X is an indirect QCL reference of a target channel, there exists at least one other source signal on the QCL chain between RS X and the target channel
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| [**R1-2111086**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2111086.zip) | Discussion on enhancements on multi-TRP inter-cell operation | Spreadtrum Communications |
| Proposal 1: For inter-cell multi-TRP operation, PDSCH/PDCCH from the serving cell should not be rate-matched around non-serving cell SSB.Proposal 2: For inter-cell multi-TRP operation, PDSCH/PDCCH from non-serving cell (PCI) associated with TCI state and/or QCL-info is not rate matched around serving cell SSB. |
| [**R1-2111223**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2111223.zip) | Remaining issues on inter-cell operation for multi-TRP/panel | CATT |
| Proposal-1: MAC CE based switching between intra-cell and inter-cell mTRP has already been supported without additional spec impact.Proposal-2: PDSCH/PDCCH from serving cell is rate matched around non-serving cell SSB. PDSCH/PDCCH from non-serving cell is rate matched around serving cell SSB. |
| [**R1-2111281**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2111281.zip) | Enhancement on inter-cell multi-TRP operation | OPPO |
| Proposal 1: UE is not expected to track a SSB with additional PCI which is not associated with any activated TCI state unless the SSB is configured for L1 measurement.Proposal 2: UE is not expected to monitor a Type0/0A/1/2 CSS in a CORESET when the active TCI state is associated with a PCI different from serving cell PCI.Proposal 3: If SSB and PDSCH associated with the same PCI are transmitted in the same symbol, the PDSCH and SSB should be QCLed with QCL-TypeD and should not overlap. |
| [**R1-2111455**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2111455.zip) | Enhancements on Multi-TRP inter-cell operation | LG Electronics |
| Proposal #1: Deprioritize dynamic switching enhancement between intra-cell mTRP and inter-cell mTRP.Proposal #2: PDSCH /PDCCH from serving cell should be rate matched around non-serving cell SSB and PDSCH /PDCCH from non-serving cell should be rate matched around serving cell SSB. |
| [**R1-2111478**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2111478.zip) | Multi-TRP enhancements for inter-cell operation | Intel Corporation |
| Proposal-1: Support indication of half-frame index associated with the non-serving cell to the UEProposal-2: UE performs PDSCH rate-matching based on the ssb-PositionsInBurst and half-frame index of the corresponding serving cell.Proposal-3: Support indication of ss-PBCH-BlockPower associated with the non-serving cell to the UE.Proposal-4: Support configuration of SSB with non-serving PCID as QCL source RS for SRS, PUCCH, and PUSCH transmission |
| [**R1-2111542**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2111542.zip) | Disscussion on Multi-TRP Inter-cell operation | Xiaomi |
| Proposal 1: For inter-cell multi-TRP, the TRP or non-serving ell selection/indication signaling is necessary if more than one additional PCI is configured to UE.Proposal 2: For inter-cell multi-TRP, SSB associated with a physical cell ID different from that of the serving cell can only be used as an indirect QCL reference for PDSCH.Proposal 3: We prefer to support additional rate matching behavior. Proposal 4: The association between PCI and CORESETPoolIndex should be further studied when more than one additional PCI is configured to UE.Proposal 5: Before the further discussion of the association between PCI and CORESETPoolIndex when switching between intra-cell mTRP and inter-cell mTRP, it should be decided whether/how to support the switching between intra-cell mTRP and inter-cell mTRP.Proposal 6: Enhancements of spatial relation for UL beam management should further discussed. |
| [**R1-2111599**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2111599.zip) | Enhancements on Multi-TRP inter-cell operation | CMCC |
| Proposal 1: Switching between intra-cell mTRP and inter-cell mTRP can be achieved via MAC-CE without additional spec impact.Proposal 2: A new RRC IE can be introduced to configure the non-serving cell information.Proposal 3: For inter-cell multi-TRP, PDSCH /PDCCH from serving cell (or cell with different PCI) is not rate matched around SSBs from the cell with different PCI (or serving cell). |
| [**R1-2111685**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2111685.zip) | Discussion on multi-TRP inter-cell operation | NEC |
| Proposal 1: PDSCH/PDCCH associated with one CORESETPoolIndex can be associated with only one PCI at a time, and at least one of the two CORESETPoolIndexes should be associated with PCI of serving cell. Proposal 2: Configuration framework of Rel-17 unified TCI and inter-cell mTRP can be further discussed, at least for CORESETPoolIndex associated with PCI of the serving cell, it seems Rel-17 unified TCI framework can be applied. Proposal 3: TRP specific beam failure recovery can be jointly discussed with switching between intra-cell and inter-cell mTRP.  |
| [**R1-2111719**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2111719.zip) | Enhancements on Multi-TRP inter-cell operation | Samsung |
| **Proposal 1:** Support inter-operation, e.g., switching, between intra-cell MTRP and inter-cell MTRP* One PCI associated with activated TCI states can be associated with more than one CORESETPoolIndex and one CORESETPoolIndex can be associated with only one PCI associated with activated TCI states
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| [**R1-2111855**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2111855.zip) | Views on Rel-17 Inter-cell multi-TRP operation | Apple |
| Proposal 1: Support to introduce a UE capability to report the following information* Whether PDSCH /PDCCH from serving cell (PCI) is rate matched around non-serving cell SSB
* Whether PDSCH/PDCCH from non-serving cell (PCI) associated with TCI state and/or QCL-info is rate matched around serving cell SSB

Proposal 2: If SSB collides with DL signals associated with the same PCI, gNB should ensure the DL signals and SSB are QCLed with QCL-TypeD.Proposal 3: For inter-cell mTRP, the non-UE dedicated signal should be QCLed with SSB from serving cell indirectly to make sure there is no serving cell change.* The non-UE dedicated signal includes PDCCH/PDSCH associated with Type 0/0a/1 CSS.

Proposal 4: Additional info for non-serving cell should include rate matching pattern as well as LTE-CRS rate matching pattern.Proposal 5: For downlink signals associated with a non-serving cell, if virtual cell ID is not configured, the default ID should be PCI for the non-serving cell.Proposal 6: With regard to minimal delay for L1-RSRP measurement from overlapped SSBs, additional delay should be introduced with Z=Z3+d and Z’=Z3’+d, where d indicates the number of symbols for the overlapped SSBs |
| [**R1-2112078**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2112078.zip) | Discussion on Multi-TRP inter-cell operation | ASUSTEK |
| Proposal 1: Confirm that TRP-specific BFD counter and timer in the MAC procedure is supported on both Serving Cell and non-Serving Cell in inter-Cell multi-TRP operation. Proposal 2: Confirm that BFRQ framework based on Rel.16 SCell BFR BFRQ is supported on both Serving Cell and non-Serving Cell in inter-Cell multi-TRP operation. Proposal 3: RAN1 discuss whether up to two PUCCH-SR resources are supported in a cell group for inter-cell mTRP operation.Proposal 4: If up to two PUCCH-SR resources are supported for inter-cell mTRP operation, RAN1 discuss whether to configure PUCCH-SR resource(s) on non-serving cell(s).Proposal 5: If two dedicated PUCCH-SR resources is supported for inter-cell mTRP operation, a dedicated PUCCH-SR resource in a cell group should be associated with a non-Serving Cell, where the UE performs inter-Cell multi-TRP operation on the non-Serving Cell and a Serving Cell in the cell group. Proposal 6: If one PUCCH-SR resource is supported for inter-cell mTRP operation, adopt table 1 for initiating BFR procedure for inter-cell mTRP SpCell regarding different scenarios of beam failure detection. |
| [**R1-2112091**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2112091.zip) | Discussion on inter-cell multi-TRP operation | NTT DOCOMO, INC. |
| Proposal 1:* + *Define default case for UE capability of X values for MTRP inter-cell. Either option can be supported.*
	+ *Option1: By default Case 1 with X1=1 and Case 2 with X2=1 are supported.*
	+ *Option2: By default Case 1 with X1=1 (and Case2 with X2=0) is supported.*

Proposal 2:* + *The information related to “SSB time domain position” for SSB with PCI different from the serving cell consists of halfFrameIndex.*
	+ *Define a new/independent IE for cells with additional PCIs for MTRP inter-cell operation.*
	+ *At least PhysCellId is included in the IE.*
	+ *A new RRC indicator/signaling (e.g., re-index the non-serving cells) is needed in the IE to indicate each cell with different PCI.*

Proposal 3:* + *At most one PCI is associated with the activated TCI states for PDSCH/PDCCH associated with one CORESETPoolIndex.*

Proposal 4:* + *UE is not expected to be configured a Type0/0A/1/2 CSS to a CORESET with a TCI state associated with an SSB having additional PCI.*

Proposal 5:* + *A SSB associated with additional PCI can be configured as the RS of the spatial relation info or PL-RS for UL SRS, PUCCH, and PUSCH for MTRP inter-cell operation.*

Proposal 6:* + *For multi-DCI based MTRP inter-cell operation,*
		- *For per-cell BFR, SSB associated with additional PCI can be configured as BFD-RS explicitly/implicitly.*
		- *For per-TRP BFR, SSB associated with additional PCI can be configured as BFD-RS in the BFD-RS set associated with corresponding CORESETPoolIndex.*

Proposal 7:* + *PDSCH/PDCCH from a cell with a given PCI (serving cell or a cell with additional PCI) should not be rate-matched around SSB from a cell with different PCI from the given PCI (serving cell or a cell with additional PCI).*
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| [**R1-2112178**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2112178.zip) | Enhancements to enable inter-cell multi-TRP operations | Nokia, Nokia Shanghai Bell |
| **Observation 1:** MAC CE based switching is already supported**Proposal 1:** Support inter-cell multi-DCI based multi-TRP operation, for both cases of CORESETPoolIndex is configured and not configured.**Proposal 2:** Don’t support additional rate matching behaviour for inter-cell multi-TRP operation.**Proposal 3:** During the intermediate state (during the switching) between serving cell and different PCI, the UE is not required to monitor scheduling from a CORESET with associated with different PCI if the TCI state is associated with different PCI than the latest activated TCI state under the same CORESETpoolindex.**Proposal 4:** In inter-cell multi-TRP, the UE is not expected to monitor CSS type0/0A/1/2 in a CORESET when active TCI is associated with a PCI different from serving cell PCI.**Proposal 5:** Apply Rel-17 BFR enhancement for mTRP also for inter-cell mTRP. |
| [**R1-2112198**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2112198.zip) | Enhancements on Multi-TRP inter-cell operation | Qualcomm Incorporated |
| Proposal 1: When SSB is used as reference signal in *SRS-SpatialRelationInfo, PUCCH-SpatialRelationInfo, PUCCH-PathlossReferenceRS, PUSCH-PathlossReferenceRS,* and *pathlossReferenceRS* under *SRS-ResourceSet*, the configuration indicates whether the *SSB-Index* is associated with the serving cell PCI or the other PCI. Proposal 2: In the set of symbols indicated to a UE by non-serving cell *ssb-PositionsInBurst*,* Option 1: The UE does not transmit any UL signal/channel.
* Option 2: The UE can only transmit UL signal/channel associated with the serving cell PCI.
* Further study the impact on the following Rel. 15/16 procedures based on a selected option from Option 1 or 2 above:
	+ Procedure 1: When SSB overlaps with UL channel/RS, UE does not transmit the UL channels/RS [38.213, Section 11.1].
	+ Procedure 2: UE does not expect the set of SSB symbols to indicated as uplink symbols either semi-statically or dynamically (by SFI) [38.213, Section 11.1 and Section 11.1.1].
	+ Procedure 3: SSB symbols are assumed to be invalid symbols in a nominal repetition for PUSCH repetition Type B [38.214, Section 6.1.2.1].
	+ Procedure 4: For determination of the $N\_{PUCCH}^{Repeat}$ slots in the case of PUCCH repetition, i.e., a slot is not counted toward the $N\_{PUCCH}^{Repeat}$ slots if the PUCCH resource in that slot overlaps with a SSB [38.213, Section 9.2.6].
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