**3GPP TSG RAN WG1 #106bis-e R1-210xxxx**

**e-Meeting, October 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. Item1: Number of RRC configured additional PCIs

On the number of X reported as UE capability, companies are requested to provide views on following 3 alternatives, it is proposed to downselect in RAN1#106b-e.

Alt1: support 1 value of X is reported as UE capability for all cases.

Alt2: support 2 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.

* X1=3 (SSB time domain positions or periodicity of additional PCIs is not exactly the same as serving cell PCI)
* X2=7 (SSB time domain positions and periodicity are exactly the same among the additional PCIs and the same as serving cell PCI)

Alt3: support 3 independent X values are reported as a UE capability

* Case 1: SSBs from different cells are overlapped in time domain
* Case 2: SSBs from different cells are non-overlapped and multiplexed in the same slot
* Case 3: SSBs from different cells are non-overlapped and multiplexed in different slots

Alt4: whether to support a single value of X or two independent values depends on whether the measurement for the SSB is limited within SMTC.

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| Company | comments |
| InterDigital | Support Alt. |
| Apple | Support Alt3. To clarify it a little bit. For some SSB patterns, the SSBs are multiplexed in consecutive symbols, and it would require UE to implement symbol level beam sweeping. That’s why we think it is necessary to consider the case for SSBs within a slot or across slot. |
| OPPO | We support Alt2 with X1=1. |
| ZTE | Support Alt1.Basically, we think it is sufficient to report a single value of X for the case only when SSB time domain positions or periodicity of additional PCIs is not exactly the same as SSB of serving cell PCI (case 2 and case 3). In other words, the value of X does NOT need to report as a UE capability when SB time domain positions and periodicity of additional PCIs are exactly the same as SSB of serving cell PCI (case 1), because there is no additional UE storage are required for rate matching. Therefore, we think it makes sense to support UE reports one value of X for all cases. |
| QC | Support Alt2. We do not understand ZTE’s comment. UE may be able to support more PCIs when SSBs are aligned compared to the case where SSBs are not aligned. If SSBs are aligned, there is no impact to rate matching. |
| MediaTek | Support Alt2 |
| LG | Support Alt1. |
| DOCOMO | Support Alt2. |

On the value range of X, companies are requested to provide views on following 4 alternatives, it is proposed to downselect in RAN1#106b-e.

Alt1: at least the value of X=7 is supported

Alt2: X values of {1, 2, 4, 6} in FR1 and {1, 2, 4} in FR2 per CC are supported

Alt3: X values of {1,2,3,4,5,6,7} are supported

Alt4: subset of X values, e.g. {2,3,6} or {1,2,3} or {3,7} or {1,3,7} are supported

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| Company | comments |
| InterDigital | Support Alt3. Since X value will be based on UE capability, then all values ≤7 should be allowed. |
| Apple | Support Alt3 |
| OPPO | We support X={1,2,3} |
| ZTE | Support Alt1.From the NW scheduling flexibility perspective, it is beneficial to support as large number of RRC-configured X as possible. Besides, to follow the previous agreement that the maximum number of X cannot be larger than 7, at least X = 7 should be supported. |
| QC | Ok with Alt3.  |
| MediaTek | Support Alt3 |
| LG | Support Alt3 |
| DOCOMO | Support Alt1. Okay with Alt3. |

* 1. Item 2: Indication/association of non-serving cell information with TCI state

Companies are requested to provide views on following 2 alternatives, it is proposed to downselect in RAN1#106b-e.

Alt1: SSB with PCI different from serving cell is used as QCL source for CSI-RS from serving cell, which is then used as QCL source for PDSCH/PDCCH in serving cell.

* Clarify that “PDSCH/PDCCH from non-serving cell (PCI)” in previous agreement 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

Alt2: only SSB is allowed to be the source RS type for RS transmitted from the non-serving cell TRP.

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| Company | comments |
| Apple | I think we have concluded that no new QCL rule would be introduced, it seems that is enough. We failed to see the necessity for the discussion, maybe some clairficaiton is helpful. |
| OPPO | We don’t think further clarfication is needed for this. SSB can be the QCL source RS for PDSCH directly or indirectly according to current QCL rule. |
| Spreadturm | Re OPPO, SSB can not be QCL source RS for PDSCH dirctly according to current QCL rule.Support Alt1.For Alt2, clarification is needed. Does the ‘RS transmitted from the non-serving cell TRP’ also include DMRS for PDCCH and PDSCH ? |
| ZTE | Regarding item#2, we think it is not needed. We fail to see the intention of this item because RAN1 have agreed inter-cell MTRP should be based on Rel-15/16 QCL rules.Regarding item#2-1, we think it is good to define a new IE for non-serving cell SSB information, and this can be informed to RAN2 for clearly understand and simplify the signalling design.Regarding item#2-2, 2-3 and 2-4, all of them is NOT in line with the WID, which indeed aims to QCL/TCI related enhancements when inter-cell MTRP. Hence we suggest to deprioritize these items. |
| QC | We do not think any discussion is needed here. |
| LG | We have same view with Apple. |
| DOCOMO | We can support Alt1 or nothing. |

Following issues are proposed by companies however according to agreement from RAN1#106-e and LS to RAN2, detailed signaling design is up to RAN2, hence are lower priority in this meeting.

Issue#2-1: 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.

Issue#2-2: 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.

Issue#2-3: 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 containing RS resources associated with one or more non-serving cells.

Issue#2-4: The non-serving cell SSB information can be configured explicitly in CSI-SSB-ResourceSet.

* 1. Item 3: Rate matching

Companies are requested to provide views on following 3 alternatives, it is proposed to downselect in RAN1#106b-e.

Alt1: Don’t support additional rate matching behaviour for inter-cell multi-TRP operation,

* Note: above implies that 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

Alt2: UE performs PDSCH rate-matching based on the union of ssb-PositionsInBurst

* 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

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| Company | comments |
| InterDigital | Support Alt1. |
| Apple | Support Alt2.  |
| OPPO | Support Alt1.  |
| Spreadtrum | Support Alt1 |
| ZTE | Support Alt1 to ensure resource efficiency and avoid performance loss.Besides, although RAN1 has endorsed an agreement that 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 important to clarify in RAN1 whether rate matching is around SSBs in activated TCI states, instead of all activated and inactivated TCI states. We propose:*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* |
| QC | Support Alt1. |
| MediaTek | Support Alt1 |
| LG | Support Alt2.  |
| DOCOMO | Support Alt1. |

* 1. Item 4: PCI association with CORESETPoolIndex

There is a following FFS point from RAN1#106-e

* FFS: The association between PCI and *CORESETPoolIndex* when switching between intra-cell mTRP and inter-cell mTRP

According to contributions following alternatives are listed to address the above FFS point.

Companies are requested to provide views on following 3 alternatives, it is proposed to downselect in RAN1#106b-e

Alt1: MAC CE based switching between intra-cell and inter-cell mTRP without additional spec impact, for PDSCH/PDCCH associated with one CORESETPoolIndex, MAC CE activates one or more TCI states associated with only one PCI at a time

Alt2: dynamic indication on the serving cell to determine the PCI association with CORESETPoolIndex

Alt3: RRC re-configuration is needed to switch between intra-cell mTRP and inter-cell mTRP.

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| Company | comments |
| InterDigital | We believe there are two separate problems that need to be discussed,* First, whether the switching between inter-cell and intra-cell is dynamic or RRC-based.
* Second, how PCI is associated to the CORESETPoolIndex
 |
| Apple | It seems MAC CE is the only choice, since we agreed only one additional PCI can be associated with active TCI states in last meeting. **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
 |
| OPPO | Support Alt1. No additional agreement is needed for this. |
| Spreadtrum | Support Alt1.  |
| ZTE | Support Alt1.We believe the reached agreements and the current framework of intra-cell MTRP in Rel-16 can successfully support dynamic switching of intra-cell and inter-cell MTRP via MAC CE. We think take Alt1 as a conclusion is sufficient. |
| QC | Alt1 is already supported. No need for additional discussions. |
| LG | Alt1 and 3 are already supported. No need for additional discussions. |
| DOCOMO | Alt3 is already supported. For Alt1, since the association between CORESETs and CORESETPoolIndex is configured by RRC signaling, using MAC CE to update the TCI states of the CORESETs between intra-cell mTRP and inter-cell mTRP means that the configuration of CORESETs for intra-cell and inter-cell is always the same. Even though it is not always true for such configuration, we can accept it. |

* 1. Item 5: relation with CORESET

**Proposal 5-1:**

UE is not expected to be configured a Type0/0A/1/2 CSS to a CORESET with a TCI state associating SSB with PCI different from serving cell PCI.

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| Company | comments |
| Apple | Support the proposal in principle, but we suggest we add a bracket for Type2 CSS for further study. |
| OPPO | Support the proposal.  |
| Spreadtrum | Support the proposal.  |
| ZTE | Support, we also agree with Apple’s suggestion to add a FFS for the case when Type 2 CSS. |
| QC | Support. Not clear what is the aspect that requires further study. This proposal has been discussed since the first Rel-17 meeting. |
| MediaTek | Support |
| LG | Support the proposal.  |
| DOCOMO | Support |

* 1. Item 6: Non-serving cell information

**Proposal 6-1:** down select one alternative between following 2 alternatives

Alt1: Center frequency, SCS, SFN offset are assumed to be the same for the serving cell and the configured cells having TRPs with different PCI for inter-cell multi TRP operation.

Alt2: Other non-serving cell SSB information provided to UE should also include SFN offset, especially in inter-frequency operation.

**Proposal 6-2:**

For non-serving cell SSB information, the information related to “SSB time domain position” for non-serving cell SSB consists of halfFrameIndex and ssb-PositionsInBurst

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| Company | comments |
| Apple | 6-1 : Support6-2 : Support |
| OPPO | For 6-1, support Alt1. For 6-2, Support. |
| OPPO | For 6-1, support Alt1. For 6-2, Support. |
| ZTE | Regarding proposal 6-1, we support to Alt2.According to the current TS 38.211 (as shown in follows), it is intuitive to allow UE reports frame timing difference (up to 5ms) between serving cell and non-serving cell in an L3 measurement reporting. Meanwhile, given that the frame timing difference between serving cell and neighbor cell can be different **when CA operation for Rel-16 mDCI MTRP**. Hence it should support to configure SFN offset be different between serving cell and non-serving cell, and treat SFN offset as non-serving cell SSB information.

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| **TS 38.211, Subclause 6.3.3.2 Mapping to physical resource***<Omitted Part>*For handover purposes to a target cell in paired or unpaired spectrum where the target cell uses $L\_{max}=4$, the UE may assume the absolute value of the time difference between radio frame $i$ in the current cell and radio frame$i$ in the target cell is less than $153600T\_{s}$ if the association pattern period in clause 8.1 of [5, TS 38.213] is not equal to 10 ms.*<Omitted Part>* |

Regarding proposal 6-2, we are supportive. |
| QC | 6-1: Support Alt1.6-2: Support. |
| MediaTek | 6-1: Support Alt16-2: Support |
| LG | 6-1: Support Alt16-2: Support |
| DOCOMO | 6-1: Support Alt16-2: Support |

* 1. Item 7: Others

**Proposal 7-1**: The configured non-serving cell’s SSB is within the SMTC configured for this cell.

**Proposal 7-2**: Indication of an additional PCI for same/cross-carrier scheduling is not needed.

**Proposal 7-3**: 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 7-4**: Sequence generation of a non-serving cell TRS used as TCI source should be based on slot index of this non-serving cell.

**Proposal 7-5**: Support to use non-serving cell SSB for mobility measurement as the PL-RS for uplink transmission.

**Proposal 7-6**: Support configuration of SSB with non-serving PCID as QCL source RS for SRS, PUCCH, and PUSCH transmission

**Proposal 7-7**: UE is not expected to track the SSB with additional PCI which is not associated with any activated TCI state unless the SSB is configured for L1 measurement.

**Proposal 7-8**: at least for CORESETPoolIndex associated with PCI of the serving cell, Rel-17 unified TCI framework can be applied.

**Proposal 7-9**: For the HARQ operation, at least extend the separate HARQ-ACK feedback mechanism to inter-cell mTRP.

**Proposal 7-10**: 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 7-11**: Apply Rel-17 BFR enhancement for mTRP also for inter-cell mTRP

**Proposal 7-12**: 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 7-13**: 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 7-14**: 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 7-15**: 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 be 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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| Company | comments |
| Apple | We think 7-10 should be discussed, otherwise based on current spec which requires gNB to ensure QCL, gNB cannot transmit SSB and PDSCH from different cells in the same symbols. |
| OPPO | We are fine to discuss 7-10, but the proposal is unclear to us. We propose the following based on current specification:**Proposal 7-10**: 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. |
| ZTE | If the time budget is enough in this meeting, we suggest to discuss the following two aspects of inter-cell MTRP:First priority: UL channels/signals QCL enhancements, i.e. proposal 7-5, proposal 7-6.Second priority: collision handling between UL channels/signals and non-serving cell SSB, i.e. proposal 7-3, proposal 7-15. |
| QC | Agree with ZTE. |
| DOCOMO | We think Proposal 7-6 is important. |

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.

1. Reference

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| [**R1-2108758**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2108758.zip) | Enhancements on inter-cell multi-TRP operation in Rel-17 | Huawei, HiSilicon |
| ***Proposal 1: SSB with PCI different from serving cell one is used as QCL source for CSI-RS from serving cell, which is then used as QCL source for PDSCH/PDCCH in serving cell.******Proposal 2: Candidate values for UE capability reporting on maximum number of additional RRC-configured PCIs per CC includes {1, 2, 4, 6} in FR1 and {1, 2, 4} in FR2, and a single value is reported for any possible SSB position and periodicity.******Proposal 3: Don’t support additional rate matching behaviour for inter-cell multi-TRP operation.*** ***Observation 1: With the aid of existing information in MO, there is no need to explicitly indicate neighbor cell information such as SSB time domain position and SSB transmission periodicity.*** |
| [**R1-2108791**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2108791.zip) | Inter-cell multi-TRP operation | FUTUREWEI |
| **Proposal 1: For the number of additional PCIs configured per CC, prefer Alt 1 of a single X value for all cases.****Proposal 2: Confirm that inter-cell M-TRPs have the same BWP bandwidth and SCS.****Proposal 3: 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 4: CORESET pool index is useful for the scenario of switching between intra-cell M-TRP and inter-cell M-TRP.****Proposal 5:** **Indication of an additional PCI for same/cross-carrier scheduling is not needed.** |
| [**R1-2108810**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2108810.zip) | Further Details on M-TRP Inter-cell Operation | InterDigital, Inc. |
| ***Observation 1:*** *RAN1 has already agreed to support RRC configuration of non-serving cell information.* *Therefore, for switching between inter- and intra-cell operation, it does not make much sense to use RRC configuration to switch between intra and inter cell mTRP operation.****Observation 2:*** *For dynamic switching between intra- and inter-cell mTRP operation, we can use TCI states activation at the MAC level to determine the association of* *CORESETPoolIndex = 1.****Observation 3:*** *According to the agreement in the last meeting, a configuration for operation in the inter-cell MTRP can clearly differentiate its TCI states configurations.****Observation 4:*** *Alt 3 may seem as a lower complexity version of Alt 1. However, depending on selection of X1 and X2 values, it may be as complex as Alt 1. For example, if both X1 and X2 are equal to 7, then the complexity of UE processing may become quite significant.* ***Proposal 1:*** *Support dynamic switching between intra- and inter-cell mTRP operation.****Proposal 2:*** *Consider MAC CE activation of TCI states for switching between intra- and inter-cell mTRP operation.****Proposal 3:*** *Use the received dynamic indication on the serving cell for operating in inter-cell mode to determine the PCI associated to the CORESETPoolIndex.****Proposal 4:*** *Support Alt 1 where a single value of X is reported as UE capability for any possible SSB time domain position and periodicity.* |
| [**R1-2108872**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2108872.zip) | Discussion on Multi-TRP inter-cell operation | ZTE |
| ***Proposal 1:*** *For the value of X is configured by RRC, at least the value of X = 7 should be adopted as candidate.****Proposal 2:*** *For the value of X is reported as UE capability, support Alt.1 that a single value of X is reported as UE capability for any possible SSB time domain position and periodicity.****Proposal 3:*** *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 4:*** *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 5:*** *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 6:*** *Other non-serving cell SSB information provided to UE should also include SFN offset, especially in inter-frequency operation.****Proposal 7:*** *Support to use non-serving cell SSB for mobility measurement as the PL-RS for uplink transmission.****Proposal 8:*** *Sequence generation of a non-serving cell TRS used as TCI source should be based on slot index of this non-serving cell.* |
| [**R1-2108897**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2108897.zip) | Discussion on enhancements on multi-TRP inter-cell operation | Spreadtrum Communications |
| ***Proposal 1: Regarding the value of X reported by UE, support Alt 1, i.e., a single value of X is reported as UE capability for any possible SSB time domain position and periodicity.******Proposal 2: For inter-cell multi-TRP operation, PDSCH/PDCCH from the serving cell should not be rate-matched around non-serving cell SSB.******Proposal 3: 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.*** |
| [**R1-2108953**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2108953.zip) | Further discussion on inter-cell MTRP operation | vivo |
| **Proposal 1: support the maximum number (X) of {2, 3, 6} of RRC configured PCIs different from serving cell PCI.****Proposal 2: 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 3: 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 4: 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: 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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| [**R1-2109040**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109040.zip) | Enhancement on inter-cell multi-TRP operation | OPPO |
| ***Proposal 1: For the value of X, X={1,2,3} can be reported as a UE capability. If RAN1 cannot converge on other values than 1, only X=1 will be supported.******Proposal 2: 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.******Proposal 3: UE is not expected to track the SSB with additional PCI which is not associated with any activated TCI state unless the SSB is configured for L1 measurement.*** ***Proposal 4: Switching between intra-cell mTRP and inter-cell mTRP can be achieved via activation of TCI states associated with each CORESETPoolindex without additional specification impact.*** |
| [**R1-2109105**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109105.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.*** |
| [**R1-2109124**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109124.zip) | Discussion on multi-TRP inter-cell operation | NEC |
| ***Proposal 1: MAC CE based switching between intra-cell and inter-cell mTRP is sufficient. And for PDSCH/PDCCH associated with one CORESETPoolIndex, MAC CE activates one or more TCI states associated with only one PCI at a time.*** ***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.***  |
| [**R1-2109186**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109186.zip) | Discussion on inter-cell operation for multi-TRP/panel | CATT |
| ***Proposal-1: For the report value of X, X={3,7} could be support. Two independent X values (X1, X2) are reported as a UE capability for two different assumptions on SSB time domain position and periodicity with respect to serving cell SSB.******Proposal-2: Center frequency, SCS, SFN offset are not needed, which are assumed to be the same for the serving cell and the configured cells having TRPs with different PCI for inter-cell multi TRP operation.******Proposal-3: 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.*** |
| [**R1-2109272**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109272.zip) | Enhancements on Multi-TRP inter-cell operation | CMCC |
| ***Proposal 1: For the maximum number of additional RRC -configured PCIs  per CC, whether a single value of X or two independent values should be supported is decided on whether the measurement for the SSB is limited within SMTC.******Proposal 2: For the value of X, at least X=3 can be supported.******Proposal 3: A new RRC IE can be introduced to configure the non-serving cell information.******Proposal 4: 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).*** |
| [**R1-2109380**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109380.zip) | Disscussion on Multi-TRP Inter-cell operation | Xiaomi |
| ***Proposal 1: We prefer that only SSB is allowed to be the source RS type for RS transmitted from the non-serving cell TRP.******Proposal 2: The non-serving cell SSB information can be configured explicitly in CSI-SSB-ResourceSet.******Proposal 3: To associate the TCI state with non-serving cell information, the referenceSignal in QCL-Info can be configured as the newly introduced RRC indicator/signalling.******Proposal 4: 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 5: For the HARQ operation, we prefer to at least extend the separate HARQ-ACK feedback mechanism to inter-cell mTRP.*** |
| [**R1-2109470**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109470.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*

**Proposal 2:** *A single value of X is reported as UE capability for any possible SSB time domain position and periodicity* |
| [**R1-2109593**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109593.zip) | Multi-TRP enhancements for inter-cell operation | Intel Corporation |
| ***Proposal-1: In terms of the max number of additional RRC -configured PCIs per CC, support up to X=7.******Proposal-2: Support indication of ssb-PositionsInBurst and half-frame index associated with the non-serving cell to the UE******Proposal-3: UE performs PDSCH rate-matching based on the union of ssb-PositionsInBurst and half-frame index associated with the serving cell and the non-serving cell******Proposal-4: Support indication of ss-PBCH-BlockPower associated with the non-serving cell to the UE.******Proposal-5: Support configuration of SSB with non-serving PCID as QCL source RS for SRS, PUCCH, and PUSCH transmission*** |
| [**R1-2109660**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109660.zip) | Discussion on inter-cell multi-TRP operation | NTT DOCOMO, INC. |
| **Proposal 1:*** + ***Support independent X values for at least following two cases. The candidate value for Case1 can support 7 at least, and the candidate value for Case2 can support 3 at least.***
	+ ***Case 1: SSB time domain positions and periodicity are exactly the same among the additional PCIs and the same as serving cell PCI***
	+ ***Case 2: SSB time domain positions or periodicity of additional PCIs is not exactly the same as serving cell PCI***

**Proposal 2:*** + ***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.***
	+ ***UE assumes the same center frequency, SCS, and SFN offset between serving cell and the cells with additional PCIs.***

**Proposal 3:*** + ***RRC re-configuration is needed to switch between intra-cell mTRP and inter-cell mTRP.***

**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:*** + ***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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| [**R1-2109834**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109834.zip) | Finalizing inter-cell multi-TRP operation | Ericsson |
| [Proposal 1 Support Alt.2, two values for X is indicated, X1 for unrestricted SSB case and X2 for aligned SSB case (all RRC configured SSBs have same SSB time domain position and periodicity as the serving cell)](#_Toc83634839)[Proposal 2 The supported value other than the default value 1 is X1=3, X2=7](#_Toc83634840)[Proposal 3 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 foreseen.](#_Toc83634841) |
| [**R1-2109872**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2109872.zip) | Enhancements to enable inter-cell multi-TRP operations | Nokia, Nokia Shanghai Bell |
| **Observation 1: For inter-cell multi-TRP operation, RAN1 to discuss different possibilities of PCI and CORESETPoolIndex association and define behaviours for those.** Proposal 1: Support inter-cell multi-DCI based multi-TRP operation, for both cases of CORESETPoolIndex is configured and not configured. * **When CORESETPoolIndex is configured, multi-DCI based multi-TRP operation is applied regardless that CORESETPoolIndex values are associated with the same PCI or different PCIs. i.e. inter-cell multi-DCI multi-TRP or intra-cell multi-DCI multi-TRP operations.**
* **When CORESETPoolIndex is not configured but CORESETs are associated with two different PCIs, multi-DCI based multi-TRP operation is applied assuming that as if CORESETPoolIndex would be configured and CORESETPoolIndex are associated to different PCI.**

**Proposal 2: For the report value of X, X=7 is supported.****Proposal 3: Select 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****Proposal 4: Apply Rel-17 BFR enhancement for mTRP also for inter-cell mTRP.** |
| [**R1-2110015**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2110015.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: Support to report 3 independent X values for the following cases:**** ***Case 1: SSBs from different cells are overlapped in time domain***
* ***Case 2: SSBs from different cells are non-overlapped and multiplexed in the same slot***
* ***Case 3: SSBs from different cells are non-overlapped and multiplexed in different slots***

***Proposal 3: 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 4: 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.*** |
| [**R1-2110079**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2110079.zip) | Enhancements on Multi-TRP inter-cell operation | LG Electronics |
| **Proposal #1: Support X = {1,3,7} and report single value as UE capability for any possible SSB time domain position and periodicity.****Proposal #2: Deprioritize dynamic switching enhancement between intra-cell mTRP and inter-cell mTRP.****Proposal #3: 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.** |
| [**R1-2110111**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2110111.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: 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.**  |
| [**R1-2110167**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106b-e/Docs/R1-2110167.zip) | Enhancements on Multi-TRP inter-cell operation | Qualcomm Incorporated |
|   **Proposal 1: For non-serving cell SSB information** * **The SSBs of non-serving cell have the same center frequency and SCS as the SSBs of the serving cell, and are associated with the same SFN.**
* **The information related to “SSB time domain position” for non-serving cell SSB consists of**
	+ **halfFrameIndex**
	+ **ssb-PositionsInBurst**

**Proposal 2: Value of X (additional RRC-configured PCIs per CC) can be 1, 2, .., 7, and the UE indicates the supported value of X separately for*** **Aligned SSBs: SSB time domain positions and periodicity are exactly the same among the additional RRC-configured PCIs and same as serving cell PCI**
* **Unaligned SSBs: SSB time domain positions or periodicity of a additional RRC-configured PCI is not exactly the same as serving cell PCI**

**Proposal 3: 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 4: 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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