**3GPP TSG RAN WG1 #104b-e- R1-200xxxx**

**e-Meeting, April 12th – 20th, 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 and tentative proposals are provided.

1. 1. Item 1: Clarification on “non-serving cell”

**Huawei**

Clarify that ‘PDSCH/PDCCH from non-serving cell (PCI)’ refer to PDSCH/PDCCH from the serving cell but has a SSB/CSI-RS from non-serving cell as (indirect) QCL source.

**vivo**

For discussion purpose, define PDSCH/PDCCH/RS from non-serving cell (PCI) as following:

* + A non-serving cell RS is one of the following (agreement till now):
		- SSBs associated with the non-serving cell information;
		- RS configured with TCI states associated with non-serving cell information;
		- RS configured with TCI state with QCL source RS as a non-serving cell RS (including all three different kinds);
	+ A PDCCH/PDSCH from non-serving cell is the PDCCH/PDSCH transmitted with TCI states with QCL source RS as a non-serving cell RS.

**Futurewei**

For inter-cell multi-TRP enhancement, replace the term “non-serving cell” with “cooperating cell” or the like.

**Observation1:** There are few contributions proposed to clarify the term “non-serving cell”,

Based on above observation, a tentative proposal is made below.

**Proposal1**: Discuss whether such clarification is needed.

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| Company | comments |
| QC | Clarification may be needed, but this also depends on the outcome of Proposal 2-2. We suggest to discuss this proposal after we have an agreement on Proposal 2-2. |
| ZTE | Ok to discuss it. |
| Ericsson | It may be good to discuss for a common understanding in RAN1 but we may not need a strict definition to be agreed. We are not sure inter-cell for mTRP will be visible in RAN1 specifications, it may only be visible in RRC specifications 38.331. In our view, RAN1 specifications are (mostly) agnostic to whether an SSB has serving cell PCI or another PCI (at least for the discussions in this agenda). There may be some impact on the rate matching section though, but how to deal with this can be left to editors. |
| OPPO | We think “non-serving cell SSB” is sufficient for RAN1 discussion. Other non-serving cell channel/signal can be described by “QCLed to non-serving cell SSB”. We don’t need to define each channel/signal from non-serving cell respectively.  |

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

**Huawei**

Support Option 1, i.e., explicitly indicate the PCI of a neighbour cell in the SSB configuration inside a TCI state.

**IDC**

Support Option 1 or 2 where an explicit indication of association of TCI state /QCL information with a serving/non-serving cell is implemented through inclusion of PCID into TCI state/QCL information or introducing a flag, respectively.

**Spreadtrum**

Support to indicate/associate non-serving cell PCI in the TCI state.

**Futurewei**

Explicitly configure the non-serving cell PCI as physicalCellId, reusing Rel-16 mechanism as much as possible.

Explicitly configure the non-serving cell SSB index

Indicate/associate non-serving cell PCI via QCL/TCI state, which implicitly groups all RSs, channels, resources, and TCI states to the serving cell and the non-serving cell respectively. CORESET pool index is not necessary.

**Intel**

Multi-cell reception mode is supported by providing the following information explicitly to the UE

* PCID (PhysCellId)
* SSB pattern (ssb-PositionsInBurst, ssb-periodicityServingCell)
* sub-carrier spacing (subcarrierSpacing)
* frequency (absoluteFrequencySSB)

**Nokia**

To configure SSB as non-serving cell RS, indicate the associated cell (PCI) and SSB-index for the SSB in the *referenceSignal* parameter (Option 1).

For inter-cell multi-DCI based multi-TRP support, the CORESETs of non-serving cell are pooled under the same CORESETPoolIndex.

**Ericsson**

[Agree on Option 1: Indicate/associate non-serving cell PCI in the TCI state. FFS other non-serving cell information](#_Toc68618536)

[Send an LS to RAN2 with the agreements made in the inter-cell multi-TRP agenda item, so they can start their work on the signalling.](#_Toc68618537)

**OPPO**

To associate non-serving cell information with a TCI state, support Option 2: introduce a flag to indicate whether a TCI state/QCL information is associated with non-serving cell information or serving cell.

The neighboring cell (PCI) indicated by non-serving cell information should be one of the cells (PCIs) measured and reported by UE based on MeasObject.

**CMCC**

A flag or a new indicator can be configured in /associated with a TCI state when the SSB from non-serving cell is used as the QCL reference RS.

A new RRC IE can be introduced to configure the non-serving cell information.

**Xiaomi**

Prefer Option 2 or Option 5 to configure TCI state associated with non-serving cell.

**Apple**

For inter-cell multi-TRP operation, support option 2/3/5 to define the association between TCI and non-serving cell information, where an indicator can be used to provide the linkage between non-serving cell information and a TCI

* The TCI with the same indicator should be associated with the same CORESETPoolIndex

**Qualcomm**

When SSB is used as reference signal in *QCL-Info*, support Option 2: Introduce a flag to indicate whether the *SSB-Index* is associated with the serving cell or is associated with non-serving cell. RRC signalling details are up to RAN2 to decide.

UE does not expect channels associated with CORESETPoolIndex value 0 and 1 to have TCI states associated with non-serving cell and serving cell PCI, respectively.

**Lenovo**

SSB index 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.

The non-serving PCID configured in SSB-InfoNcell-r16/SSB-Configuration-r16 is associated with a neighboring cell configured in the MO.

The configured non-serving cell’s SSB index is within the SMTC configured for this cell.

Option 3 should be supported.

In inter-cell multi-DCI based multi-TRP scenario, CORESETPoolIndex=0 is associated with the serving PCID and CORESETPoolIndex=1 is associated with a non-serving PCID different from the serving PCID.

**ZTE**

Support to introduce a new RRC IE linking with some TCI states.

* At least MeasObjectId and PCI should be contained in the new IE.

For the configuration TCI state/ QCL-info with non-serving cell SSB information, support Opt. 3 that all TCI states should be split into two groups which corresponding to serving cell and non-serving cell, respectively.

* Each group of TCI states is associated with a CORESETPoolIndex value.

**CATT**

Introduce a new indicator to indicate the non-serving cell information that a TCI state/QCL information is associated with (Option5). The indicator could be configured in the activation MAC-CE.

**DOCOMO**

* + Define a separate IE for non-serving cell configuration for MTRP inter-cell operation.
	+ At least PhysCellId is included in the IE.
	+ A new indicator (e.g., re-index the non-serving cells) is needed in the IE to indicate each non-serving cell.
	+ Support to configure more than one non-serving cell’s configurations on a CC.
	+ Support to configure at least 3 non-serving cells on a CC with 2-bit new indicator.
	+ Support Option 5 for TCI state/QCL-info configuration, i.e., to configure a new indicator (e.g., re-index the non-serving cells) in TCI state/QCL-Info configuration to indicate the non-serving cell.
	+ Support to configure up to 1 non-serving cell from the re-indexing indexes to be associated with the TCI state/QCL-info configuration on a CC.

**LG**

*MeasObjectId*, and PCID and SSB index in *MeasObjectNR* corresponding *MeasObjectId* should be associated with or configured as *referenceSignal* in *QCL-info* in *TCI-State.*

**Vivo**

Strive to down select one of the 5 options for indication/association of non-serving cell information with TCI states, send LS to RAN2 on RAN1 agreements on inter-cell MTRP operation.

**Samsung**

For non-serving cell PCI indication for inter-cell mTRP operation

* Selecting between explicit and implicit methods of indicating the non-serving cell PCI in TCI state shall take into account signaling overhead, payload variation, and RAN2 impact.
* In terms of minimizing the signaling overhead, the implicit non-serving cell PCI indication in TCI state shall be supported.

**Observation2:** following observations are made based on contributions

1. There are different views on whether to support explicit or implicit indication/association of non-serving cell PCI in the TCI state, i.e. selecting one of the options from RAN1#104e
2. Few companies proposed that a new RRC IE can be introduced to configure the non-serving cell information
3. Few companies proposed that *MeasObjectId* is associated with TCI state, that means neighboring cell (PCI) is one of the PCI reported by UE based on MeasObject
4. Few companies proposed that TCI states are grouped, e.g. CORESETPoolIndex value 0 and 1 to have TCI states associated with non-serving cell and serving cell PCI, while one company proposed that CORESETPoolIndex is not necessary
5. Few companies proposed to send LS to RAN2 informing them about the RAN1 agreement on indication/association of PCI to TCI state is needed for inter-cell MTRP operation, how to design the signalling is up to RAN2.

Based on above observation tentative proposal is made below

**Proposal 2-1:**

* Send LS to RAN2 informing them on necessity of indication/association of non-serving cell information in the TCI state for inter-cell MTRP operation, and detailed signaling design is up to RAN2

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| Company | comments |
| QC | LS can be sent as part of normal procedures (to inform RAN2 about the agreement, and not specific to this issue). We think RAN1 still needs to agree on some more details such as the number of non-serving cells, etc. In addition, in the agreement with five options in the previous meeting, we had “further discuss following options and down select in RAN1#104bis-e”.  |
| ZTE | Although it can be RAN2’s business to determine the association/indication between non-serving cell info and TCI state/QCL-info, we think the following issues should be addressed in RAN1 first:1. How many non-serving cell TRPs can be configured for inter-cell MTRP operation?

As per our view, the number of configured non-serving cell TRP should be 1. With respect to MTRP inter-cell operation is based on Rel-16 MDCI MTRP scheme, it means up to two TRPs can be used for this operation. Then, it is natural that one out of the two TRPs is deployed in the serving cell, and the other TRP is deployed in the non-serving cell. ii) What kind of other information of non-serving cell SSB is needed?This is related to item 3 where our response can be found accordingly. |
| Ericsson | **Support the proposal.** Moreover, we don’t understand the need to agree on a restriction of the number of non-serving cell TRPs, perhaps ZTE and Qualcomm can elaborate on what the issue is that requires a restriction.  |
| OPPO | We agree with QC and ZTE that we should at least agree on the number of non-serving cell in RAN1, e.g. whether multiple non-serving cells are allowed, before sending LS. Without this information, RAN2 is not able to design the corresponding signaling, e.g. the maximal number of IEs for non-serving cell information.  |

**Proposal 2-2:**

* Discuss whether to specify the limitation between CORESETPoolIndex and non-serving cell information.
	+ The TCI associated with the same non-serving cell information should be associated with the same CORESETPoolIndex
	+ UE does not expect channels associated with CORESETPoolIndex value 0 and 1 to have TCI states associated with non-serving cell and serving cell PCI, respectively

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| Company | comments |
| QC | Support the proposal. We do not see why TCI states associated with a given PCI should be used across both CORESETPoolIndex values. |
| ZTE | Support FL’s proposal. |
| Ericsson | No need to discuss this, we don’t see why there should be a relation between pool index and TCI states associated with ns-cell and s-cell. This sounds like an artificial restriction.  |
| OPPO | Support the 1st sub-bullet of the proposal. We agree that serving cell and non-serving cell should be associated with different values of *CORESETPoolIndex*, but the restriction on value 0 for serving cell and value 1 for non-serving cell seems unnecessary.  |

* 1. Item 3: Other non-serving cell information

**CATT**

The necessity of frequency (i.e. ssb-Freq-r16 and absoluteFrequencySSB) and SCS (i.e. sbSubcarrierSpacing-r16) parameters depends on whether inter-frequency scenario is supported. SFN and half-frame index are further needed for inter-cell mTRP.

**ZTE**

Other non-serving cell SSB information provided to UE should at least include center frequency, SCS, and SFN offset.

**Qualcomm**

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

**Observation3:** There are few contributions proposed to support other non-serving cell SSB information and clarification on “SSB time domain position”

Based on above observation, a tentative proposal is made below.

**Proposal3**: Discuss whether other non-serving cell SSB information are needed. Clarify “SSB time domain position” for non-serving cell SSB consists of “halfFrameIndex” and “ssb-PositionsInBurst”.

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| Company | comments |
| QC | Support the proposal. We think both configs are needed for the purpose of referring to a SSB index as well as for rate matching.In addition, we would like to clarify that same SCS, freq., and SFN should be assumed. |
| ZTE | Support FL’s proposal. We believe that center frequency, SCS and SFN offset of non-serving cell SSB should be provided with the following analyses.**Center frequency:** It is typical that the non-serving cell SSB should be one of the SSB(s) that configured in *MeasObjectNR*, but there can be multiple SSBs for measurement with different center frequency which configured for one cell (identified by one PCI) according to the current specs. Thus, center frequency of SSB in MO should be provided.**SCS**, **SFN offset:** When MTRP inter-cell in CA or inter-frequency operation, both of SCS and SFN can be different among serving cell and non-serving cell. Correspondingly, SCS and SFN offset of non-serving cell SSB should also be provided. |
| OPPO | We agree with QC on the clarification. |

* 1. Item 4: Other RS

**Huawei**

Support using NZP-CSI-RS from a non-serving cell or CSI-RS for RRM associated with a non-serving cell as QCL source for multi-DCI based multi-TRP transmission.

**OPPO**

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

**vivo**

* + CSI-RS for mobility should be supported as the QCL source for channels/RS.
	+ CSI-RS for CSI, beam management and tracking should all be allowed to be associated with non-serving cell RS for L1 inter-cell measurement.
		- FFS whether specification enhancement is needed.

**ZTE**

Supported to use non-serving cell CSI-RS for mobility as the QCL source for MTRP inter-cell transmission.

**Nokia**

To configure NZP-CSI-RS resource as non-serving cell RS, configure the RS with a QCL source RS that is associated with a non-serving cell.

**LG**

Consider mobility CSI-RS for QCL type C/D source of TRS/CSI-RS as well.

**Xiaomi**

Not support CSI-RS from non-serving cell as non-serving cell RS.

**Observation4:** There are few companies proposed to support non-serving cell NZP-CSI-RS for mobility, CSI as QCL source, while one company proposed not to support.

**Proposal4**: Discuss whether to support non-serving cell RS other than SSB for inter-cell MTRP operation

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| Company | comments |
| QC | Do not support. Motivation is not clear. The following is already concluded, and there is no need for further discussions on this:**Conclusion**Reuse Rel-15/16 QCL rule between the source and target RS/channel for non-serving cell RS/channel.  |
| ZTE | Support FL’s proposal. We think non-serving cell CSI-RS for mobility should be used as the QCL source in the light of the following reasons:i) Same as SSB for mobility, the UE can use RX beam or other large-scale channel parameters derived from CSI-RS for mobility to receive signal from non-serving cell;ii) Compared with SSB for mobility, CSI-RS for mobility has larger bandwidth, which can provide more accurate QCL derivation and can be implemented with narrower beam, especially it is more suitable to be QCL source of PDSCH in terms of TypeD since PDSCH usually uses narrow beam for transmission;iii) CSI-RS for mobility can be QCL source to speed up UE Rx beam sweeping, save power of UE, reduce overhead of signaling and reuse measurement signal transmitted from gNB;iv) Using CSI-RS for mobility as QCL source can support more flexible scenarios, especially when considering some non-serving cells only transmit CSI-RS for mobility but does not transmit SSB. |
| Ericsson | Do not support, agree with QC. Moreover, we don’t need to consider L1/L2 mobility measurements and procedures in multi-TRP agenda, let’s use MB agenda for this.  |
| OPPO | Do not support.  |

* 1. Item 5: TCI state association with CORESET

**vivo**

Clarify UE ehaviour when CORESETs with type 0/1/2 SS is configured/activated with TCI states associated with SSB of another PCI

**Ericsson**

The UE is not expected to be configured a common search space to a CORESET configured with a TCI state associated directly or indirectly with an non-serving-cell SSB

**Observation5:** there are two companies raised the issue on UE ehaviour when CORESET configured with a TCI state is configured with a common search space.

**Proposal5:** The UE is not expected to be configured a common search space to a CORESET configured with a TCI state associated directly or indirectly with an non-serving-cell SSB

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| Company | comments |
| QC | We are ok with this in principle. However, should this be applied to all CSS? For example, what is the motivation for this restriction for Type3-CSS? |
| ZTE | Share the same view with QC that the use case of Type3-PDCCH CSS should be clarified. |
| Ericsson | Support the proposal and good suggestion from QC and ZTE, some details needs to be clarified. We can perhaps add an FSS on the different Types, e.g .Type 3.  |
| OPPO | The same view as QC and ZTE. For Type3-PDCCH CSS, e.g group common TPC, it can be allowed to be transmitted from serving cell or non-serving cell.  |

* 1. Item 6: UL spatial relation info and PL-RS

**vivo**

Spatial relation and power control related configurations should be enhanced for SRS, PUCCH, PUSCH transmission towards target cell.

**ZTE**

Support non-serving cell SSB and CSI-RS for mobility can be configured as the PL-RS for uplink transmission.

**Lenovo**

SSB from a non-serving cell can be configured as the spatial relation and PL-RS for PUCCH resources and SRS resources.

When CSI-RS resource is configured as the spatialRelationInfo and/or PL-RS for PUCCH and/or SRS resource targeting a TRP associated with a non-serving PCID, the UE assumes that the CSI-RS is QCLed with a SSB index from the non-serving cell.

**Futurewei**

For inter-cell multi-TRP, generalize QCL types to include all existing QCL types, DL-UL spatial relation info, SRI relation, CSI-RS and SRS association, and PL RS relation.

**Qualcomm**

When SSB is used as reference signal in *SRS-SpatialRelationInfo, PUCCH-SpatialRelationInfo, PUCCH-PathlossReferenceRS, PUSCH-PathlossReferenceRS,* and *pathlossReferenceRS* under *SRS-ResourceSet*, support introducing a flag to indicate whether the *SSB-Index* is associated with the serving cell or is associated with non-serving cell. RRC signalling details are up to RAN2 to decide.

**DOCOMO**

Support configuration of non-serving cell SSB as QCL source RS with existing QCL relation for UL SRS, PUCCH, and PUSCH transmission.

**Observation6:** Several companies proposed to support configuration of non-serving cell SSB as QCL source for UL SRS, PUSCH, PUCCH transmission, while few companies also proposed to support non-serving cell CSI-RS as PL-RS for UL transmission.

Based on the observation, following tentative proposal is made.

**Proposal6:** Support configuration of non-serving cell SSB as QCL source RS with existing QCL relation for UL SRS, PUCCH, and PUSCH transmission

* FFS other non-serving cell RS

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| Company | comments |
| QC | Support the proposal. For multi-DCI, we need to have UL (PUCCH/PUSCH/SRS) to both TRPs.  |
| ZTE | Support FL’s proposal.  |
| Ericsson | Support the proposal in principle, but I wonder if we need to discuss this. In our view, when we have an SSB associated to a ns-cell PCI agreed, then Rel.16 behaviour for mTRP operation follows automatically. No need to discuss all the Rel.16 details again.  |
| OPPO | Support to add non-serving cell SSB into spatial relation information of PUCCH/SRS. However, for PUSCH, we are not sure whether it is needed based on Rel-16 signaling. The spatial relation of PUSCH comes from SRI/SRS/PUCCH but not DL signal in current specification. Whether we need to support UL-TCI in Rel-17 for this function? |

* 1. Item 7: Rate matching

**OPPO**

The resource of DL signal from serving cell is not impacted by the SSB configured by neighboring cell information.

**Spreadtrum**

For inter-cell multi-TRP operation, PDSCH/PDCCH from the serving cell should not be rate-matched around non-serving cell SSB.

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.

**Vivo**

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.

**CATT**

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.

**ZTE**

Support that PDSCH /PDCCH from serving cell is rate matched around non-serving cell SSB, and support that PDSCH/PDCCH from non-serving cell is rate matched around serving cell SSB.

**Apple**

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

**Qualcomm**

For PDCCH clarify that: PDCCH candidates associated with non-serving cell PCI / CORESETPoolIndex value 1 are not monitored if they overlap with a non-serving cell SSB.

* Serving cell SSBs do not impact PDSCH/PDCCH from non-serving cell PCI.
* Non-serving cell SSBs do not impact PDSCH/PDCCH from serving cell PCI.

**LG**

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.

**DOCOMO**

Do not support PDSCH /PDCCH from serving cell (or non-serving cell) rate matched around non-serving cell (or serving cell) SSB.

**Observation7:** several companies expressed their views on rate matching of PDSCH /PDCCH from serving cell (or non-serving cell) rate matched around non-serving cell (or serving cell) SSB, however there are few companies supporting and others against, slight majority of do not support.

Based on observation above, following tentative proposal is made

**Proposal7:** Discuss whether to support PDSCH /PDCCH from serving cell (or non-serving cell) rate matched around non-serving cell (or serving cell) SSB.

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| Company | comments |
| QC | We think there is no need for the additional rate matching.In addition, in the previous agreement, for both PDSCH and PDCCH, the word “rate matching” is used. However, we do not have rate matching around PDCCH in existing spec. We suggest to clarify that for PDCCH, dropping is meant, and not rate matching. |
| ZTE | Support to discuss it and we think PDSCH/PDCCH and non-serving cell SSB form different cells should be rate matched in MTRP inter-cell operation to guarantee inter-cell transmissions’ performance. |
| Ericsson | Agree with QC, no need for additional rate matching. In our view, when we have an SSB associated to a ns-cell PCI agreed, then Rel.16 behaviour for mTRP operation follows automatically, including rate matching. No need to discuss all the Rel.16 details again. |
| OPPO | Agree with QC and Ericsson that no additional rate matching is needed. If rate-matching is needed, rate-matching pattern can be used. There will be performance loss if the rate-matching is mandatory. |

* 1. Item 8: Others

**ZTE**

Support sequence generation of a non-serving cell TRS used as TCI source should be based on slot index of this non-serving cell.

**Xiaomi**

Group based beam reporting is slightly preferred for inter-cell beam pairing.

Inter-cell beam management by gNB can be supported.

Whether the PDCCH candidate or CCE from CORESETs associated with neighboring cell should be considered as same as that of serving cell or not when calculating the maximum number of monitored PDCCH candidates and the maximum number of non-overlapped CCE.

**Intel**

Consider associating the following with a TCI-State including SSB-Index from another PCID:

* TRS
* CORESETs
* DCI codepoint for TCI-State switching
* NZP-CSI-RS-ResourceSet with repetition set to ‘on’ (L1-RSRP)
* BFD resources (failureDetectionResources)
* CSI-RS for CSI measurement

**Qualcomm**

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].

**Futurewei**

For an inter-cell TRP, a signal/antenna port is non-co-located (NCLed) to the serving cell (i.e., the serving cell’s SSB) and is directly or indirectly QCLed to the non-serving cell’s SSB.

**Samsung**

For QCL source RS and QCL source RS type from non-serving cell

* For DL channels, large scale QCL properties are inferred from up to two RSes for QCL-TypeA and QCL-TypeD respectively.
* The QCL-TypeA source RS is TRS from non-serving cell, and QCL-TypeD source RS is non-serving cell SSB.

**Sony**

Non-serving cell information such as Cell ID or Physical Cell ID for RS shall be added in the CSI-ReportConfig.

QCL information among CSI-ResourceConfig in terms of beam sweeping property shall be included in the CSI-ReportConfig.

**LG**

Neighbor cell’s SSB can be configured as QCL type C/D source of TRS/CSI-RS to support inter-cell multi-TRP operations.

**Nokia**

For L1 SSB based beam measurements and reporting, enhance the *CSI-SSB-ResourceSet IE* to associate set of SSBs with a cell-specific identifier (PCI).

For non-serving cell CSI-RS measurements, configure the NZP-CSI-RS with a QCL source RS that is associated with a non-serving cell identifier.

**Ericsson**

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.

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| Company | comments |
| QC | At least the case of overlap between non-serving SSBs and UL signals / channels should be clarified.  |
| ZTE | How to successfully generate the sequence of non-serving cell TRS should be studied. |
| Ericsson | The Point A issue needs to be clarified. (includes the TRS sequence and CSI-RS, DRMS sequence).  |

1. Reference

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| [**R1-2102335**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2102335.zip) | Enhancements on inter-cell multi-TRP operations in Rel-17 | Huawei, HiSilicon |
| Proposal 1: Clarify that ‘PDSCH/PDCCH from non-serving cell (PCI)’ refer to PDSCH/PDCCH from the serving cell but has a SSB/CSI-RS from non-serving cell as (indirect) QCL source. Proposal 2: Support Option 1, i.e., explicitly indicate the PCI of a neighbour cell in the SSB configuration inside a TCI state.Proposal 3: Support using NZP-CSI-RS from a non-serving cell or CSI-RS for RRM associated with a non-serving cell as QCL source for multi-DCI based multi-TRP transmission. |
| [**R1-2102380**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2102380.zip) | Enhancement on inter-cell multi-TRP operation | OPPO |
| Proposal 1: Non-serving cell information includes SSB configuration information (e.g. PCI) of one neighboring cell, which is configured separately from QCL information to reduce signaling overhead.Proposal 2: To associate non-serving cell information with a TCI state, support Option 2: introduce a flag to indicate whether a TCI state/QCL information is associated with non-serving cell information or serving cell.Proposal 3: The neighboring cell (PCI) indicated by non-serving cell information should be one of the cells (PCIs) measured and reported by UE based on MeasObject.Proposal 4: For a CSI-RS QCLed with neighboring cell SSB, the transmit power is calculated based on powerControlOffsetSS and the SSB transmission power in neighboring cell information.Proposal 5: The resource of DL signal from serving cell is not impacted by the SSB configured by neighboring cell information. |
| [**R1-2102434**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2102434.zip) | Remaining Issues for M-TRP Inter-cell Operation | InterDigital, Inc. |
| Proposal 1: Support explicit signalling of the non-serving cell related information.Proposal 2: Support Option 1 or 2 where an explicit indication of association of TCI state /QCL information with a serving/non-serving cell is implemented through inclusion of PCID into TCI state/QCL information or introducing a flag, respectively. |
| [**R1-2102443**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2102443.zip) | Discussion on enhancement multi-TRP inter-cell operation | Spreadtrum Communications |
| Proposal 1: Support to indicate/associate non-serving cell PCI in the TCI state.Proposal 2: For inter-cell multi-TRP operation, PDSCH/PDCCH from the serving cell should not be rate-matched around non-serving cell SSB.Proposal3: 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. |
| [**R1-2102508**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2102508.zip) | Further discussion on inter-cell MTRP operation | vivo |
| Proposal 1: Strive to down select one of the 5 options for indication/association of non-serving cell information with TCI states, send LS to RAN2 on RAN1 agreements on inter-cell MTRP operation.Proposal 2: Clarify UE behaviour when CORESETs with type 0/1/2 SS is configured/activated with TCI states associated with SSB of another PCI.Proposal 3: * + CSI-RS for mobility should be supported as the QCL source for channels/RS.
	+ CSI-RS for CSI, beam management and tracking should all be allowed to be associated with non-serving cell RS for L1 inter-cell measurement.
		- FFS whether specification enhancement is needed.

Proposal 4: For discussion purpose, define PDSCH/PDCCH/RS from non-serving cell (PCI) as following: * + A non-serving cell RS is one of the following (agreement till now):
		- SSBs associated with the non-serving cell information;
		- RS configured with TCI states associated with non-serving cell information;
		- RS configured with TCI state with QCL source RS as a non-serving cell RS (including all three different kinds);
	+ A PDCCH/PDSCH from non-serving cell is the PDCCH/PDSCH transmitted with TCI states with QCL source RS as a non-serving cell RS.

Proposal 5: 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 6: Spatial relation and power control related configurations should be enhanced for SRS, PUCCH, PUSCH transmission towards target cell. |
| [**R1-2102600**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2102600.zip) | Discussion on inter-cell operation for multi-TRP/panel | CATT |
| Proposal-1: The necessity of frequency (i.e. ssb-Freq-r16 and absoluteFrequencySSB) and SCS (i.e. sbSubcarrierSpacing-r16) parameters depends on whether inter-frequency scenario is supported. SFN and half-frame index are further needed for inter-cell mTRP.Proposal-2: Introduce a new indicator to indicate the non-serving cell information that a TCI state/QCL information is associated with (Option5). The indicator could be configured in the activation MAC-CE.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.  |
| [**R1-2102662**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2102662.zip) | Discussion on Multi-TRP inter-cell operation | ZTE |
| **Proposal 1:** Other non-serving cell SSB information provided to UE should at least include center frequency, SCS, and SFN offset.**Proposal 2:** Support to introduce a new RRC IE linking with some TCI states. * At least MeasObjectId and PCI should be contained in the new IE.

**Proposal 3:** For the configuration TCI state/ QCL-info with non-serving cell SSB information, support Opt. 3 that all TCI states should be split into two groups which corresponding to serving cell and non-serving cell, respectively.* Each group of TCI states is associated with a CORESETPoolIndex value.

**Proposal 4:** Supported to use non-serving cell CSI-RS for mobility as the QCL source for MTRP inter-cell transmission.**Proposal 5:** Support non-serving cell SSB and CSI-RS for mobility can be configured as the PL-RS for uplink transmission.**Proposal 6:** Support 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:** Support that PDSCH /PDCCH from serving cell is rate matched around non-serving cell SSB, and support that PDSCH/PDCCH from non-serving cell is rate matched around serving cell SSB. |
| [**R1-2102762**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2102762.zip) | Inter-cell multi-TRP operation | FUTUREWEI |
| Proposal 1: For inter-cell multi-TRP enhancement, replace the term “non-serving cell” with “cooperating cell” or the like.Proposal 2: For an inter-cell TRP, a signal/antenna port is non-co-located (NCLed) to the serving cell (i.e., the serving cell’s SSB) and is directly or indirectly QCLed to the non-serving cell’s SSB.Proposal 3: Explicitly configure the non-serving cell PCI as physicalCellId, reusing Rel-16 mechanism as much as possible.Proposal 4: Explicitly configure the non-serving cell SSB index.Proposal 5: For inter-cell multi-TRP, generalize QCL types to include all existing QCL types, DL-UL spatial relation info, SRI relation, CSI-RS and SRS association, and PL RS relation.Proposal 6: Indicate/associate non-serving cell PCI via QCL/TCI state, which implicitly groups all RSs, channels, resources, and TCI states to the serving cell and the non-serving cell respectively. CORESET pool index is not necessary. |
| [**R1-2102840**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2102840.zip) | Enhancements on Multi-TRP inter-cell operation | Lenovo, Motorola Mobility |
| Proposal 1: SSB index 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 in the MO.Proposal 3: The configured non-serving cell’s SSB index is within the SMTC configured for this cell.Proposal 4: Option 3 should be supported.Proposal 5: In inter-cell multi-DCI based multi-TRP scenario, CORESETPoolIndex=0 is associated with the serving PCID and CORESETPoolIndex=1 is associated with a non-serving PCID different from the serving PCID.Proposal 6: The UE assumes that TRS contained in the TCI state activated for PDCCH/PDSCH transmitted from TRP associated with a non-serving PCID is QCLed with a SSB index from this non-serving cell.Proposal 7: SSB from a non-serving cell can be configured as the spatial relation and PL-RS for PUCCH resources and SRS resources.Proposal 8: When CSI-RS resource is configured as the spatialRelationInfo and/or PL-RS for PUCCH and/or SRS resource targeting a TRP associated with a non-serving PCID, the UE assumes that the CSI-RS is QCLed with a SSB index from the non-serving cell. |
| [**R1-2102879**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2102879.zip) | Enhancements on Multi-TRP inter-cell operation | CMCC |
| Proposal 1: A flag or a new indicator can be configured in /associated with a TCI state when the SSB from non-serving cell is used as the QCL reference RS. Proposal 2: A new RRC IE can be introduced to configure the non-serving cell information. |
| [**R1-2102961**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2102961.zip) | Enhancement on Inter-cell Multi-TRP operations | Xiaomi |
| Proposal 1: Prefer Option 2 or Option 5 to configure TCI state associated with non-serving cell. Proposal 2: Not support CSI-RS from non-serving cell as non-serving cell RS.Proposal 3: Group based beam reporting is slightly preferred for inter-cell beam pairing.Proposal 4: Inter-cell beam management by gNB can be supported.Proposal 5: Whether the PDCCH candidate or CCE from CORESETs associated with neighboring cell should be considered as same as that of serving cell or not when calculating the maximum number of monitored PDCCH candidates and the maximum number of non-overlapped CCE. |
| [**R1-2103016**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2103016.zip) | Multi-TRP enhancements for inter-cell operation | Intel Corporation |
| Proposal-1: Multi-cell reception mode is supported by providing the following information explicitly to the UE* PCID (PhysCellId)
* SSB pattern (ssb-PositionsInBurst, ssb-periodicityServingCell)
* sub-carrier spacing (subcarrierSpacing)
* frequency (absoluteFrequencySSB)

Proposal-2: Consider associating the following with a TCI-State including SSB-Index from another PCID:* TRS
* CORESETs
* DCI codepoint for TCI-State switching
* NZP-CSI-RS-ResourceSet with repetition set to ‘on’ (L1-RSRP)
* BFD resources (failureDetectionResources)
* CSI-RS for CSI measurement
 |
| [**R1-2103090**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2103090.zip) | Views on Rel-17 Inter-cell multi-TRP operation | Apple |
| Proposal 1: For inter-cell multi-TRP operation, support option 2/3/5 to define the association between TCI and non-serving cell information, where an indicator can be used to provide the linkage between non-serving cell information and a TCI* The TCI with the same indicator should be associated with the same CORESETPoolIndex

Proposal 2: 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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| [**R1-2103152**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2103152.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: When SSB is used as reference signal in *QCL-Info*, support Option 2: Introduce a flag to indicate whether the *SSB-Index* is associated with the serving cell or is associated with non-serving cell. RRC signalling details are up to RAN2 to decide. Proposal 3: UE does not expect channels associated with CORESETPoolIndex value 0 and 1 to have TCI states associated with non-serving cell and serving cell PCI, respectively. Proposal 4: When SSB is used as reference signal in *SRS-SpatialRelationInfo, PUCCH-SpatialRelationInfo, PUCCH-PathlossReferenceRS, PUSCH-PathlossReferenceRS,* and *pathlossReferenceRS* under *SRS-ResourceSet*, support introducing a flag to indicate whether the *SSB-Index* is associated with the serving cell or is associated with non-serving cell. RRC signalling details are up to RAN2 to decide. Proposal 5: For PDCCH clarify that: PDCCH candidates associated with non-serving cell PCI / CORESETPoolIndex value 1 are not monitored if they overlap with a non-serving cell SSB.* Serving cell SSBs do not impact PDSCH/PDCCH from non-serving cell PCI.
* Non-serving cell SSBs do not impact PDSCH/PDCCH from serving cell PCI.

Proposal 6: 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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| [**R1-2103223**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2103223.zip) | Enhancements on Multi-TRP inter-cell operation | Samsung |
| **Proposal 1:** For non-serving cell PCI indication for inter-cell mTRP operation* Selecting between explicit and implicit methods of indicating the non-serving cell PCI in TCI state shall take into account signaling overhead, payload variation, and RAN2 impact.
* In terms of minimizing the signaling overhead, the implicit non-serving cell PCI indication in TCI state shall be supported.

**Proposal 2:** For QCL source RS and QCL source RS type from non-serving cell* For DL channels, large scale QCL properties are inferred from up to two RSes for QCL-TypeA and QCL-TypeD respectively.
* The QCL-TypeA source RS is TRS from non-serving cell, and QCL-TypeD source RS is non-serving cell SSB.
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| [**R1-2103289**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2103289.zip) | Considerations on inter-cell operation | Sony |
| Proposal 1 Non-serving cell information such as Cell ID or Physical Cell ID for RS shall be added in the *CSI-ReportConfig*.Proposal 2 QCL information among CSI-ResourceConfig in terms of beam sweeping property shall be included in the *CSI-ReportConfig*. |
| [**R1-2103367**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2103367.zip) | Enhancements to enable inter-cell multi-TRP operations | Nokia, Nokia Shanghai Bell |
| Proposal 1: To configure SSB as non-serving cell RS, indicate the associated cell (PCI) and SSB-index for the SSB in the *referenceSignal* parameter (Option 1).Proposal 2: To configure NZP-CSI-RS resource as non-serving cell RS, configure the RS with a QCL source RS that is associated with a non-serving cell.Proposal 3: For L1 SSB based beam measurements and reporting, enhance the *CSI-SSB-ResourceSet IE* to associate set of SSBs with a cell-specific identifier (PCI).Proposal 4 : For non-serving cell CSI-RS measurements, configure the NZP-CSI-RS with a QCL source RS that is associated with a non-serving cell identifier.Proposal 5: For inter-cell multi-DCI based multi-TRP support, the CORESETs of non-serving cell are pooled under the same CORESETPoolIndex. |
| [**R1-2103506**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2103506.zip) | Enhancements on Multi-TRP inter-cell operation | LG Electronics |
| Proposal #1: Neighbor cell’s SSB can be configured as QCL type C/D source of TRS/CSI-RS to support inter-cell multi-TRP operations. Proposal #2: Consider mobility CSI-RS for QCL type C/D source of TRS/CSI-RS as well.Proposal #3: *MeasObjectId*, and PCID and SSB index in *MeasObjectNR* corresponding *MeasObjectId* should be associated with or configured as *referenceSignal* in *QCL-info* in *TCI-State.*Proposal #4: 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. |
| [**R1-2103561**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2103561.zip) | Discussion on inter-cell multi-TRP operations | NTT DOCOMO, INC. |
| Proposal 1:* + Define a separate IE for non-serving cell configuration for MTRP inter-cell operation.
	+ At least PhysCellId is included in the IE.
	+ A new indicator (e.g., re-index the non-serving cells) is needed in the IE to indicate each non-serving cell.

Proposal 2:* + Support to configure more than one non-serving cell’s configurations on a CC.
	+ Support to configure at least 3 non-serving cells on a CC with 2-bit new indicator.

Proposal 3:* + Support Option 5 for TCI state/QCL-info configuration, i.e., to configure a new indicator (e.g., re-index the non-serving cells) in TCI state/QCL-Info configuration to indicate the non-serving cell.
	+ Support to configure up to 1 non-serving cell from the re-indexing indexes to be associated with the TCI state/QCL-info configuration on a CC.

Proposal 4:* + Support configuration of non-serving cell SSB as QCL source RS with existing QCL relation for UL SRS, PUCCH, and PUSCH transmission.

Proposal 5:Do not support PDSCH /PDCCH from serving cell (or non-serving cell) rate matched around non-serving cell (or serving cell) SSB. |
| [**R1-2103715**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104b-e/Docs/R1-2103715.zip) | On 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 foreseen.](#_Toc68618533)[Proposal 2 The UE is not expected to be configured a common search space to a CORESET configured with a TCI state associated directly or indirectly with an non-serving-cell SSB](#_Toc68618535)[Proposal 3 Agree on Option 1: Indicate/associate non-serving cell PCI in the TCI state. FFS other non-serving cell information](#_Toc68618536)[Proposal 4 Send an LS to RAN2 with the agreements made in the inter-cell multi-TRP agenda item, so they can start their work on the signalling.](#_Toc68618537) |