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

**e-Meeting, August 16th – 26th, 2021**

Source: moderator (vivo)

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

Agenda Item: 8.1.2.2

Document for: Discussion and Decision

1. Introduction

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

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

**Item 1-1**

The options below refers to the 5 options from RAN1#104-e.

**Option1 :** Huawei/HiSi, Spreadtrum, Ericsson, Nokia, Futurewei(?)

**Option2 :** IDC, OPPO, CMCC, Apple,

**Option3 :** ZTE, Lenovo/MotM, Apple

**Option4 :**

**Option5 :** CATT, Apple, DOCOMO, Xiaomi

**Observations :**

* From the proposals in the contributions, support for different options are almost equally split.
* There are few contributions proposing to introduce a new RRC IE to link TCI states with PCI differnt from serving cell PCI, or explicit signaling for the second cell PCI.
* There is one contribution proposing to agree on explicit or implicit indication/association of TCI states with PCI different from serving cell PCI
* There are few contributions proposing to send LS to RAN2 with the agreements made so far on necessary information for linking TCI states with PCI differnt from serving cell PCI

**Proposal 1-1:**

**Item 1-2**

Number of RRC configured PCI different from serving cell PCI

**Alt1:** the maximum number of RRC-configured PCIs different from the serving cell PCI per CC is equal to 1

Support: OPPO, Qualcomm, Intel, Apple

**Alt2:** the maximum number of RRC-configured PCIs different from the serving cell PCI per CC is greater than 1 with at most 1 additional PCI is activated

Support: Huawei/HiSi, IDC (max 2), Ericsson, Futurewei, DOCOMO (at least 3)

**Proposal 1-2:**

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| Company | comments |
| QC | Item 1-1: We prefer Option 2. Also, we prefer RAN1 select one option since we agreed before that we will down-select one option. If this is not possible, we would be ok to let RAN2 decide it (in which case, LS needs to describe RAN1’s intention rather than copying the 5 options).Issue 1-2: We support Alt1. As discussed offline, we can be a bit more flexible for this part if there is strong demand for larger number. In that case, the complexity associated with memory as well as rate matching patterns (SSB locations) need to be considered. For rate matching part, if all PCIs have the same exact SSB locations, the concern is alleviated. Hence, we suggest the following as a compromise:* Max number of additional RRC-configured PCIs is 1 if SSB time domain positions or periodicity is not exactly the same as serving cell PCI
* Max number of additional RRC-configured PCIs is X if SSB time domain positions and periodicity is exactly the same among the PCIs and same as serving cell PCI
	+ X= 3 or 7 (so that 2 or 3 bits would be enough to identify the PCI if RAN1/RAN2 decides to minimize the RRC overhead)
	+ Max supported X is UE capability (granularity can be discussed, e.g., UE capability can be whether more than 1 is supported (binary) or can directly indicate max value of X)
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* 1. Item 2: Rate matching

**Item2-1**

Clarify previous agreement as below:

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

**Proposal2-1:**

**Item2-2**

Clarify the following with respect to PDSCH rate matching / not monitoring PDCCH candidates:

* 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.

**Proposal2-2:**

**Item2-3**

**Alt1:** PDSCH /PDCCH associated with serving cell PCI should be rate matched around non-serving cell SSB, and PDSCH/PDCCH associated with non-serving cell PCI should be rate matched around serving cell SSB as well.

Support: ZTE, CATT, Intel, Apple (with UE capability), LG,

**Alt2:** PDSCH/PDCCH from the serving cell should not be rate-matched around non-serving cell SSB, and PDSCH/PDCCH from non-serving cell (PCI) associated with TCI state and/or QCL-info is not rate matched around serving cell SSB.

Support: Spreadtrum, OPPO, DOCOMO, vivo

**Observation2-3:** support for 2 alternatives are almost equally split, further discussion on the alternatives is needed.

**Proposal2-3:**

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| Company | comments |
| QC | Item 2-1: We do not understand the intention. This is already agreed, and the “indirect part” is just Rel.15/16 TCI framework. We already twice agreed with “reusing Rel-15/Rel-16 QCL rules”. Do we need to agree to this one more time?Item 2-2 / 2-3: These two are the same issue. Our preference is Item 2-2 or Alt2 in Item 2-3. |
| Apple | Item 2-3, we have a question for Alt2, without rate matching, does it mean UE can do SSB measurement and PDSCH decoding in the overlapped REs simultaneously, or we assume this case would not happen based on network scheduling?  |
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* 1. Item 3: PCI association with CORESETPoolIndex

**Item 3-1**

Whether CORESETPoolIndex should be configured for inter-cell MTRP operation in Rel-17?

Yes:

No:

**Proposal3-1:**

**Item3-2**

**Alt1:** one PCI associated with one or more of activated TCI states for [PDSCH]/PDCCH can be associated with only one CORESETPoolIndex

Support: ZTE, Lenovo/MotM, Spreadtrum, Samsung, OPPO, Qualcomm, CMCC, Apple, LG, DOCOMO, Xiaomi, Nokia, Futurewei

**Alt2:** one PCI associated with one or more of activated TCI states for [PDSCH]/PDCCH can be associated with more than one CORESETPoolIndex

Support: Huawwei/HiSi, IDC, CATT, Futurewei

**Alt3:** one PCI associated with TCI states for [PDSCH]/PDCCH via QCL relationship without association with CORESETPoolIndex

Support: Ericsson, Intel, Futurewei

**Observation3-2:** Majority of companies support Alt1.

**Proposal3-2:**

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| Company | comments |
| QC | Issue 3-1: Yes.Issue 3-2: Alt1. Furthermore, the other direction is also needed as mentioned by Samsung:* One CORESETPoolIndex can be associated with only one PCI associated with one or more of activated TCI states for [PDSCH]/PDCCH

We would like to mention that any other alternative is out of scope based on the last RANP agreement:“1. RAN confirms that inter-cell mTRP in RAN1 work only considers multi-DCI and multi-PDSCH reception (per WI objective). Any scheme tailored for reception of a single PDCCH and/or a single PDSCH is not supported in Rel-17 mTRP.” |
| Apple | Issue 3-1: Yes |
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* 1. Item 4: relation with CORESET

**Proposal4:**

[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 SSB having additional PCI (i.e. non-serving PCI)](#_Toc79134958)

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| Company | comments |
| QC | Ok with Type0/0A/1/2 CSS. We think Type3 CSS does not need to have this restriction. |
| Apple | We do not think this is necessary. |
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* 1. Item 5: Other non-serving cell information

**Proposal5:** Whether to support one or more of the following information from cell with different PCI for inter-cell MTRP operation

* Center frequency
* SCS
* SFN offset (for inter frequency operation)
* half-frame index
* ssb-PositionsInBurst
* ss-PBCH-BlockPower

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| Company | comments |
| QC | Support the last 3 (• half-frame index, • ssb-PositionsInBurst, • ss-PBCH-BlockPower) + periodicity for clarification, which are already agreed in principle in our understanding:**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

For the first 3 items (center freq., SCS, SFN), we do not understand why they are needed. What is the use case? We are discussing mDCI based mTRP, which is defined in a given CC (intra-frequency).  |
| Apple | In our view, the last 3 have been agreed.For the first 3 items, we think one possible way is that UE should assume all of them be the same for both cells. |
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* 1. Item 6: UL signal/channels

**Proposal 2-6:**

* 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.

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| Company | comments |
| QC | Support. We think AI 8.1.1 does not address this issue. This is because the corresponding enhancement in 8.1.1 assume unified TCI (no spatial relation info) while inter-cell mTRP is based on Rel-15/16 TCI framework as clarified in the revised WID.Any company who believes that this is out-of-scope, has to explain why? The WID mentions the following, and part of multi-DCI based mTRP operation is related to sending the feedback for PDSCH (on PUCCH or PUSCH).1. Enhancement on the support for multi-TRP deployment, targeting both FR1 and FR2:
	1. Identify and specify QCL/TCI-related enhancements to enable inter-cell multi-TRP operations, assuming multi-DCI based multi-PDSCH reception based on Rel-15/16 TCI framework
 |
| Apple | Do not support. CSI-RS should be sufficient. In addition, we failed to see that this is within scope. |
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* 1. Item 7: Others

**#7-1:** clarification on terms used in the context of inter-cell MTRP operation

* For inter-cell multi-TRP enhancement, adopt the terms “additional PCI”, “additional cell”, “additional SSB”, or according to RAN2 inputs.

**#7-2:** Clarification

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

**#7-3:** CSI-RS from the cell with different PCI

* 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.
* The additional PCI is associated with the TCI state configured for CSI-RS in addition to PDSCH/PDCCH.

**#7-4:** sequence generation of TRS from cell with different PCI

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

**#7-5:** restriction on SSB from cell with different PCI

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

**#7-6:** assumption on Point A

* [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.](#_Toc79134957)

**#7-7:** Overlap with UL signals/channels

* How the non-serving cell SSBs should be treated with respect to the UL-related Procedures 1-4 below:
	+ 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 (indicated by *ssb-PositionsInBurst*) 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 slots in the case of PUCCH repetition, i.e., a slot is not counted toward the slots if the PUCCH resource in that slot overlaps with a SSB [38.213, Section 9.2.6].

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| Company | comments |
| QC | We added issue 7-7 above, which we explained in our contribution, and we think should be addressed. |
| Apple | We think 7-3 and 7-6 should be discussed, since both issues are about the measurement for the QCL enhancement. Other issues can be deprioritized. |
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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

1. Reference

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| R1-2106465 | Enhancements on inter-cell multi-TRP operation in Rel-17 | Huawei, HiSilicon |
| **Observation 1: For inter-cell multi-TRP operation, with the aid of existing information in MO, there is no need to explicitly indicate non-serving cell information such as SSB time domain position, SSB transmission periodicity, and SSB transmission power.****Proposal 1: Clarify that ‘PDSCH/PDCCH from non-serving cell’ refer to PDSCH/PDCCH from the serving cell but has a SSB/CSI-RS from non-serving cell as indirect QCL source.** **Proposal 2: The additional PCI that is different from the serving cell PCI can be indicated as part of TCI state configured for CSI-RS contained in TCI states activated for PDSCH/PDCCH.****Proposal 3: Support more than one PCIs which is different from the serving cell that can be RRC-configured for multi-DCI based inter-cell multi-TRP operation.****Proposal 4:** **Support Alt2, one PCI that is different from the serving cell and associated with activated TCI states for PDSCH/PDCCH can be associated with more than one CORESETPoolIndex.****Proposal 5: Support Option 1, i.e., explicitly indicating one PCI that is different from the serving cell along with the SSB index inside a TCI state.** |
| [**R1-2106543**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106543.zip) | Discussion on Multi-TRP inter-cell operation | ZTE |
| **Observation 1:** Non-serving cell SSB used as QCL source RS for inter-cell MTRP operation should be one of SSBs which aims to mobility measurement.**Proposal 1:** Other non-serving cell SSB information provided to UE should also include center frequency, SCS, and SFN offset, especially when inter-frequency operation.**Proposal 2:** Support to introduce a new RRC IE to link TCI states with non-serving cell SSB information.* At least MeasObjectId and PCI of the non-serving cell SSB should be included in the new IE.

**Proposal 3:** For inter-cell MTRP operation, one PCI associated with one or more of activated TCI states for [PDSCH]/PDCCH can be associated with only one CORESETPoolIndex.(Alt. 1)**Proposal 4:** For the configuration of associating TCI state/ QCL-info with non-serving cell SSB information, support that all TCI states should be split into two groups which corresponding to serving cell and non-serving cell, respectively. (Option 3)* Each group of TCI states is associated with a CORESETPoolIndex value.

**Proposal 5:** Support to use non-serving cell SSB for mobility measurement as the PL-RS for uplink transmission.**Proposal 6:** 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 non-serving cell PDSCH/PDCCH is rate matched around a subset of non-serving cell SSBs of transmitted SSBs configured in ssb-PositionsInBurst. **Proposal 8:** PDSCH /PDCCH associated with serving cell PCI should be rate matched around non-serving cell SSB, and PDSCH/PDCCH associated with non-serving cell PCI should be rate matched around serving cell SSB as well.**Proposal 9:** 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. |
| [**R1-2106573**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106573.zip) | Further discussion on inter-cell MTRP operation | vivo |
| **Proposal1**: * **Discuss and agree on maximum number of PCIs that can be configured to the UE to support inter-cell multi TRP operation**
* **Discuss and agree on the options (5 options from RAN1#104-e) for associating TCI state with PCI different from serving cell PCI, send LS to RAN2 on the agreements**
* **Discuss and agree on the alternatives (3 alternatives from RAN1#104b-e) for associating TCI states with CORESETPoolIndex, outcome of the agreements can be captured in RAN1 specification**

**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: 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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| R1-2106642 | On M-TRP Inter-cell Operation | InterDigital, Inc. |
| **Proposal 1:** The SSB related information (time domain position, transmission periodicity, transmission power) to be included in the measurement’s configuration object to support inter-cell multi-TRP UE operation.**Proposal 2:** Support explicit signalling for the second cell PCI measurements.**Proposal 3:** Support Option 2 where a flag is introduced to indicate whether a TCI state/QCL information is associated with non-serving cell information or serving cell**.****Proposal 4:** Agree on Alternative 2: one PCI associated with one or more of activated TCI states for [PDSCH]/PDCCH can be associated with more than one CORESETPoolIndex. **Proposal 5:** For the maximum number of PCIs across the CCs agree on scaling the carrier aggregation’s maximum number of CCs limit, considering 2 PCIs per CCs inter-cell multi-TRP decision. |
| [**R1-2106668**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106668.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: Option 3 should be supported.*** **Explicit or implicit grouping of TCI states associated with non-serving cell information corresponding to the serving cell and the non-serving cell respectively**

**Proposal 5: PCI associated with one or more of activated TCI states for [PDSCH]/PDCCH can be associated with only one CORESETPoolIndex.****Proposal 6: 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.****Proposal 7: SSB from a non-serving cell can be configured as the spatial relation and PL-RS for PUCCH resources and SRS resources.** |
| [**R1-2106687**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106687.zip) | Discussion on enhancements on Multi-TRP inter-cell operation | Spreadtrum Communications |
| **Observation 1: For multi-DCI based inter-cell multi-TRP transmission, the framework where different TRPs use different CORESETs in PDCCH-Config could be still used.****Proposal 1: one PCI associated with TCI state shall be associated with CORESETPoolIndex.****Proposal 2: Support to indicate/associate non-serving cell PCI in the TCI state.****Proposal 3: For inter-cell multi-TRP operation, PDSCH/PDCCH from the serving cell should not be rate-matched around non-serving cell SSB.****Proposal 4: 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.** |
| [**R1-2106867**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106867.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 inter-cell mTRP operation,* * *Support the association between CORESETPoolIndex values and PCIs.*
* *One CORESETPoolIndex shall be associated with only one PCI with active TCI state for PDCCH/PDSCH.*
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| R1-2106937 | Enhancements 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).** **Proposal-3: Considering the association between non-servng cell information and CORESETPoolIndex, one PCI associated with one or more of activated TCI states for [PDSCH]/PDCCH can be associated with more than one CORESETPoolIndex (Alt-2) should be supported.****Proposal-4: 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.**  |
| [**R1-2107026**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107026.zip) | On Multi-TRP inter-cell operation  | Ericsson |
| [**Proposal 1 The additional PCI is associated with TCI states for PDSCH/PDCCH via QCL relationships and without association or relation with a CORESETPoolIndex, i.e. support Alt.3**](#_Toc79134955)[**Proposal 2 Any RRC configured TCI state that contains an SSB (following Rel.16 multi-DCI specifications) can optionally be configured with an additional PCI value. How to configure this is up to RAN2. No restriction is needed on how many different additional PCI values that can be RRC configured**](#_Toc79134956)[**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.**](#_Toc79134957)[**Proposal 4 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 SSB having additional PCI (i.e. non-serving PCI)**](#_Toc79134958)[**Proposal 5 Agree on Option 1: Indicate/associate non-serving cell PCI in the TCI state. FFS other non-serving cell information**](#_Toc79134959)[**Proposal 6 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 RRC signalling.**](#_Toc79134960) |
| [**R1-2107080**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107080.zip) | Inter-cell multi-TRP operation | FUTUREWEI |
| **Proposal 1: For inter-cell multi-TRP enhancement, adopt the terms “additional PCI”, “additional cell”, “additional SSB”, or according to RAN2 inputs.****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 additional cell’s SSB.****Proposal 3: At most 1 additional PCI can be activated per carrier at a time, and at most n additional PCIs can be configured per carrier, FFS n.****Proposal 4: Explicitly configure the additional** **cell SSB index.****Proposal 5: (Implicit) Association/grouping of inter-cell M-TRP resources via QCL/TCI association to the serving PCI or additional PCI is sufficient. Explicit indexing with a unique ID (not the PCI) is not necessary or essential.****Proposal 6: 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 7: 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 8: If CORESET pool index is to be used for inter-cell M-TRP, more bits may be needed and the indexing shall be consistent with association of resources to a PCI via QCL/TCI states.****Proposal 9: Indicate/associate additional cell PCI via QCL/TCI state, which implicitly groups all RSs, channels, resources, and TCI states to the serving cell and the additional cell respectively.** **Proposal 10:** **A PCI may be associated with no, one, or more CORESET pool indexes depending on the scenarios:*** **For a PCI without intra-cell M-TRP resources, no CORESET pool index is assigned;**
* **For a PCI with intra-cell M-TRP resources, one or no (absent) CORESET pool index is assigned to each of the groups of intra-cell M-TRP resources.**

**Proposal 11:** **Indication of an additional PCI for same/cross-carrier scheduling is not needed.** |
| [**R1-2107205**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107205.zip) | Enhancement on inter-cell multi-TRP operation | OPPO |
| ***Proposal 1: One PCI different from the serving cell PCI can be configured by RRC per CC, which should be one of the PCIs measured and reported by UE based on MeasObject.******Proposal 2: The maximum number of PCIs different from the serving cell PCI across all CCs is up to UE capability.******Proposal 3: Non-serving cell information includes SSB configuration information of one neighboring cell, which is configured separately from QCL information to reduce signaling overhead.******Proposal 4: 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 5: Clarify that SSB time domain position for non-serving cell SSB consists of “halfFrameIndex” and “ssb-PositionsInBurst”.******Proposal 6: 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 7: When two PCIs are associated with activated TCI states for [PDSCH]/PDCCH, support Alt 1: one PCI associated with one or more activated TCI states for [PDSCH]/PDCCH can be associated with only one CORESETPoolIndex.*** ***Proposal 8: The resource of DL signal from serving cell is not impacted by the SSB configured by neighboring cell information.*** |
| [**R1-2107325**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107325.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: For a CC associated with two CORESETPoolIndex values, the maximum number of RRC-configured PCIs different from the serving cell PCI per CC is equal to 1.****Proposal 3: For intercell MTRP operation, support Alt1 for both PDCCH and PDSCH*** **Alt1: one PCI associated with one or more of activated TCI states for PDSCH/PDCCH can be associated with only one CORESETPoolIndex**

**Proposal 4: 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.** * **RRC signalling details are up to RAN2 to decide.**

**Proposal 5: Clarify the following with respect to PDSCH rate matching / not monitoring PDCCH candidates:*** **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 slots in the case of PUCCH repetition, i.e., a slot is not counted toward the slots if the PUCCH resource in that slot overlaps with a SSB [38.213, Section 9.2.6].**
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| [**R1-2107392**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107392.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: For intercell MTRP operation, support Alt1:*** ***one PCI associated with one or more of activated TCI states for [PDSCH]/PDCCH can be associated with only one CORESETPoolIndex.******Proposal 3: A new RRC IE can be introduced to configure the non-serving cell information.*** |
| R1-2107572 | Multi-TRP enhancements for inter-cell operation | Intel Corporation |
| ***Proposal-1: A single additional PCI per CC is sufficient when the target RS is CSI-RS for CSI.******Proposal-2: Associate a non-serving PCI with TCI states for PDSCH/PDCCH via QCL relationship without association with CORESETPoolIndex******Proposal-3: Support indication of ssb-PositionsInBurst and half-frame index associated with the non-serving cell to the UE******Proposal-4: 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-5: Support indication of ss-PBCH-BlockPower associated with the non-serving cell to the UE******Proposal-6: Support configuration of SSB with non-serving PCID as QCL source RS for SRS, PUCCH, and PUSCH transmission*** ***Proposal-7: Association of non-serving PCID with TCI state can be left to RAN2. RAN1 can provide the following information to RAN2 – a single non-serving PCI associated to activated TCI states for CSI-RS for CSI/PDSCH/PDCCH, a single non-serving PCI associated to activated TCI states for PUCCH-spatialRelationInfo or SRS-spatialRelationInfo for PUSCH, source RS for non-serving cell PCI is SSB and target RS for non-serving cell PCI is CSI-RS, DMRS for PDCCH/PDSCH, PL-RS (PUCCH, PUSCH)***  |
| [**R1-2107720**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107720.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***

***Proposal 3: For PCI and CORESETPoolIndex association, support Alt 1, where one PCI associated with one or more of activated TCI states for PDSCH/PDCCH can be associated with only one CORESETPoolIndex.******Proposal 4: Only 1 additional PCI is supported for inter-cell mTRP.******Proposal 5: The additional PCI is associated with the TCI state configured for CSI-RS in addition to PDSCH/PDCCH.*** |
| [**R1-2107816**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107816.zip) | Enhancements on Multi-TRP inter-cell operation | LG Electronics |
| **Proposal #1: For intercell MTRP operation, different PCID associated with one or more of activated TCI states for PDSCH/PDCCH should be associated with different CORESETPoolIndex.****Proposal #2: *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 #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.** |
| [**R1-2107840**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107840.zip) | Discussion on inter-cell multi-TRP operations | NTT DOCOMO, INC. |
| **Proposal 1:*** + ***Define a separate IE for cells with different PCI 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 cell with different PCI.***

**Proposal 2:*** + ***Support to configure more than one cell with different PCI on a CC.***
	+ ***Support to configure at least 3 cells with different PCI 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.***

**Proposal 4:*** + ***Support Alt1: one PCI associated with one or more of activated TCI states for PDSCH/PDCCH can be associated with only one CORESETPoolIndex.***

**Proposal 5:*** + ***Support configuration of SSBs from a cell with different PCI as QCL source RS with existing QCL relation for UL SRS, PUCCH, and PUSCH transmission.***

**Proposal 6:*** + ***Do not support PDSCH /PDCCH from serving cell (or cell with different PCI) rate matched around SSBs from the cell with different PCI (or serving cell).***
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| [**R1-2107895**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107895.zip) | QCL/TCI-related enhancements on Inter-cell Multi-TRP | 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 should be configured explicitly like the SSB-Configuration-r16 in ssb-InfoNcell-r16.******Proposal 3: Prefer Option 5 to configure TCI state associated with non-serving cell.******Proposal 4: We support alt.1 that one PCI associated with one or more of activated TCI states for PDSCH/PDCCH can be associated with only one CORESETPoolIndex for inter-cell multi-TRP in Rel17.******Proposal 5: Which cell UE should report the beam measurement results to needs to be discussed for inter-cell multi-TRP:**** ***Option1: Beam measurement results of both non-serving cell and serving cell(s) should be reported to serving cell.***
* ***Option2: Beam measurement results should be reported to their corresponding cell***

***Note: Other feasible options are not excluded.*** |
| [**R1-2108029**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2108029.zip) | Discussion on Multi-TRP inter-cell operation | ASUSTEK COMPUTER (SHANGHAI) |
| **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.**  |
| [**R1-2108054**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2108054.zip) | Enhancements to enable inter-cell multi-TRP operations | Nokia, Nokia Shanghai Bell |
| Observation 1: SSB is the main QCL source for beam management reference signals.Observation 2: Associating SSB with a cell-specific identifier enables configuration of non-serving cell RS within the beam management framework.Observation 3: To associate NZP-CSI-RS with a non-serving cell, a QCL source (e.g. SSB) associated with non-serving cell identifier can be used.Observation 4: The *referenceSignal* parameter is used for SRS-SpatialRelationInfo, PUSCH-PathlossReferenceRS-r16, PUSCH-PathlossReferenceRS, PUCCH-SpatialRelationInfo and PUCCH-PathlossReferenceRS-r16.Observation 5: SSB based measurements can be supported by BM framework by associating the SSBs with a cell-specific identifier.Observation 6: NZP-CSI-RS measurements can be supported by BM framework by configuring the SSB with a cell-specific identifier as a QCL source in the TCI State.Observation 7: Even without CORESETPoolIndex configured for CORESETs, the UE can determine the inter-cell mTRP configuration/PDCCH reception through the QCL source for the RS indicated by active TCI state for a CORESET.**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: To support inter-cell multi-DCI based multi-TRP operation, select Alt.1,*** **Alt1: one PCI associated with one or more of activated TCI states for [PDSCH]/PDCCH can be associated with only one CORESETPoolIndex.**
* **In order to associate PCI and CORESETPoolIndex, select one or both of the following,**
	+ **Option 1: Configure CORESETPoolIndex explicitly and only one PCI associated (in the activated TCI states) with one CORESETPoolIndex.**
	+ **Option 2: Use an association between PCI (in the activated TCI states) and CORESETPoolIndex (e.g. lowest PCI is CORESETPoolIndex = 0) such that the UE can assume Rel-16 defined multi-DCI multi-TRP operations.**
		- **Note: Alt.3 defined dynamic point selection can be supported when activated TCI states of CORESETs are associated with single PCI.**
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