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

**e-Meeting, January 25th – February 5th, 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

Following agreements were reached in RAN1#103e

**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

In section 2, issues raised in contributions are summarized and proposals are provided.

1. Following items are proposed for discussion
	1. Item 1: Non-serving cell information

**Proposal 1-1:** Non-serving cell information associated with the TCI state and/or QCL -info at least includes non-serving cell PCI

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| QC | Support the proposal in principle. To avoid confusion, we suggest Non-serving cell information ~~associated with the TCI state and/or QCL -info~~ at least includes non-serving cell PCIThis is because whether PCI is directly indicated in TCI-state/QCL-Info or a flag is indicated is a separate discussion (topic of proposal 1-3). |
| OPPO | Support the proposal. |
| ZTE | Support in principle.In the last meeting, we agreed that to configure RRC signalling of no-serving cell info **when use “neighbor cell SSB” as “QCL referenceSignal”**. Thus, we suggest to refine this proposal as below.Non-serving cell information associated with the TCI state and/or QCL -info at least includes non-serving cell PCI when use “neighbor cell SSB” as “QCL referenceSignal”. |
| APT | We support this proposal.  |
| Samsung | We do not support the proposal. How to associate non-serving cell PCI with TCI-state/QCL-Info (explicit or implicit) should be discussed under proposal 1-3 by listing all options. Without the association part, this proposal is not needed at all. |
| MediaTek | Support |
| LG | Support ZTE’s comment. |
| DOCOMO | Support this proposal. |
| Huawei, HiSilicon | Support the proposal. |
| Apple | Support the proposal |

Non-serving cell information other than PCI associated with the TCI state and/or QCL –info, following are proposed in contributions. Discuss whether all or some of them are needed.

* *sbSubcarrierSpacing-r16*
* *ssb-Freq-r16*
* *sfn0-Offset-r16,*
* *sfn-SSB-Offset-r16*
* *halfFrameIndex*
* *ssb-PositionsInBurst*
* *ssb-Periodicity*
* *absoluteFrequencySSB*
* *ss-PBCH-BlockPower*
* other information not precluded

**Proposal 1-2:**

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| QC | From our point of view, at least the following are not needed and should be the same as the serving cell: SCS and SFN related parameters. In addition, to be consistent with L1/L2 mobility in item 1, the frequency location of non-serving cell SSB should be the same as the serving cell.For other parameters, we are open to include them as part of non-serving cell information. |
| OPPO | According to the agreement in 8.1.1, only intra-frequency scenario is assumed now, where the SSBs of non-serving cells have the same center frequency and SCS as the SSBs of the serving cell. Based on this, SCS and frequency configuration is not needed in non-serving cell information. We are open to other information.  |
| ZTE | We are NOT supportive of this proposal in principle.It is obvious that most of the listed non-serving cell information provided by *SSB-Configuration-r16* only. However, in the lasting meeting, RAN1 agreed that the information of non-serving cell SSB can also be provided by *MeasObject*. To avoid any ambiguity and backward discussion, we suggest to modify this proposal as below.Non-serving cell information other than PCI associated with the TCI state and/or QCL –info when use “neighbor cell SSB” as “QCL referenceSignal”, following are proposed in contributions. Discuss whether all or some of them are needed.* Subcarrier spacing of SSB
* Frequency of SSB
* Absolute frequency of Common RB 0 and offset to Point A
* Half frame index of SSB
* Time domain positions of the transmitted SSB in a half frame
* SFN offset of SSB
* Transmission periodicity of SSB
* Transmission power of SSB
* Other information not preclude

FFS: How to configure these above non-serving cell information.Besides and by extrapolation, it can NOT be seen the logic that to link this AI with L1/L2-centric inter-cell mobility in AI 8.1.1. For inter-cell MTRP operation in AI 8.1.2.2, it aims to enhance TCI/QCL-related aspect, which based on Rel-16 eMIMO framework. In contrast, the design of L1/L2-centric mobility in AI 8.1.1 aims to enhance the beam management with mobility, which will be based on Rel-17 FeMIMO framework, and RAN1 has not preclude the inter-frequency scenario. Based on the above analysis, it makes no sense to limit the frequency allocation, SCS and SFN of non-serving cell SSB to be the same as that of serving cell. |
| Samsung | We would like to add a list of non-serving cells (PCIs) (e.g., pci-List in MO) as part of the non-serving cell information. Again, how to associate PCI with TCI-state/QCL-info should be discussed in proposal 1-3 by listing all options. So we cannot support “Non-serving cell information other than PCI associated with the TCI state and/or QCL –info” in this proposal, which has unclear/confusing implications. |
| MediaTek | Agree with QC and OPPO. The same center frequency and SCS can be assumed. |
| LG | We support ZTE’s suggestion and would like to add *MeasObjectId,* which can be associated with QCL reference signal with PCID. |
| DOCOMO | We think non-serving cell should have the same center frequency and SSB SCS as serving cell. Hence, center frequency and SSB SCS configurations are not needed.In addition, at least ssb-Periodicity and ss-PBCH-BlockPower are needed. We are open to further discuss other parameters. |
| Huawei, HiSilicon | As agreed in 8.1.1, intra-frequency scenario is assumed for L1/L2-mobility, this scenario is equally applicable to inter-cell M-TRP operation and as such: parameters such as SSB center frequency, SFN, half-frame indexes are expected to be the same across cells. Also, multi-DCI operation assumes the same BWP, SCS, and time domain synchronization within symbol level (i.e. within CP). So it seems only *ss-PBCH-BlockPower* may be useful. |
| Apple | We failed to see the necessity for the following parameters: * *sbSubcarrierSpacing-r16*
* *sfn0-Offset-r16,*
* *sfn-SSB-Offset-r16*
* *halfFrameIndex*
 |

**Proposal 1-3:** Regarding how to associate non-serving cell information with TCI state and/or QCL –info, support at least one of the following options accounting for RRC signaling overhead and RAN2 impact.

**Option1:** Explicitly indicate non-serving cell PCI in the TCI state or *CSI-ReportConfig* or *CSI-SSB-ResourceSet*.

* 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.

* 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.

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| QC | We support option 2, which has smaller RRC overhead.  |
| OPPO | Support Option 2 to avoid unnecessary RRC signaling overhead. |
| ZTE | From our perspective, the group of TCI states for non-serving cell in item 7 is relevant to this issue, and which should be one candidate for further discussion. Based on that, we are supportive of option 3. |
| APT | In view of reducing RRC signaling overhead, we can support Option 2. We agree with ZTE that grouping of TCI states may be a candidate solution for this issue. But details of how to perform grouping may need further discussed.  |
| Samsung | We would like to add Option 4 in the proposal and also suggest some edits on the proposal (highlighted) |
| MediaTek | Support option 2. |
| LG | We prefer to leave it up to RAN 2. What RAN 1 needs to discuss is what information is need for neighboring SSB. |
| DOCOMO | For MTRP inter-cell, we support Option2 considering only one non-serving cell needs to be configured.On the other hand, we think it is better to support the same configuration framework for L1/L2 inter-cell in AI 8.1.1 and MTRP inter-cell. However, for MTRP inter-cell, more than one non-serving cells may be configured. In that case, a flag may be not sufficient for non-serving cell indication. To apply the same configuration framework, we would like to add following Option5 in the proposal. When there is only one non-serving cell, it means the same as Option2.**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. |
| Huawei, HiSilicon | In our understanding: the main functionality to enable for inter-cell M-TRP operation is the indication of non-serving RSs as QCL sources for the TRS (thereby PDCCH/PDSCH), therefore we support the indication of non-serving cell PCI in the TCI state. Still, we don’t see the need to indicate non-serving cell PCI in *CSI-ReportConfig* or *CSI-SSB-ResourceSet* as suitable neighbor TRPs can be identified based on reference signals configured for mobility measurements in *MeasObjectNR*. In short, we support Option 1 after removing *CSI-ReportConfig* or *CSI-SSB-ResourceSet.* |
| Apple | Support option 3. Another way is to leave it to RAN2. |

* 1. Item 2: QCL indication and types

Following points are raised in contributions,

* Rel-15/16 configuration restriction on the source and target RS/channel of QCL chains is also applicable
* Reuse the same QCL type(s) defined for QCL indication in serving cell for non-serving cell
* Neighbor cell’s SSB can be configured as QCL type C/D source of TRS/CSI-RS to support inter-cell multi-TRP operations
* QCL-Info indicates both non-serving cell SSB set ID as well as SSB-Index within the set.

**Proposal 2:** Reuse Rel-15/16 mechanism of QCL chain between the source and target RS/channel for non-serving cell RS/channel

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| QC | Support the proposal. |
| OPPO | Support the proposal. |
| ZTE | OK to discuss it further. |
| APT | Support  |
| Samsung | We are OK to discuss, but require further clarifications/elaborations on the purpose of this proposal |
| MediaTek | Support |
| LG | Support  |
| DOCOMO | Support the proposal. |
| Huawei, HiSilicon | We think in addition to R15/16 QCL chain, CSI-RS for RRM can be supported for inter-cell scenario to reduce UE complexity if the UE is already configured to monitor CSI-RS for mobility in RRM, measurement reports based on CSI-RSs for mobility can be used to identify suitable neighbor TRPs for inter-cell M-TRP operation. |
| Apple | Support to make this proposal as a conclusion |

* 1. Item 3: Other RS

Further discuss whether to support other non-serving cell RS than SSB as QCL source

* NZP-CSI RS,
* TRS
* CSI-RS for RRM

**Proposal 3:**

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| QC | We do not see the need. Top QCL source is SSB based on exiting RAN1 specification. Other signals can follow the exiting QCL chain and are transparent from this point of view. |
| OPPO | Not needed. Other RS can be QCLed to SSB from non-serving cell SSB. |
| ZTE | OK to discuss it further. |
| APT | Share similar views with QC and OPPO.  |
| Samsung | We also support TRS as a QCL source RS for DMRS following the Rel. 15/16 TCI framework |
| MediaTek | We also think other RSs are unnecessary. |
| LG | Narrower beams can be applied for CSIRS for RRM than for SSB so it provides finer QCL sources for neighbor cell DL RS. |
| DOCOMO | Not support. Similar view with QC, OPPO, APT, and MTK. |
| Huawei, HiSilicon | Support CSI-RS for RRM as a QCL source for TRS. |
| Apple | We have one question, how to identify whether the CSI-RS is from serving cell or non-serving cell? |

* 1. Item 4: UL spatial relation info and PL-RS

Further discuss following issue

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

**Proposal 5:**

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| QC | Support the proposal. Without the proposal, it is not clear how multi-DCI can actually work in practice with respect to transmission of UL signals/channels.  |
| OPPO | We are open to this issue. Actually, configuring a CSI-RS QCLed with non-serving cell SSB can achieve the same functionality. |
| ZTE | OK to discuss it further. |
| Samsung | We are OK to discuss this issue. |
| MediaTek | Support |
| LG | This is out of scope. |
| DOCOMO | Support the proposal. |
| Huawei, HiSilicon | CSI-RS itself could be PL-RS for multi-DCI scenario. The motivation of using SSB is not clear. Such issues can be discussed after enhancements for DL operation of inter-cell M-TRP is stabilized. |
| Apple | This should be out of scope. |

* 1. Item 5 : Rate matching

**Proposal 5:** proposed to down select from following options

**Option1:**

* For inter-cell multi-TRP operation, support rate matching around non-serving cell SSB

**Option2:**

* For inter-cell multi-TRP operation, do not support rate matching around non-serving cell SSB.

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| QC | We prefer option 1.  |
| OPPO | Support option 2. PDSCHs are not rate-matched on non-serving cell SSBs in Rel-15/16. If rate matching on non-serving cell SSB is introduced in Rel-17, it is difficult to ensure the same throughput as Rel-15/16. If interference from non-serving cell SSB is not an issue in Rel-15/16, it should not be an issue in Rel-17. |
| ZTE | We are confused with this proposal. What kind of signal rate match non-serving cell SSB? Serving cell PDSCH or non-serving cell PDSCH? Further clarification is needed. |
| Samsung | We agree with ZTE that further clarifications/elaborations are needed for this proposal. |
| MediaTek | Support option 1 |
| LG | We agree with OPPO. |
| DOCOMO | Agree with ZTR and Samsung that further clarification is needed. |
| Huawei, HiSilicon | Support option 2. In R16, the UE would not conduct rate matching around all non-serving cell SSB. Now in R17, with additional non-serving cell information, the UE even could conduct interference cancellation. We don’t see the motivation of SSB rate matching. |
| Apple | We think the two options are confusing.For PDSCH/PDCCH from neighbor cell, it is natural that neighbor SSB should be considered for rate matching. The open issue is PDSCH/PDCCH in current serving cell.It seems we cannot simply say rate matching should be supported around non-serving cell SSB or not. |

* 1. Item 6: Synchronization assumption

There are several contributions discussing synchronization assumption, further discuss following cases

* For FR1, agree on one of the cases below:
* Case 1a: > CP on same/different OS
	+ UE assumes that the inter-cell M-TRP signals may be beyond the CP length
* Case 1b: < CP on same OS, > CP on different OS
	+ UE is not expected to receive inter-cell M-TRP signals beyond the CP length simultaneously
* Case 1c: < CP on same/different OS
	+ UE assumes that the inter-cell M-TRP signals are within the CP length
* Case 1d: Not supported
* For FR2, agree on one of the cases below:
* Case 2a: > CP on same/different OS
	+ UE assumes that the inter-cell M-TRP signals may be beyond the CP length
* Case 2b: < CP on same OS, > CP on different OS
	+ UE is not expected to receive inter-cell M-TRP signals beyond the CP length simultaneously
* Case 2c: < CP on same/different OS
	+ UE assumes that the inter-cell M-TRP signals are within the CP length
* Case 2d: Not supported

**Proposal 6:**

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| QC | We do not see the relevance of same OS / different OS. In the case of different OS, is it expected that UE changes the FFT window at the OS-level? What about the leakage from one OS to another OS? We do not think that this is a practical UE implementation. Either there are two parallel FFTs (in which case same or different OS is irrelevant) or there is one FFT timing not changing at OS-level. We are open to consider the enhancements only for FR2: i.e. for FR1, only case 1c is acceptable to us. For FR2, Case 2a versus Case 2c can be based on the UE capability. We would be also fine with Case 2c only as this issue was not originally included in the WID. |
| OPPO | We think this issue is out of scope of the WID. Only Case 1c and 2c can be considered since any enhancement for other assumptions is not in scope. Also, we agree with QC that it is not needed to distinguish same OS and different OS. |
| ZTE | Out of scope.Considering the limited time budget and the large scope of the current Rel-17 NR FeMIMO, We prefer to deprioritize this issue compared with TCI/QCL-related enhancement. |
| Samsung | For Case 1b/2b, it is unclear to us how come the DL receptions on different OS could be beyond the CP, but on the same OS, they are still smaller than the CP length. We are OK with Case 1c/2c, i.e., UE expects that multi-TRP signals are within the CP length  |
| MediaTek | Agree with QC and OPPO. Case 1c and 2c should only be considered. |
| LG | Considering UE implantation complexity, we are fine with supporting Case 1c for FR 1. On the other hand, for FR 2, we can apply different FFT from different panel so Case 2a should be supported. PDSCHs beyond CP is not just because of unsynchronized network but also because of large propagation delay difference. Specifically, cell edge UE can take advantage of URLLC PDSCH repetition in case of blockage scenario. In that case, due to large propagation delay difference and short CP time for FR 2, the two PDSCHs cannot be within CP on same/different OS.We would like to remove Case 1d/2d since we agree to support intercell MTRP in WID.  |
| DOCOMO | Do not discuss the synchronization assumption anymore. |
| Huawei, HiSilicon | We think it should maintain the same requirement for FR1 and FR2 (as the WID says so). With multi-CC structure to implement multi-DCI, the UE should be able to cancel interference in both FR1 and FR2. |
| Apple | We do not know why this needs to be discussed. |

* 1. Item 7: Others

Further discuss on following issues

* Group based beam reporting is slightly preferred for inter-cell beam pairing.
* Inter-cell beam management by gNB can be supported.
* QCL information among CSI-ResourceConfig in terms of beam sweeping property shall be included in the CSI-ReportConfig.
* Non-serving cell information such as Cell ID or Physical Cell ID for RS shall be added in the CSI-ReportConfig
* The configured non-serving cell’s SSB index is within the SMTC configured for this cell.
* Clarify UE behavior when CORESETs with type 0/1/2 SS is configured/activated with TCI states associated with SSB of another PCI
* Consider associating the following with a TCI-State including SSB-Index from another PCID:
	+ 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
* Further study TRS sequence generation of the neighbor cell in the case when the slot indices are different between the serving cell and the neighbor cell.

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| QC | We prefer to bring back the discussions of L1-RSRP/SINR to 8.1.2.2 as they are closely related to TCI state / QCL-Info enhancements. Furthermore, we support the following proposal from Apple (similar directions proposed by Lenovo, ZTE, and Nokia):***UE shall expect the signals associated with the same CORESET pool should be associated with the same physical cell ID from QCL indication perspective***  |
| FL | @QC, regarding the proposal from Apple et al, my original thinking was to discuss on grouping of TCI states, then it becomes clear (natural) that UE expects the signals associated with the same CORESET pool is(are) associated with same PCI from QCL perspective. However, I am also fine if the group is fine to make agreement on this first. |
| OPPO | On CORESET from different cells, we think CSS should only be associated with serving cell. It is not needed to support CSS from neighboring cell. |
| ZTE | Firstly, as we mentioned in Proposal 1-3, the group of TCI states of non-serving cell is related to the discussion for the configuration of non-serving cell information, thus it should be included in item 1.Secondly, one issue about the sequence generation of non-serving cell TRS has been omitted (reference to [R1-2100287]), which is added in this item now. In current specs, the sequence generation of TRS is based on serving cell slot index. However, in Rel-15/16, it allows that the slot indices of serving cell and non-serving cell can be different (slot timing difference can be up to 5ms). With respect to inter-cell MTRP operation, UE should receive the non-serving cell TRS based on the slot index of the non-serving cell for correct encoding. Certainly, we can be general to further study this issue at first.Finally, in RAN1 #103-e, we agreed that measurement and reporting related to TCI/QCL-related enhancement should NOT overlap with AI 8.1.1. To avoid cross discussion at present, we prefer to deprioritize any issue of measurement and reporting compared with TCI/QCL-related enhancement. |
| APT | Regarding Apple’s proposal (mentioned by QC above), we are OK to discuss it. We also support to clarify whether it is allowable that CORESETs with type 0/1/2 SS is configured/activated with TCI states associated with SSB of another PCI.  |
| Samsung | We would like to propose the following measurement and reporting enhancements for discussions:**The UE could report in a single reporting instance multiple beam reports (including beam metrics and resource indicators) associated with the non-serving cell TRPs along with the beam report associated with the serving cell TRP** |
| LG | We have already conclude that measurement and reporting enhancement is handled by MB AI. |
| DOCOMO | Fine to discuss L1 measurement and reporting. And support to clarify not associate CSS with non-serving cell.  |
| Huawei, HiSilicon | Regarding the proposal that the signals associated with the same *CORESETPoolIndex* should be associated with the same PCI, we agree in principle as the mechanism to enable inter-cell M-TRP is that the UE is going to have 2 QCL chains, one associated to each *CORESETPoolIndex*.Regarding the UE behavior with regards to common signaling reception, our understanding is that the reception of CORESET#0 should remain with the serving cell of the UE. The serving cell is the cell the UE is camping on, i.e. receiving System Information from, and the serving cell will not change during inter-cell M-TRP operation. This basically ensures that only *CORESETPoolIndex=1* can be used to configure a neighbor TRP. The goal of inter-cell M-TRP operation is only to configure the UE with an additional pair of PDCCH/PDSCH so that user experience at the cell-edge can be enhanced, but no reception of common signaling is assumed on the PDCCH coming from the neighbor TRP. |
| Apple | As commented by Qualcomm, we suggest we discuss the following proposal:***UE shall expect the signals associated with the same CORESET pool should be associated with the same physical cell ID from QCL indication perspective*** |

1. Reference

|  |  |  |
| --- | --- | --- |
| [**R1-2100039**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100039.zip) | Clarification on network synchronization for inter-cell multi-TRP operation | FUTUREWEI, InterDigital |
| **Proposal: For Rel-17 inter-cell multi-TRP enhancement, consider the following UE capability/assumption of M-TRP signal receptions shorter/longer than CP on the same/different OFDM symbol(s) (OS):*** **For FR1, make a decision on the following cases:**
* **Case 1a: > CP on same/different OS**
* **Case 1b: < CP on same OS, > CP on different OS**
* **Case 1c: < CP on same/different OS**
* **Case 1d: Not supported**
* **For FR2, make a decision on the following cases:**
* **Case 2a: > CP on same/different OS**
* **Case 2b: < CP on same OS, > CP on different OS**
* **Case 2c: < CP on same/different OS**
* **Case 2d: Not supported**
 |
| [**R1-2100065**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100065.zip) | Synchronization Analysis for M-TRP Inter-cell Operation and RRC Configurations | InterDigital, Inc. |
| ***Observation 1:*** *A 3us synchronization accuracy can be considered for inter-cell M-TRP synchronous case.****Observation 2:*** *For “within a CP reception”, only FR1 with 15KHz SCS can be considered.****Observation 3:*** *DAPS handover is not defined for FR2-FR2 cases.****Observation 4:*** *Simultaneous reception can be done under DAPS synchronous when same BWP, SCS and with aligned SSBs when a maximum receive timing difference is less than 6us. If the timing difference is higher than 6us, it is considered asynchronous.****Proposal 1****: For inter-cell M-TRP operation down-select one of the following alternatives**Alt1 -* *Inter-cell M-TRP is supported only for FR1 operation with a subcarrier spacing of 15 KHz**Alt2 - Inter-cell M-TRP is supported only based on UE capability** + *Similar to Rel-16 UE DAPS, the capability signalling may comprise of the following parameters:*
		- *interCellAsync-r17 indicates whether the UE supports asynchronous DAPS handover.*
		- *interCellDiffSCS-r17 indicates supported subcarrier spacings*

*Alt3 - Inter-cell M-TRP is supported only based on cell synchronization accuracy in a given M-TRP deployment**Alt4 – All of the above****Proposal 2:*** *Reuse Rel-16 related measurement objects and procedures for inter-cell M-TRP operation.* |
| [**R1-2100120**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100120.zip) | Enhancement on inter-cell multi-TRP operation | OPPO |
| ***Proposal 1: For non-serving cell RS,**** ***Non-serving cell RS includes neighboring cell SSB.***
* ***Neighboring cell SSB can be source RS for TRS and CSI-RS for beam management, w.r.t QCL type C and/or QCL type D. FFS whether it can be the source RS/pathloss RS for UL signal/channel.***
* ***Non-serving cell information can include SSB configuration information of one neighboring cell, which is configured separately from QCL information to reduce signaling overhead.***
	+ ***The information includes at least :***
		- ***PCI (physicalCellId-r16)***
		- ***SCS of SSB (ssbSubcarrierSpacing-r16)***
		- ***Frequency information (ssb-Freq-r16)***
		- ***Time resource information (halfFrameIndex-r16, ssb-Periodicity-r16, sfn0-Offset-r16, sfn-SSB-Offset-r16).***
		- ***FFS for SSB transmit power (ss-PBCH-BlockPower-r16).***
	+ ***The neighboring cell SSB indicated by non-serving cell information should be one of the SSBs configured in MeasObject.***
* ***Introduce a flag to indicate whether a TCI state/QCL information is associated with non-serving cell information or serving cell.***

***Proposal 2: L1-beam measurement/reporting based on neighboring cell SSB should have low priority.******Proposal 3: The DL signal from serving cell should not be impacted by the SSB configured by neighboring cell information, e.g. the DL signal from serving cell are not rate-matched and can be transmitted in the same symbol as the SSB.*** |
| R1-2100210 | Enhancements on inter-cell multi-TRP operations in Rel-17 | Huawei, HiSilicon |
| ***Observation 1: Rel-17 inter-cell multi-TRP operation is assumed with the same SCS and the same C-RNTI as the serving cell, for PDCCH/PDSCH reception from the neighbour cell.******Observation 2: TRS reception procedure for TRSs using a neighbour cell RS as QCL source will need certain configuration restrictions for receiving given channels/RSs..******Observation 3: Existing mobility measurement and reporting framework is sufficient for the purpose of determining candidate cooperative TRPs***.The following proposals are provided,***Proposal 1: Explicitly indicate the PCI of a neighbour cell in the SS/PBCH block configuration of referenceSignal in the QCL-Info of the TCI state.******Proposal 2: 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 multi-TRP transmission.******Proposal 3: Extend the applicability of QCL association type, such as QCL-TypeA/B/C, to CSI-RS for mobility for inter-cell M-TRP operation***. |
| [**R1-2100275**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100275.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: 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 5: 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 6: SSB from a non-serving cell can be configured as the spatial relation and PL-RS for PUCCH resources and SRS resources.******Proposal 7: 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.*** |
| R1-2100287 | Discussion on Multi-TRP inter-cell operation | ZTE |
| ***Proposal 1:*** *The information of non-serving cell SSB should at least includes PCI, center frequency, SCS, SMTC, 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:*** *All TCI states should be split into two groups corresponding to the serving cell and the non-serving cell respectively.** *Each group is associated with a CORESETPoolIndex* *value.*

***Proposal 4:*** *Support neighbor cell TRS as the QCL source, where the sequence generation of the non-serving cell TRS is based on slot index of non-serving cell.****Proposal 5:*** *Separate rate matching around serving and non-serving cell SSB should be supported for PDSCH transmitted from the serving cell and the non-serving cell, respectively.* |
| R1-2100345 | Inter-cell operation for multi-TRP/panel | CATT |
| ***Proposal 1: SSB-Configuration-r16 can be used for non-serving cell SSB information indication in multi-TRP/panel inter-cell operation.******Proposal 2: To identify a non-serving cell SSB, non-serving cell PCI can be included in TCI configuration of RRC.******Proposal 3: Rate matching should be supported to avoid the interference between SSB and PDSCH from different cells.*** |
| [**R1-2100423**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100423.zip) | Further discussion on inter-cell MTRP operation | vivo |
| **Observation 1: SRS for positioning already supports spatial relation configured/activated targeting another PCI.****Proposal 1: TCI state configuration/activation is enhanced with additional information of the target cells which at least includes PCI information.*** + **Information in MeasObject can be starting point for providing non-serving cell information**

**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 CSI, beam management and tracking should all be allowed to be associated with non-serving cell RS for L1 inter-cell measurement.****Proposal 4: Rel-15/16 configuration restriction on the source and target RS/channel of QCL chains is also applied for Rel-17 inter-cell operation.****Proposal 5: The following two kinds of RS are considered for rate matching behavior enhancement:** * + **SSB from the non-serving cell RS**
	+ **RS that are QCL’ed with the non-serving cell SSB**

**Proposal 6: Clarify UE behaviour for receiving signals associated with different QCL source timing, with the restriction that UE does not expect to receive signals with timing offset beyond CP simultaneously.****Proposal 7: Spatial relation and power control related configurations should be enhanced for SRS, PUCCH, PUSCH transmission towards target cell.**  |
| [**R1-2100620**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100620.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: For inter-cell MTRP transmission, consider the case that the timing difference/offset between two TRPs at the UE side is larger than 1 CP due to imperfect network synchronization and the large difference of propagation delay in FR 2** |
| R1-2100638 | Multi-TRP enhancements for inter-cell operation | Intel Corporation |
| ***Proposal-1: Multi-cell reception mode is supported by providing the following information 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***
 |
| [**R1-2100785**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100785.zip) | Discussion on enhancement multi-TRP inter-cell operation | Spreadtrum Communications |
| ***Observation 1: For inter-cell multi-TRP/panel transmission,**** ***Tight synchronization should be assumed.***
* ***A UE may assume that its maximum receive timing difference between the DL transmissions from two TRPs is within a CP.***

***Observation 2: 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: For non-serving cell SSB, at least one of the following information could be considered as the configuration information:**** ***PCI***
* ***SSB-Freq***
* ***SubcarrierSpacing***
* ***Periodicity***
* ***ss-PBCH-BlockPower***

***Proposal 2: For inter-cell multi-TRP operation, all the signals/channels in the serving cell should not be rate-matched around non-serving cell SSB.*** |
| [**R1-2100846**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2100846.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*. |
| R1-2100966 | Discussion of enhancements on Multi-TRP inter-cell operation | Asia Pacific Telecom, FGI |
| **Proposal 1: Support implicit configuration for grouping TCI states associated with a same TRP/serving cell.** **Proposal 2: UL enhancement for inter-cell operation is to be discussed with lower priority.**  |
| [**R1-2101007**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101007.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: 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. 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.  |
| [**R1-2101034**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101034.zip) | Enhancements on Multi-TRP inter-cell operation | CMCC |
| ***Proposal 1: An indication, such as PCI, should be explicitly configured in TCI state to enable the SSB from non-serving cell can be referenced as a QCL source.*** ***Proposal 2: Both SSB and CSI-RS transmitted from the non-serving cell could be used as source RS, and both CSI-RS and DMRS transmitted from the non-serving cell could be target RSs.*** |
| [**R1-2101094**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101094.zip) | Enhancement on Inter-cell Multi-TRP operations | Xiaomi |
| ***Proposal 1: Add neighborcellindex* *into the definition of QCL-info. And the mapping relation between physical cell ID of neighboring cell and the neighborcellindex should be indicated to UE too.******Proposal 2: SSB from non-serving cell can be supported to be configured 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.*** |
| [**R1-2101144**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101144.zip) | Enhancement on Multi-TRP inter-cell operation | Ericsson |
| [Observation 1 RAN1 progress on inter-cell get deviated when the discussion is around the RRC configuration of introducing non-serving additional cell.](#_Toc61891583)[Observation 2 A minimum set of configurations for introducing non-serving cell shall be discussed first as part of the basic framework.](#_Toc61891584)[Observation 3 To facilitate inter-cell multi-TRP operation, the CSI report configurations and the TCI needs to be updated.](#_Toc61891585)[Observation 4 By introducing a PCI in a TCI state, the UE may be configured to perform measurements on CSI-RS transmitted from a TRP of a cell which is not the serving cell](#_Toc61891586)Based on the discussion in the previous sections we propose the following:[Proposal 1 RAN1 discussion on inter-cell shall focus on the physical layer functionality instead of how to configure the additional cell.](#_Toc61891694)[Proposal 2 UE shall follow the common signalling, system information, paging, from serving cell only.](#_Toc61891695)[Proposal 3 Dedicated PDCCH and PDSCH reception associated with an additional cell shall be supported by reusing the Multi-DCI Multi-TRP framework](#_Toc61891696)[Proposal 4 In inter-cell multi-TRP operation, PCI and SSB configurations can be configured additionally and differently compared to the serving cell in order to introduce reception/transmission from/to a TRP belonging to an additional cell.](#_Toc61891697)[Proposal 5 Include a PCI in the TCI state (at least for TCI states referring to an SSB) to facilitate the use of reference signals from a TRP of a cell which is not the serving cell as QCL source RS.](#_Toc61891698) |
| [**R1-2101188**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101188.zip) | Enhancements on Multi-TRP inter-cell operation | Samsung |
| **Proposal 1:** *Support configuring/indicating the non-serving cell RS as the QCL source RS** *Determine appropriate means to identify the non-serving cell RS in the corresponding TCI state/QCL-Info, taking into account signaling overhead, payload variation, and RAN2 impact.*
* *For QCL-typeD, support SSB from the non-serving cell TRP as the root QCL source RS for the downlink channels from the non-serving cell TRP*

**Proposal 2:** *Synchronization assumptions for the inter-cell multi-TRP operation** *At least the propagation delay difference between the coordinating TRPs can be beyond the CP length.*
* *The UE would always assume/expect that the time difference between the received multi-TRP signals is within the CP length*

**Proposal 3:** *On L1 measurement and reporting for the non-serving cell** *The serving cell configures the non-serving cell RS information*
* *UE measures and reports the non-serving cell RS, wherein the measurement report includes a measurement quantity/beam metric such as L1-RSRP or L1-SINR and a resource indicator such as SSBRI for the non-serving cell RS*

**Proposal 4:** *UE reports in a single reporting instance a two-part beam report using the Rel. 15 two-part CSI:* *part 1 is of a fixed payload size and used to identify/indicate the size of the payload in part 2** *Part 1 of the beam report contains measurement results for the serving cell and information about the selected subset of the non-serving cells*
* *Part 2 of the beam report contains measurement results for the selected subset of the non-serving cells*

 |
| [**R1-2101352**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101352.zip) | Views on Rel-17 Inter-cell multi-TRP operation | Apple |
| ***Proposal 1: Support to separately configure assistant cell physical cell ID, SSB frequency location, SSB burst pattern and SSB transmission power.**** ***SSB subcarrier spacing for the two cells should be assumed to be the same.***

***Proposal 2: UE shall expect the signals associated with the same CORESET pool should be associated with the same physical cell ID from QCL indication perspective.******Proposal 3: The allowed QCL type for assistant cell should reuse what has been defined for serving cell QCL indication.******Proposal 4: For assistant cell signals, the resources for assistant SSBs should be considered as “not available”.**** ***For serving cell signals, whether resources for assistant SSBs should be considered as “not available” or not should be reported by UE capability.***
 |
| [**R1-2101448**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_104-e/Docs/R1-2101448.zip) | Enhancements on Multi-TRP inter-cell operation | Qualcomm Incorporated |
| **Proposal 1: For providing non-serving cell information** * **A new configuration (separate from *SSB-Configuration-r16/ssb-InfoNcell-r16* and/or *MeasObject*) is introduced which includes**
	+ **PCI**
	+ **halfFrameIndex**
	+ **ssb-Periodicity**
	+ **ss-PBCH-BlockPower**
* **The SSBs of non-serving cells have the same center frequency and SCS as the SSBs of the serving cell, and are associated with the same SFN.**

**Proposal 2: When SSB is used as reference signal in *QCL-Info*, support configuration 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: If more than one non-serving cell PCI is supported, support configuring SSB set ID as part of non-serving cell information:*** **QCL-Info indicates both non-serving cell SSB set ID as well as SSB-Index within the set.**
* **For the purpose of multi-DCI based multi-TP, only one non-serving cell PCI / SSB set is configured.**

**Proposal 4: When SSB is used as reference signal in *SRS-SpatialRelationInfo, PUCCH-SpatialRelationInfo, PUCCH-PathlossReferenceRS, PUSCH-PathlossReferenceRS,* and *pathlossReferenceRS* under *SRS-ResourceSet*, support configuration 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.**  |
| R1-2101599 | 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. The IE can include the least needed parameters from SSB-Configuration-r16/ssb-InfoNcell-r16 and/or MeasObject.***
	+ ***At least PhysCellId is included in the IE. FFS other parameters.***
	+ ***A TRP-ID is needed in the IE to indicate each non-serving cell. TRP-ID can be configured in TCI state/QCL-Info configuration if SSB of non-serving cell is configured as QCL source RS.***

**Proposal 2:*** + ***Keep existing QCL relation, i.e., non-serving cell SSB can be direct QCL source for TRS/CSI-RS, and PDCCH/PDSCH DMRS can be QCLed with TRS/CSI-RS associated with non-serving cell SSB.***

**Proposal 3:*** + ***Support configuration of non-serving cell SSB as QCL source RS with existing QCL relation for UL SRS, PUCCH, and PUSCH transmission.***
 |