**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. Outcome of GTW session (25th Jan)

**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

Possible Agreement

Support at least following non-serving cell information other than PCI

* *ssb-PositionsInBurst*
* *ssb-Periodicity*
* *FFS: Other non-serving cell information*

**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

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

* FFS other non-serving cell information

Support: Huawei, HiSi, Lenovo/MotM, Nokia, vivo, Ericsson

**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

Support: QC, OPPO, APT, MediaTek, Xiaomi, NEC, CMCC

**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.

Support: ZTE, Lenovo/MotM, Apple,

**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

Support: Samsung

**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.

Support: DOCOMO, Xiaomi

1. Updated FL proposals

During the GTW session, one of the concerns raised was on whether the information IE is from *SSB-Configuration-r16*/*ssb-InfoNcell-r16* and/or *MeasObject.* RAN1 should discuss and agree on what information is needed, the details on whether a new RRC information IE or reuse one of the existing IEs is up to RAN2.

**Updated Proposal 1-2:** 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

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| NTT DOCOMO | Support the proposal. |
| ZTE | Support FL’s updated proposal. |
| OPPO | Support the proposal. |
| Lenovo/MotM | Support the proposal. |
| QC | Support the updated proposal. |
| Futurewei | Support |
| Ericsson | Support |
| Nokia | Support  |
| Huawei, HiSilicon | For multi-TRP scenario, it’s typical and rational that the gNB would configure the UE to measure list of non-serving cells in L3 procedure, as per the *MeasObjectNR* configuration.Naturally the UE will detect several non-serving cell SSBs using the SMTC window in *MeasObjectNR* and report to the gNB, which can use this for TRP identification. The information listed in *MeasObjectNR* is enough for a UE to detect non-serving SSBs, otherwise R15 mobility could not work well, therefore we don’t need to agree on what information is needed again here. The only extra information the UE need is, to base on SSB corresponding to which PCI, for coarse QCL tracking of TRS for example.  |
| MediaTek | Support |

Regarding how to associate non-serving cell information with TCI state and/or QCL –info, 5 options listed in chair’s note can be categorized as explicit and implicit association. Option 5 is similar to option 2 with one non-serving cell, the case of more than one non-serving cell can be discussed later, and hence option 5 is removed for time being. Given there is no clear majority support on either options, proposal 1-3 is updated as below.

**Updated proposal 1-3:** for inter-cell MTRP operation, down select 1 from following 2 alternatives

Alt1: explicit association of non-serving cell PCI with TCI state

Alt2: implicit association of non-serving cell PCI with TCI state

The options 1~4 below are specific schemes of explicit or implicit association, can be down selected based on outcome updated proposal 1-3.

**Option1:** Explicitly indicate non-serving cell PCI in the TCI state

* FFS other non-serving cell information

Support: Huawei, HiSi, ~~Lenovo/MotM~~, Nokia, vivo, Ericsson, MediaTek

**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

Support: QC, OPPO, APT, Xiaomi, NEC, CMCC, DOCOMO

**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.

Support: ZTE, Lenovo/MotM, Apple, Futurewei

**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

Support: Samsung

**~~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.~~

~~Support: DOCOMO, Xiaomi~~

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| Apple | I suggest not to start from down select between Alt1 and Alt2. The definition of “explicit” and “implicit” could be confusing.I am not sure whether I misunderstood anything, but I feel there is no fundamental difference between option 2 and option 3. The only difference is that in option 2, something called as “flag” is introduced, but in option 3, it is called as “group index”. Both should be a 1-bit indication.Option 1 is with large overhead. We should note that there would be 128 TCI per CC. RRC overhead is still a problem to UE memory.Option 4 is closed to option 2/3. From overhead perspective, there is no difference for option 2/3/4. But option 4 may need to change the SSB indexing. I am not sure whether this would have an impact on other topics like positioning. |
| DOCOMO | For the proposal, current wording is not clear enough.We think Alt.1 is explicit indication of non-serving cell PCI in TCI state. And Alt.2 is association of non-serving cell PCI with TCI state instead of explicit indication of non-serving cell PCI in TCI state.Regarding the options, since we have not discussed whether to support only one non-serving cell or not, we suggest keeping Option5. Otherwise, it is better to discuss the supported number of non-serving cell first, which has impact on the configuration design. |
| ZTE | We are supportive of Alt 2. For further clarification, we suggest to update Option 3 as follow.**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 *CORESETPoolIndex*  to non-serving cell.

Support: ZTE, Lenovo/MotM, Apple, Futurewei |
| OPPO | We are fine to agree on the number of non-serving cell first. In our opinion, only one non-serving cell needs to be supported in Rel-17, which is consistent with Rel-16 M-TRP. Regarding the proposal, we prefer to down select from Option 1-3 which have more support instead of Alt 1-2. As mentioned by companies, the solution for Alt 1/2 is unclear at all, e.g. whether Option 2 is explicit or implicit? |
| Lenovo/MotM | We prefer Alt.2 with ZTE’s option 3.Inter-cell multi-TRP operation is discussed based on R16 multi-DCI multi-TRP operation, where CORESETPoolIndex is configured for TRP differentiation. So we think we can first discuss how to used the existed parameter for this purpose other than introduce a new parameter. |
| QC | One question for clarification: Are all the options only applicable to the case that neighbor cell SSB is used as QCL referenceSignal? In our understanding, we have only agreed to this case so far, i.e., if CSI-RS is used as referenceSignal, we have not agreed that association of non-serving cell PCI with TCI state is needed. Suggest to add this condition to avoid confusion. |
| Futurewei | Support Option 3, and suggest to put the first bullet of Option 3 as FFS or example. We are not sure if the *CORESETPoolIndex* values are needed --- via the TCI / QCL chains, any port/resource can be linked to a PCI, either the serving cell PCI or non-serving cell PCI. This seems to achieve implicit grouping already, as long as the serving cell PCI is configured differently from the non-serving cell PCI. |
| Ericsson | The design of RRC signaling is mandated by RAN2. We should focus on the L1 functionality. We don’t see a need to decide on implicit or explicit PCI first. In our understanding companies have concern of RRC signaling overhead and the approach with implicit indication is to reduce RRC signal overhead.  |
| Nokia | Agree with E///. Based on our agreements, The yellow highlight allows non-serving cell information to be associated with TCI state/QCL-info. Blue part further allows PCI to associate with with TCI state/QCL-info.We do not think remaining association details are up to RAN1. **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**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
 |
| Huawei, HiSilicon | We support Alt1 with Option1, which provides clean and clear solution for the UE. |
| MediaTek | Support Alt1 with option 1.We have the same view as QC regarding other RSs like CSI-RS. We also suggest to add the condition to avoid the confusion.  |

* 1. Item 2: QCL indication and types

**Updated proposal 2:** capture following conclusion in chair’s note.

Conclusion:

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 |
| Apple | Support in principle. One minor editorial suggestion: to change “mechanism of QCL chain” into “QCL rule”.  |
| DOCOMO | Support the proposal. |
| ZTE | Support FL’s updated proposal. |
| OPPO | Support the wording from Apple. |
| Lenovo/MotM | Support the proposal. |
| QC | Support the proposal. |
| Futurewei | Support |
| Ericsson | Support |
| Nokia | Support  |
| Huawei, HiSilicon | Support. We are not certain what “QCL rule” is mentioned by Apple. |
| LG | Support  |
| MediaTek | Support |

* 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

Observation 3: Views are diverging among companies, slight majority of companies prefer not supporting other non-serving cell RS

**Updated proposal 3:** do not discuss in this meeting.

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| DOCOMO | Support the proposal. |
| ZTE | Support FL’s updated proposal. |
| OPPO | Support the proposal |
| Lenovo/MotM | Support the proposal. |
| QC | Support. |
| Futurewei | We support TRS and CSI-RS for RRM, and open to discuss if time allows. |
| Ericsson | Support |
| Nokia | Ok |
| Huawei, HiSilicon | This question will have to be addressed sooner or later. Neighbor TRP identification will be based on RSs used by the UE for mobility measurements, i.e. either SSBs or RRM-CSI-RS. In the scope of this Work Item, we think that this a natural extension of the current QCL framework to allow such RSs to act as QCL sources for neighbor TRP RSs/channels. |
| LG | Same view with Futurewei |
| MediaTek | Support |

* 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.

**Observation 4:** majority of companies are ok to further discuss while 3 companies commented it is “out of scope”

**Updated proposal 4:** do not discuss in this meeting

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| DOCOMO | Okay. But if time allows, we think this issue has higher priority among Issue 3-7. |
| ZTE | Support the initial proposal, and we are okay to further discuss. |
| OPPO | Support. It may be discussed later. |
| Lenovo/MotM | Fine to discussed it later. |
| QC | Support the initial proposal. We think this is a necessary functionality. |
| Futurewei | Open to discuss if time allows. |
| Ericsson | We are fine with the original proposal. |
| Nokia | This is needed. How the UL part of M-TRP work without this ? UE does not support separate HARQ-ACK? How the CSI is reported ? When the SSBs are related to PCIs, there is no restriction to use them related to all other channels/signals using Rel-15/16 mechanism. I assume the above should be a conclusion.  |
| Huawei, HiSilicon | We think with CSI-RS as spatial info and non-serving cell SSB provided to CSI-RS, current system will work. This is a low priority issue. |
| LG | Support. Response to Nokia: without SSB, we can use virtual ID based CSIRS.  |
| MediaTek | Support |

* 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.

Clarification: PDSCH/PDCCH from non-serving cell is rate matched around non-serving cell SSB, above options are for whether PDSCH/PDCCH from serving cell is rate matched around non-serving cell SSB.

**Observation 5:** views are diverging, further discussion is required

**Updated proposal 5**: do not discuss in this meeting

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| DOCOMO | Support the proposal. |
| ZTE | With FL’s clarification, we are supportive of Option 2. |
| OPPO | With clear clarification on the issue, the views are not so diverging now. If time permits, we can discuss this issue in this meeting later. We support Option 2. |
| Lenovo/MotM | Support the proposal. |
| QC | Regarding clarification “PDSCH/PDCCH from non-serving cell is rate matched around non-serving cell SSB”, does this itself require an agreement? This is not the default behavior unless if we agree to it. |
| Futurewei | Open to discuss if time allows, and we support Option 2. |
| Ericsson | We are OK to discuss this in future meeting. |
| Nokia | Not essential.  |
| Huawei, HiSilicon | Note that, the gNB can configure SSB pattern to a rate matching pattern and conduct periodic/aperiodic rate matching depending on gNB’s implementation, if necessary. So we think further mandate such rate matching behavior will restrict flexibility and the gain is not clear. |
| LG | We are OK to discuss this in future meeting. |
| MediaTek | Support |

* 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

**Observation 6:** views from companies are diverging, slight majority supports case 1c and 2c, and there are companies commented that no discussion is needed.

**Updated proposal 6:** conclude in this meeting that the UE may assume received DL transmission from multiple TRP within a CP.

Please provide your comments in the table below.

|  |  |
| --- | --- |
| Company | comments |
| Apple | We suggest we should not waste too much effort on this issue. |
| DOCOMO | We prefer to not discuss it. |
| ZTE | Do NOT any discussion, and we can be slightly supportive of FL’s updated proposal. |
| OPPO | Not to discuss it.  |
| Futurewei | Clearly a decision / conclusion is needed here. Different companies have different target cases in their mind, e.g., some think the default is 1c/2c, some think 2c only, some reject 2c as impossible in practical networks, and some support 2a. We think even the companies unwilling to discuss this issue actually have their target cases in their mind. Without a conclusion and with all the diverging views, it is unclear how the RAN1/RAN4 work will end up with.We can support 1c but we do not accept 2c. Several companies have provided technical analysis that 2c is not a realistic case. No matter how RAN4 may tighten the network synchronization requirements, the FR2 CP is still too short compared to the propagation delay difference. We do not recall seeing any technical counterargument to this. We should not make unrealistic assumptions when we design a feature. |
| Ericsson | We are fine with the conclusion. |
| Nokia | Not required to agree or conclude on this.  |
| Huawei, HiSilicon | We think FR1 and FR2 should be treated as same priority. |
| LG | Same view with Futurewei. In FR2, current network synchronization requirements cannot meet <CP and also we need to consider propagation delay difference for cell edge UE. |
| MediaTek | Support |

* 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.
* UE shall expect the signals associated with the same CORESET pool should be associated with the same physical cell ID from QCL indication perspective
* CORESET#0 is associated with the serving cell of the UE and *CORESETPoolIndex=1* can be used to configure a neighbor TRP.
* 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

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. |
| Lenovo/MotM | 1. The discussion on measurement and reporting should be handled in MB AI.
2. Since the UE shall assume the non-serving cell’s SSB are not transmitted, the configured non-serving SSB should be within the SMTC configured for this cell.
3. We support the proposal that signals associated with the same CORESETPoolIndex should be associated with the same PCI.
 |
| 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*** |
| Nokia | CORESET reception from a non-serving/serving cell is based on the association of the activated TCI state for the CORESET. Agree that CORESETs of a same cell/PCI should be associated with the same CORESETpoolIndex.  |
| Ericsson | We are OK to further discuss the CORESET pool association and the clarification on CSS.  |
| Futurewei | We think the *CORESETPoolIndex* values are not really needed. There are two separate TCI / QCL chains linking to either the serving cell PCI or non-serving cell PCI. This seems to achieve implicit grouping already for all resources. |

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***
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| [**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*

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| [**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.***
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| [**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.***
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