**3GPP TSG RAN WG1 #102-e- R1-200xxxx**

**e-Meeting, August 17th – 28th, 2020**

Source: moderator (vivo)

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

Agenda Item: 8.1.2.2

Document for: Discussion and Decision

1. Introduction

In this contribution, contributions submitted in AI 8.1.2.2 are summarized. High priority issues are listed in section 2 and issues with lower priority are listed in section 3..

1. Issues with high priority in RAN1 #102e
	1. Issue 1 : QCL/TCI state from non-serving-cell TRP

Almost all contributions discussed configuration of QCL/TCI state from non-serving cell TRP([[1]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005286.zip), [[2]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005365.zip), [[3]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005456.zip), [[4]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005484.zip), [[5]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005562.zip), [[6]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005685.zip), [[7]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005822.zip), [[9]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005985.zip), [[10]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006130.zip)[,](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006202.zip) [11], [[12]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006259.zip), [[13]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006368.zip), [[14]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006392.zip), [[15]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006501.zip), [[17]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006567.zip), [[18]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006598.zip), [[19]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006720.zip), [20], [[21](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006845.zip)]). The following listed points are from contribution however not exhaustive. There are slight differences on details in the proposals from companies.

* Use the existing UE measurement configuration/report framework that supports gNB with required measurements for TCI/QCL configuration of the secondary cell.
* SSB configured in TCI state can be either from the physical cell of the serving cell or from the physical cell of the coordinated neighbor cell.
* If SSB configured in a TCI state is from the physical cell of the coordinated neighbor cell, which/how the SSB information needs to be defined should be studied in Rel-17.
* Consider both QCL enhancement for DL and spatial relation enhancement for UL.
* The default QCL for a CORESET other than a CORESET with index0 needs to be associated with suitable SSB/PBCH block the UE identified during the CORESET reception.
* SSB from a non-serving cell can be set as the source QCL-TypeC and QCL-TypeD RS for TRS, CSI-RS for beam management and CSI-RS for CSI acquisition
* Support to divide TCI states into N groups, where each group is associated with a physical cell ID
* Reuse neighbor cell’s SSB or mobility CSI-RS in measurement object for QCL type C/D source of TRS/CSI-RS to support inter-cell multi-TRP operations.
* Support the use of SSBs from the serving-cell TRP as the QCL source/reference for the downlink transmissions from the non-serving-cell TRP depending on the QCL type
* The information of the SSBs from the non-serving-cell TRP may need to be available at the UE, and their monitoring/measurement procedure may also need to be specified
* RAN1 to study and decide the maximum number of additional (non-serving cell) SSB sets for inter-cell multi-TRP operation
* Some other information, like SCS, may also be needed.
* Support to configure the physical cell ID, SSB transmission power and periodicity for a TCI state group
* provide the following information to the UE: SSB pattern (ssb-PositionsInBurst, ssb-periodicityServingCell), sub-carrier spacing (subcarrierSpacing), frequency (absoluteFrequencySSB)
* 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
* Clarify UE behaviour when CORESETs with type 0/1/2 SS is configured/activated with TCI states associated with SSB of another PCI.
* The complexity at UE side should be considered before discussing inter-cell multi-TRP operation
* Discuss necessary UE assumptions/behaviour/capability to support multiple QCL assumptions linking to multiple SSBs on the same carrier/OFDM symbol
* Study number of UE capability parameter for time duration for QCL. If it is necessary, RAN1 should send a LS to RAN4.

Base on the input from companies, further study on details is required for TCI state and beam management signal enhancement in future meetings.

Proposal 1: Study the following aspects of configuration enhancement for reception of signals transmitted from non-serving cell TRP.

* Additional information needed for configuration of non-serving cell RS;
* Configuration method for additional information related to non-serving cell;
* Allowed RS types for RS transmitted from the non-serving cell TRP;
* Allowed QCL types for RS transmitted from the non-serving cell TRP;
* Clarification on potential UE behavior for associating non-serving cell RS with other RS/channels;
* Other details not precluded.

|  |  |
| --- | --- |
| Companies | comments |
| Apple | According to the WID, this agenda is about QCL/TCI enhancement for inter-cell mTRP. So we suggest changing the proposal to be more specific as follows:“Study QCL/TCI related control signaling enhancement with source reference signal from non-serving cell TRP. * Detail information for the control signaling;
* Configuration method for control signaling;
* Allowed RS types for RS transmitted from the non-serving cell TRP;
* Allowed QCL types for RS transmitted from the non-serving cell TRP;
* ”
 |
| vivo | Support the FL proposal.For Yushu’s update, we would like to point out that the main bullet is only to study the potential aspects for inter-cell multi-TRP operation. It does not hurt at this stage to keep aspects as long as they are within the scope of the WID. For example, for the deleted “Clarification on potential UE behavior for associating non-serving cell RS with other RS/channels”, I think there are several companies raised the points related to whether CORESET #0 could be activated with TCI state associated with another PCI, whether UE complexity should be clarified with the additional TCI states from another PCI etc. These are all related to “QCL/TCI-related enhancements”, thus they are within the scope of item 2b.  |
| LG | Support Apple’s revision |
| Ericsson | Support the proposal |
| Nokia/NSB | The proposal could be more focused on what is possible based on WI objective. The discussion list could already mention the configuration enhancements to TCI framework to support inter-cell mTRP operation (changes by Apple seems a good direction).Also, in addition to reception, the proposal could cover the measurement and reporting aspects (i.e. not see those as separate issues, at least at the moment) |
| Spreadtrum | Fine with the proposal |
| Lenovo, Motorola Mobility | Support FL’s proposal.  |
| InterDigital | Support Apple’s revision |
| QC | Regarding “Allowed RS types”, it is not clear if it refers to source RS or target RS. In our understanding, source RS in the context of enhancements is always SSB of the non-serving cell (CSI-RS does not need to be differentiated for serving/non-serving cell explicitly). For target RS, we prefer to list the possibilities for DL and UL to further study.Also, we think the last two bullets maybe too much details at this stage.Regarding measurement and reporting aspects, we share the same view as Nokia. They should be both studied and designed consistently. |
| Samsung  | Support the proposal |
| Futurewei | Support FL’s proposal. Also support vivo’s comment and Nokia/NSB’s comment on related issues. These issues are closely related, and the implications of adding non-serving cell’s RS/PCI/SSB as well as the associated QCL/TCI states (which we support) should be well understood to make this feature useful. |

* 1. Issue 2: UL/DL synchronization assumptions

There are several contributions discussing about UL and DL synchronization assumptions ([1[]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005286.zip), [2], [8], [[10](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006130.zip)], [12]).

* For inter-cell multi-TRP UL enhancement, support to acquire and maintain multiple TA values for multiple TRPs on the same carrier.
* Support TRP-specific TA offset value in UL transmission for inter-cell multi-TRP
* Clarify the scenario and key assumptions on time/frequency synchronization, backhaul, inter-cell signal delay spread, and UL support
* It should be clarified that whether UE is expected to receive channels/RS that are not within CP of each other in Rel-17 discussion.
* Target deployment scenario for multi-cell operation should consider Rx timing difference less than CP as well as more than CP for both FR1 and FR2
* Tight synchronization should be assumed for inter-cell multi-TRP/panel transmission.

Focus on DL reception part first and later deal with UL synchronization.

Proposal 2: Study and clarify the following aspects related to synchronization assumptions:

* UE behavior for receiving signals with different timing source;
* The scenarios for DL signals from inter-cell multi-TRP are beyond CPs;
* The scenarios for UL signals toward different TRPs with different TAs;
* The potential spec impact, if any;

|  |  |
| --- | --- |
| Companies | comments |
| Apple | According to the WID, this agenda is about QCL/TCI related enhancement for inter-cell mTRP. We think this proposal is out of scope of this sub-agenda, and it can be discussed in agenda 8.1.1. |
| vivo | According to the WID, the scope of this item is to * “Identify and specify QCL/TCI-related enhancements to enable inter-cell multi-TRP operations, assuming multi-DCI based multi-PDSCH reception”.

Our understanding is that the timing clarification is related to QCL-type A and QCL-type C, these aspects could be studied in this item according to the WID. For UL synchronization related aspects, we can further discuss whether to study them in this item or not. |
| LG | Same view with Apple. Regarding timing issue, it has been discussed in UE feature session and conclude two PDSCHs are within CP. |
| Ericsson | Support the proposal |
| Nokia/NSB | We can support the proposal as this is mainly something for further study.  |
| Spreadtrum | Share same view with Apple and LG. |
| Lenovo, Motorola Mobility | Same view as Apple. In this agenda, we can assume all gNBs are synchronized, and both DL and UL are within CP.  |
| InterDigital | We have a similar view as Lenovo. Apple is correct in that the main scope of the discussion is related to QCL/TCI, however for the purpose of this study, we cannot wait for the discussion in 8.1.1 to complete. So, as Lenovo suggested, we should proceed with assumption of synchronized gNBs. |
| QC | We are fine to further study the issue. However, it is important that as a result of this, new mTRP schemes are not introduced. Basically, we should avoid turning an agenda item with clear scope to something that may effectively require many more TUs / time in RAN1 without explicit RAN involvement. In any case, this does not belong to high priority items in our view. |
| Samsung | Support the proposal, both DL and UL scenarios need further study. In Rel-16 CA, there are specification supports to have multiple TA across different serving cells. We think deployment scenario for inter-cell multi-TRP can be the same with Rel-16 CA so that the similar specification support for UL is necessary. Also, we can treat DL and UL equally since WID does not prioritize one over the other. |
| Futurewei | Support the FL’s proposal. Based on the contributions, different companies may have different assumptions on the scenarios (especially gNB synchronization, backhaul assumptions, and the received signals with respect to the CP length). We think it is of high priority to align these fundamental assumptions in RAN1 before discussing potential standard impact. And a key to determine which scenarios Rel-17 should consider is to see what are not well supported in Rel-16 M-TRP already.Rel-16 already provides M-TRP support, which may be used to support some inter-cell M-TRP deployments in a transparent way, i.e., the inter-cell TRS may be QCLed to the serving cell for the timing, and other inter-cell signals can then be QCLed to that TRS. This transparent inter-cell support works well for some limited deployment scenarios (tightly synched, small ISD, etc.) so that the timings of the M-TRP signals are sufficiently close to each other. These scenarios can be deprioritized in Rel-17 as no enhancement is needed.Our understanding is that Rel-17 is intended to support more deployment scenarios that require non-transparent inter-cell enhancements. For example, the timings of the M-TRP signals are not sufficiently close to each other, and hence the inter-cell PCI/SSB needs to be added as a source of QCL. In this case, the UE behavior for receiving and transmitting may be different from that in Rel-16 and is critical to support new scenarios not covered by Rel-16. Thus, we think the proposal is a good starting point. |

1. Issues with low priority in RAN1 #102e
	1. Issue3: UL related enhancement

UL related enhancement is mentioned by several companies ([[2]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005365.zip), [[13]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006368.zip), [16], [[20](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006792.zip)])

* The signaling for spatial relation of SRS for positioning in Rel-16 can be the starting point with additional signaling reduction.
* Spatial relation and power control related configurations should be enhanced for SRS, PUCCH, PUSCH transmission towards target cell.
	+ E.g. introduce a PCI in the configurations related to UL transmissions: spatial relations and pathloss reference RS.
* Introduce a PCI in the configurations related to UL transmissions: spatial relations and pathloss reference RS.
* Inter-cell beam management by both UE and gNB should be supported. And inter-cell beam management by gNB is much more preferred.
* Support using non-serving cell SSB as reference signal for the following purposes:
	+ QCL-Info: To define TCI states corresponding to a TRP with a non-serving cell PCI.
	+ SRS-SpatialRelationInfo: To define SRS spatial relation info corresponding to a TRP with a non-serving cell PCI.
	+ PUCCH-SpatialRelationInfo: To define PUCCH spatial relation info corresponding to a TRP with a non-serving cell PCI.
	+ PUCCH-PathlossReferenceRS: To define PL RS for PUCCH power control corresponding to a TRP with a non-serving cell PCI.
	+ PUSCH-PathlossReferenceRS: To define PL RS for PUSCH power control corresponding to a TRP with a non-serving cell PCI.
	+ pathlossReferenceRS under SRS-ResourceSet: To define PL RS for SRS power control corresponding to a TRP with a non-serving cell PCI.

Proposal 3: Further discuss (if deemed necessary) in RAN1 UL spatial relation and power control related enhancement for inter-cell multi-TRP operation.

|  |  |
| --- | --- |
| Companies | comments |
| Apple | According to the WID, this agenda is about QCL/TCI related enhancement for inter-cell mTRP. We think this proposal is out of scope of this agenda, and it can be discussed in agenda 8.1.1. Since we are going to use a unified TCI framework, we do not think it is necessary to make any enhancement for spatial relation. |
| Vivo | Support the FL’s proposal to further discuss this issue in future meetings based on companies’ input. |
| LG | This is out of scope according to WID |
| Ericsson | Support Proposal 3. A discussion how to split topics for discussion/decisions between MB and this agenda is useful.  |
| Nokia/NSB | Ok to discuss. Few companies discussed the association of SSB index with PCI in a TCI state and similar solution/association mechanism would be beneficial for e.g. beam management (measurements and reporting aspects) as well as UL SpatialRelationinfo enhancement. |
| Spreadtrum | Out of scope according to WID. |
| Lenovo, Motorola Mobility | This should be studied in 8.1.1.  |
| InterDigital | Agree with Apple and others that it is out of the scope of WID. |
| QC | This item should have equal priority as DL. If DL beam is based on SSB of a neighbor cell, how is the UL beam supposed to work? Also, this aspect already exists in Rel. 16 (SRS for positioning), and it is a matter of extending it more generally. We do not understand how “QCL/TCI related” can be interpreted as UL is out-of-scope. UL beam is QCL/TCI related for sure. |
| Samsung | Support the proposal, counterpart of DL QCL enhancement |
| Futurewei | Support the FL’s proposal.Depending on the deployment scenarios, UL transmissions to multiple TRPs seem inevitable, and hence spatial relation and PC should be discussed.  |

* 1. Issue 4: Enhancement for L1-RSRP and L1-SINR measurement report

Two companies ([9], [20]) mentioned enhancement of L1-RSRP and L1-SINR report:

* Study and specify enhancements required to support L1-RSRP/SINR measurement and reporting corresponding to one or more non-serving cell SSBs.
* Study the necessity of L1-beam measurement/reporting based on neighboring cell SSB

Proposal 4: Further discuss in RAN1 L1-RSRP/SINR measurement and reporting enhancement for inter-cell multi-TRP operation if deemed necessary

|  |  |
| --- | --- |
| Companies | comments |
| Apple | According to the WID, this agenda is about QCL/TCI related enhancement for inter-cell mTRP. We think this proposal is out of scope of this sub-agenda, and it can be discussed in agenda 8.1.1 or 8.1.2.3. |
| vivo | Support the FL’s proposal to further discuss this issue in future meetings based on companies’ input. |
| LG | According to the WID, this should be discussed in MB enhancement agenda item.  |
| Ericsson | Support Proposal 4. In our view, this can be handled in MB agenda |
| Nokia/NSB | Ok to discuss, as the QCL/TCI enhancement for inter-cell mTRP most likely affects to beam management (DL measurements and reporting) the same.At minimum it could be concluded whether this is further discussed in this agenda item. |
| Spreadtrum | This should be discussed in MB agenda, according to Rel-17 MIMO WID. |
| Lenovo, Motorola Mobility | Support this proposal.  |
| InterDigital | Support FL proposal, but some coordination with 8.1.1 may be needed. |
| QC | Support the proposal. MB agenda is about mobility-related aspects for inter-cell. We think L1-RSRS/SIRN should be discussed together with QCL-related issues in this AI. |
| Samsung | According to the WID, this proposal should be discussed under MB enhancement |
| Futurewei | Ok to discuss. |

* 1. Issue 5: Relationship with *CORESETPoolIndex*

Two companies ([[1]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005286.zip), [[8](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005860.zip)]) mentioned the relationship between inter-cell operation with *CORESETPoolIndex*

* Target deployment is the case where each cell is associated with a different *CORESETPoolIndex*.
* *CORESETPoolIndex* may not need to be explicitly configured.

Proposal 5: Further discuss (if deemed necessary) in RAN1 the relationship between inter-cell multi-TRP operation and configuration of *CORESETPoolIndex.*

|  |  |
| --- | --- |
| Companies | comments |
| Apple | We failed to see the necessity to define this relationship. Some clarification could be needed. |
| vivo | Support the FL’s proposal to further discuss this issue in future meetings based on companies’ input. |
| LG | CORESETPoolIndex is used for almost every aspects to support M-DCI based MTRP such as default beam, A/N codebook, condition for out of order operation and so on. So, it needs to be configured even in inter-cell scenario. |
| Ericsson | Support the proposal to discuss this but it can be low priority for now |
| Nokia/NSB | Ok to discuss. In our view, this is relevant discussion since it relates to the mDCI based mTRP framework defined in Rel16 (as mentioned in WI).  |
| Spreadtrum | Actually we have related agreements in Rel-16, it should be also valid or as the starting point for Rel-17.**Agreement**To support multiple-PDCCH based multi-TRP/panel transmission with intra-cell (same cell ID) and inter-cell (different Cell IDs), following RRC configuration can be used to link multiple PDCCH/PDSCH pairs with multiple TRPs* one CORESET in a “PDCCH-config” corresponds to one TRP
	+ FFS whether to increase the number of CORESETs per “PDCCH-config” more than 3

FFS: UE monitoring/decoding behavior for multiple PDCCHs.Include in LS to RAN2 |
| Lenovo, Motorola Mobility | Support the proposal. The configuration of CORESETPoolIndex should be clarified with the proposals.  |
| InterDigital | Support the FL’s proposal. |
| QC | We do not see any reason to create an unnecessary relationship, but we are ok with the proposal to further discuss. |
| Samsung | Support the proposal but with low priority |
| Futurewei | Support FL’s proposal.CORESETPoolIndex is a way to differentiate the TRPs and is necessary at least for Rel-16 M-TRP. Rel-17 inter-cell M-TRP also needs some way to differentiate the TRPs. Further study is needed. |

* 1. Issue 6: Rate matching assumptions for channels/signals associated with non-serving cell

One company ([9]) mentioned rate matching assumption if RS

* If SSB of neighboring cell is included in TCI state or CSI resource, the other DL signal should not be impacted by the SSB, e.g. the other DL signal are not rate-matched and can be transmitted in the same symbol as the SSB.

Proposal 6: Further discuss in RAN1 the rate matching assumption for RS associated with non-serving cell if deemed necessary

|  |  |
| --- | --- |
| Companies | comments |
| Apple | According to the WID, this agenda is about QCL/TCI enhancement for inter-cell mTRP. We this proposal is out of scope of this sub-agenda, and it can be discussed in agenda 8.1.1. |
| vivo | Support the FL’s proposal to further discuss this issue in future meetings based on companies’ input. |
| LG | Support proposal 6. It is worth studying whether neighbor cell SSB without rate matching can provide enough accuracy as QCL source. |
| Ericsson | Support to further discuss |
| Nokia/NSB | Support the proposal. But lower priority.  |
| Spreadtrum | Fine to discuss about it, but low priority. |
| Lenovo, Motorola Mobility | OK to discuss with low priority. |
| InterDigital | This is a relevant discussion; however it should be treated with a lower priority. |
| QC | Support the proposal to further discuss. |
| Samsung | Support the proposal |
| Futurewei | Ok to discuss. |

* 1. Issue 7: Enhancement for beam failure recovery

One company ([16]) mentioned beam failure recovery enhancement for inter-cell multi-TRP operation:

* Consider the beam failure recovery of neighboring cell and the straightforward method is to reuse the beam failure recovery mechanism of SCell.

Proposal 7: Further discuss in RAN1 beam failure recovery enhancement for inter-cell multi-TRP operation if deemed necessary

|  |  |
| --- | --- |
| Companies | comments |
| Apple | According to the WID, this agenda is about QCL/TCI enhancement for inter-cell mTRP. We think this proposal is out of scope of this sub-agenda, and it can be discussed in agenda 8.1.1 or 8.1.2.3. |
| vivo | Support the FL’s proposal to further discuss this issue in future meetings based on companies’ input. |
| LG | This issue is out of scope according to the WID. |
| Ericsson | Do not support. Belong to another agenda (MB or MB for mTRP) |
| Nokia/NSB | Discuss in MTRP beam management agenda.  |
| Spreadtrum | This should be discussed in MB agenda, according to Rel-17 MIMO WID. |
| Lenovo, Motorola Mobility | Do not support. This is should be discussed in 8.1.2.3. |
| InterDigital | Not in the scope. |
| QC | This issue belongs to 1a or 2c.  |
| Samsung | This should be discussed under MB enhancements for multi-TRP, not in this agenda |
| Futurewei | This can be discussed in MB agenda. |

* 1. Issue 8: Others

The following restrictions are proposed by different companies for discussion of inter-cell multi-TRP([[2]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005365.zip), [[8]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005860.zip), [[13]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006368.zip), [[21]](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006845.zip)),companies could take these considerations into account when discussing inter-cell multi-TRP operation.

* Rel-16 multi-TRP schemes are subject to the enhancements for inter-cell operations. No new multi-TRP schemes are discussed for this purpose.
* DCI based beam switch is not envisioned from one cell to another (downlink)
* No enhancements are envisioned for multi-cell operation considering a cell without SSB transmission
* Enhancements on intra-cell multi-TRP operation should also be considered.
1. Reference

|  |  |  |
| --- | --- | --- |
| [1] [**R1-2005286**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005286.zip) | Inter-cell multi-TRP operation | FUTUREWEI |
| Observation 1: Several discussions in Rel-16 eMIMO are relevant to Rel-17 FeMIMO inter-cell M-TRP:* Assumptions related to the deployment, e.g., CP / FFT window / backhaul for M-TRP
* TCI framework to include PCI/SSB of a non-serving cell
* TRP-specific CORESET (i.e., CORESET pool indexes for different TRPs)

Proposal 1: For inter-cell multi-TRP enhancement:* Clarify the scenario and key assumptions on time/frequency synchronization, backhaul, inter-cell signal delay spread, and UL support
* Discuss necessary UE assumptions/behaviour/capability to support multiple QCL assumptions linking to multiple SSBs on the same carrier/OFDM symbol

Proposal 2: For inter-cell multi-TRP enhancement, QCL/TCI state can include a non-serving cell SSB, and CORESET pool indexes may not need to be explicitly configured.Proposal 3: For inter-cell multi-TRP UL enhancement, support to acquire and maintain multiple TA values for multiple TRPs on the same carrier. |
| [2] [**R1-2005365**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005365.zip) | Discussion on inter-cell MTRP operation | vivo |
| Observation 1: Inter-cell multi-TRP operation (with only DPS) would improve UE perceived throughput at cell edge.Observation 2: When UE is configured with QCL information with SSB of target cell or RS associated with the SSB, UE follows the timing of the indicated SSB for reception. Observation 3: SRS for positioning already supports spatial relation configured/activated targeting another PCI.Proposal 1: Inter-cell multi-TRP operation in Rel-17 should be enhanced towards seamless mobility between cells for targeted mobility scenarios in Rel-17 FeMIMO.Proposal 2: Inter-cell multi-TRP operation in Rel-17 should consider both ideal backhaul and non-ideal backhaul scenarios.Proposal 3: Inter-cell multi-TRP operation in Rel-17 should consider both QCL enhancement for DL and spatial relation enhancement for UL.Proposal 4: Inter-cell m-TRP enhancement should consider both of the following two aspects:* TCI state configuration/activation enhancement with additional information of the target cells (at least including PCI information)
* Enhanced configuration/activation of L1 measured SSBs with additional information of the target cells (at least including PCI information)

Proposal 5: It should be clarified that whether UE is expected to receive channels/RS that are not within CP of each other in Rel-17 discussion.Proposal 6: Spatial relation and power control related configurations should be enhanced for SRS, PUCCH, PUSCH transmission towards target cell.  |
| [3] [**R1-2005456**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005456.zip) | Discussion on Multi-TRP inter-cell operation | ZTE |
| Proposal 1: Support that SSB configured in TCI state can be either from the physical cell of the serving cell or from the physical cell of the coordinated neighbor cell. Proposal 2: If SSB configured in a TCI state is from the physical cell of the coordinated neighbor cell, which/how the SSB information needs to be defined should be studied in Rel-17.Observation: To indicate the correct SSB from the target neighbor cell, only PCI is not sufficient.Proposal 3: If an SSB configured in a TCI state is from the physical cell of the coordinated neighbor cell, at least the SSB frequency and PCI should be informed to UE. Some other information, like SCS, may also be needed.  |
| [4] [**R1-2005484**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005484.zip) | TCI/QCL Enhancements for M-TRP Inter-cell Operation | InterDigital, Inc. |
| Observation 1: The PCI code must be known by UE to perform and report the beam measurements correctly.Observation 2: The network needs appropriate measurements information for the second cell TRP before configuring the UE for inter-cell M-TRP operation. Proposal 1: Extend the TCI state configuration with the PCI information.Proposal 2: Use the existing UE measurement configuration/report framework that supports gNB with required measurements for TCI/QCL configuration of the secondary cell.  |
| [5] [**R1-2005562**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005562.zip) | Considerations on inter-cell operation | Sony |
| Proposal 1: Specify the default QCL for a CORESET other than a CORESET with index0 needs to be associated with suitable SSB/PBCH block the UE identified during the CORESET reception.Proposal 2 Study number of UE capability parameter for time duration for QCL. If it is necessary, RAN1 should send a LS to RAN4. |
| [6] [**R1-2005685**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005685.zip) | Discussion on multi-TRP/panel inter-cell operation | CATT |
| Proposal 1: SSB of non-serving cell should be used as QCL source for RSs transmitted from that cell in inter-cell M-TRP operation.Proposal 2: Include the PCI of non-serving cell in RRC configured TCI states. |
| [7] [**R1-2005822**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005822.zip) | Enhancements on Multi-TRP inter-cell operation | Lenovo, Motorola Mobility |
| Proposal 1: SSB from a non-serving cell can be set as the source QCL-TypeC and QCL-TypeD RS for TRS, CSI-RS for beam management and CSI-RS for CSI acquisition.Proposal 2: Enhancements on intra-cell multi-TRP operation should also be considered. |
| [8] [**R1-2005860**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005860.zip) | Multi-TRP enhancements for inter-cell operation | Intel Corporation |
| Proposal-1: Clarify scope of WID as follows. * Target deployment is the case where each cell is associated with a different CORESETPoolIndex.
* DCI based beam switch is not envisioned from one cell to another (downlink)
* No enhancements are envisioned for multi-cell operation considering a cell without SSB transmission

Proposal-2: Target deployment scenario for multi-cell operation should consider Rx timing difference less than CP as well as more than CP for both FR1 and FR2.Proposal-3: 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-4: 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
* PUCCH-SpatialRelationInfo
* PUCCH-PathlossReferenceRS
 |
| [9] [**R1-2005985**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005985.zip) | Enhancement on inter-cell multi-TRP operation | OPPO |
| Proposal 1: Introduce PCID and resource information of neighboring cell SSB in QCL information. The signaling for spatial relation of SRS for positioning in Rel-16 can be the starting point with additional signaling reduction.Proposal 2: Study the necessity of L1-beam measurement/reporting based on neighboring cell SSB.Proposal 3: If SSB of neighboring cell is included in TCI state or CSI resource, the other DL signal should not be impacted by the SSB, e.g. the other DL signal are not rate-matched and can be transmitted in the same symbol as the SSB. |
| [10] [**R1-2006130**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006130.zip) | Enhancements on Multi-TRP inter-cell operation | Samsung |
| **Proposal 1:** *Support the use of SSBs from the serving-cell TRP as the QCL source/reference for the downlink transmissions from the non-serving-cell TRP depending on the QCL type** *The information of the SSBs from the non-serving-cell TRP may need to be available at the UE, and their monitoring/measurement procedure may also need to be specified.*

**Proposal 2:** *Investigate at least the following alternatives for enabling the use of SSBs from the non-serving-cell TRP as the QCL source:* * *Including the TRP-specific information such as the PCI in the QCL information*
* *Adding CSI-RS for mobility as the QCL source for the TRS from the non-serving-cell TRP*

**Proposal 3:** *Support TRP-specific TA offset value in UL transmission for inter-cell multi-TRP* |
| [11] [**R1-2006202**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006202.zip) | Enhancements on Multi-TRP inter-cell operation | CMCC |
| Proposal 1: SSBs with an independently configured PCI should be configured to UE.Proposal 2: An indication, such as PCI, should be configured in TCI state to enable the SSB from that cell can be referenced as a QCL source. |
| [12] [**R1-2006259**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006259.zip) | Discussion on enhancement multi-TRP inter-cell operation | Spreadtrum Communications |
| Observation 1: For multi-DCI based inter-cell multi-TRP transmission, the framework where different TRPs use different CORESETs in PDCCH-Config could be still used.Proposal 1: Tight synchronization should be assumed for inter-cell multi-TRP/panel transmission.Proposal 2: For inter-cell multi-DCI based multi-TRP operation, support to enhance TCI framework by configuring SSB information from neighbor cell, e.g., PCI of a SSB should be included into a TCI state configuration.  |
| [13] [**R1-2006368**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006368.zip) | On inter-cell operation for mTRP | Ericsson |
| [Proposal 1 Rel-16 multi-TRP schemes are subject to the enhancements for inter-cell operations. No new multi-TRP schemes are discussed for this purpose.](#_Toc47707677)[Proposal 2 Include a PCI in the TCI state (at least for TCI states referring to an SSB) to facilitate the use of reference signals from non-serving cells as QCL sources.](#_Toc47707678)[Proposal 3 Introduce a PCI in the configurations related to UL transmissions: spatial relations and pathloss reference RS.](#_Toc47707679) |
| [14] [**R1-2006392**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006392.zip) | Enhancements on inter-cell Multi-TRP operations in Rel-17 | Huawei, HiSilicon |
| Observation: Inter-cell multi-TRP operation involves using reference signals not associated to the physical cell identity used by the serving cell.Proposal: Support using reference signals from a non-serving cell as QCL source for multi-DCI multi-TRP transmission. |
| [15] [**R1-2006501**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006501.zip) | On Inter-cell multi-TRP operation | Apple |
| Proposal 1: A unified framework should be supported for both L1/L2 centric mobility and inter-cell multi-TRP operation.Proposal 2: Support to divide TCI states into N groups, where each group is associated with a physical cell ID.* Support to configure the physical cell ID, SSB transmission power and periodicity for a TCI state group.
 |
| [16] [**R1-2006545**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006545.zip) | Enhancement on Inter-cell Multi-TRP operations | Beijing Xiaomi Electronics |
| **Proposal 1:** The complexity at UE side should be considered before discussing inter-cell multi-TRP operation.**Proposal 2:** Inter-cell beam management by both UE and gNB should be supported. And inter-cell beam management by gNB is much more preferred.**Proposal 3:** Consider the beam failure recovery of neighboring cell and the straightforward method is to reuse the beam failure recovery mechanism of SCell. |
| [17] [**R1-2006567**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006567.zip) | Enhancement on inter-cell multi-TRP operation | Sharp |
| **Proposal:** SSB/CSI-RS and PCI should be introduced into the TCI framework. |
| [18] [**R1-2006598**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006598.zip) | Enhancements on Multi-TRP inter-cell operation | LG Electronics |
| Proposal #1: Reuse neighbor cell’s SSB or mobility CSI-RS in measurement object for QCL type C/D source of TRS/CSI-RS to support inter-cell multi-TRP operations.  |
| [19] [**R1-2006720**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006720.zip) | Discussion on inter-cell multi-TRP operations | NTT DOCOMO, INC. |
| Proposal 1:* + Support to configure SSBs of non-serving cell with a different PhysCellId as source RS for QCL configuration.
 |
| [20] [**R1-2006792**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006792.zip) | Enhancements on Multi-TRP inter-cell operation | Qualcomm Incorporated |
| Observation 1: Using non-serving cell SSB as QCL source and RS for spatial relation info / PL RS has been already specified as part of Rel. 16 positioning enhancements for PRS and SRS for positioning, respectively.Proposal 1: Support using non-serving cell SSB as reference signal for the following purposes:* QCL-Info: To define TCI states corresponding to a TRP with a non-serving cell PCI.
* SRS-SpatialRelationInfo: To define SRS spatial relation info corresponding to a TRP with a non-serving cell PCI.
* PUCCH-SpatialRelationInfo: To define PUCCH spatial relation info corresponding to a TRP with a non-serving cell PCI.
* PUCCH-PathlossReferenceRS: To define PL RS for PUCCH power control corresponding to a TRP with a non-serving cell PCI.
* PUSCH-PathlossReferenceRS: To define PL RS for PUSCH power control corresponding to a TRP with a non-serving cell PCI.
* pathlossReferenceRS under SRS-ResourceSet: To define PL RS for SRS power control corresponding to a TRP with a non-serving cell PCI.

Proposal 2: RAN1 to study and decide the maximum number of additional (non-serving cell) SSB sets for inter-cell multi-TRP operation. Proposal 3: Study and specify enhancements required to support L1-RSRP/SINR measurement and reporting corresponding to one or more non-serving cell SSBs. |
| [21] [**R1-2006845**](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006845.zip) | Enhancements to enable inter-cell multi-TRP operations | Nokia, Nokia Shanghai Bell |
| Observation 1: With CA approach the current beam management framework could be reused to support inter-cell multi-DCI based multi-TRP operation.Observation 2: With CA approach, a mechanism to differentiate serving cell being an SCell or a non-serving cell in M-TRP would be needed.Observation 3: Inter-cell multi-TRP operation with CA approach may not be feasible anymore due to the changes required in basic design principals of multi-DCI based multi-TRP operation.Observation 4: Inter-cell multi-TRP operation with separate BWPs, the existing beam management signaling can be reused.Observation 5: Inter-cell multi-TRP operation with different BWP approach may not be suitable as it differs from the basic framework of multi-DCI based multi-TRP operation. Proposal 1: For inter-cell multi-DCI based multi-TRP support, extend the TCI framework using the Rel-16 multi-DCI based multi-TRP framework, where the QCL reference Signal can be an SSB associated with a specific PCI.Proposal 2: RAN1 to discuss and clarify the scope of L1/L2 centric mobility and the relationship to inter-cell multi-TRP, and L1/L2 centric mobility may refer to the same solution that will be defined to the inter-cell multi-TRP.  |