**3GPP TSG RAN WG1 #108-e R1-220xxxx**

**e-Meeting, February 21st – March 3rd, 2022**

**Source: Moderator (Intel Corporation)**

**Title: Summary#2 of AI: 8.1.2.4 Maintenance on enhancements for HST-SFN deployment**

**Agenda item: 8.1.2.4**

**Document for: Discussion and Decision**

# Introduction

The document contains summary of maintenance issues and text proposals (TPs) on enhancements for HST-SFN deployment.

# Maintenance issues

## Issues related to new agreements

### Issue #1-1 (SFN CORESET before reception of MAC-CE)

One company (Qualcomm [15]) has noted that in Rel-15 MAC CE signaling is not mandatory when UE’s CORESET is configured with only one TCI state. It was proposed to extend the principle to Rel-17, where Rel-17 MAC-CE activation of two TCI states for SFN PDCCH is required only when more than two TCI states are RRC configured in the CORESET.

#### Round-1

**Proposal #1-1:**

* For a CORESET that is indicated with SFN mode by higher layer signalling and RRC-configured with only two TCI states, the UE assumes that the DM-RS antenna port associated with PDCCH receptions in the CORESET are QCLed with the DL RSs in the two TCI states

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| **Company** | **Comment** |
| Moderator | This issue has been discussed in the previous meeting. Meanwhile companies are welcome to provide their views on this issue. |
| NTT DOCOMO | We think MAC CE based beam indication should be mandatory feature for HST-SFN. In HST-SFN, UE speed is much higher, and the appropriate beam can be changed frequently than single TRP in Rel.15. In RRC based beam indication, we don’t understand how gNB can operate beam indication in HST-SFN. |
| OPPO | Fine with the proposal. |
| vivo | Don’t support.When SFN PDCCH is configured and only two TCI states are by RRC in TCI pool for PDCCH, UE could work in STRP mode if one TCI state is activated by MAC CE. However, the proposal #1-1would restrict this case.  |
| Lenovo/MotM | We believe this is an optimization since “RRC-configured with only two TCI states” is not a typical/common configuration. Furthermore, gNB can use MAC CE to activate one or two TCI states when only two TCI states are configured. |
| Apple | We think NW can still use MAC-CE instead of using the proposed implicit rule |
| Qualcomm | Support FL proposal. The UE behavior before reception of the MAC-CE should be clarified. |
| Ericsson | Will this proposal introduce different CORESET behavior dependent on UE capability signaling? It seems to us that this proposal is not aligned with the previous agreement.**Agreement**Enhanced SFN PDCCH transmission scheme (scheme 1 or TRP-based pre-compensation) is identified by the number of TCI states activated per CORESET and RRC parameter* FFS: Configuration detail of RRC parameter
	+ Including whether the same RRC parameter is used for PDCCH and PDSCH
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| Samsung | Not support. Although there are only two configured TCI states, one or two TCI states can be activated by MAC-CE for the CORESET.Regarding Qualcomm’s comment, if the intention of the proposal is to clarify a UE behavior after RRC configuration and before reception of the MAC-CE, we think that it can be discussed further regardless of the number of configured TCI states and the relevant spec. part as follows can be a starting point to discuss:Clause 10.1 in TS38.213-h00For a CORESET other than a CORESET with index 0,…- if a UE has been provided a configuration of more than one TCI states by *tci-StatesPDCCH-ToAddList* and *tci-StatesPDCCH-ToReleaseList* for the CORESET as part of Reconfiguration with sync procedure as described in [12, TS 38.331] but has not received a MAC CE activation command for one of the TCI states as described in [11, TS 38.321], the UE assumes that the DM-RS antenna port associated with PDCCH receptions is quasi co-located with the SS/PBCH block or the CSI-RS resource the UE identified during the random access procedure initiated by the Reconfiguration with sync procedure as described in [12, TS 38.331]. |
| Spreadtrum | Fine |
| ZTE | Do NOT support. MAC CE can either activate one or two TCI states for STRP and SFN respectively even only two TCI states are configured by RRC. Besides, it’s worth noting that SFN mode is indicated per BWP rather than per CORESET. |
| Xiaomi | From our understanding, the intention of the proposal is to clarify the UE behavior after RRC configuration and before MAC CE activation. We prefer the starting point proposed by Samsung regardless of the number of configured TCI states. |
| LGE | Not support. We share the similar view with Ericsson, we already have made the agreement for MAC-CE activation for two TCI states.  |
| Nokia/NSB | Do not support. We think MAC-CE signaling should be used for indicating two TCI states.  |
| Huawei, HiSilicon | Not support. The proposal has precluded the case that the UE is configured with two TCI states and activated with only one TCI, which should be in STRP transmission. If the intention of the proposal is to resolve the issue of TCI states before reception of MAC CE, the spec cited by Samsung can be a starting point. |
| CATT | Not support. For scheduling flexibly, if a CORESET configured with SFN scheme by RRC and UE is capable of dynamic switching to STRP, MAC CE still can activate one TCI state even two TCI states are configured by RRC. |
| InterDigital | We are OK with the proposal, but also open to discuss it as suggested by Samsung. |
| Moderator | It appears there is large number of companies that don’t support the proposal. No more discussion on this issue.  |
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#### Round-2

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### Issue #1-2 (MAC-CE for CORESET not configured with SFN)

In RAN1#106-e meeting it was agreed to study whether and how to update the CORESET with TCI state that is not configured to SFN scheme in the indicated CCs set. The corresponding issue was discussed in several meetings, but not agreement was made. In this meeting several companies (CATT [5], CMCC [11], Lenovo / MotMobility [14], Qualcomm [15],…) have made the following proposals corresponding to Alt 1 and Alt 2.

**Issue #1-2:**

* Alt 1: If single MAC-CE activates two TCI states for CORESETs in a CC/serving cell set. For CCs not configured with SFN, 1st TCI state of the two indicated TCI states is selected.
	+ **Supported by**: NTT DOCOMO, CATT, Lenovo / MotMobility, Samsung
* Alt 2: UE doesn’t expect to receive a MAC-CE activating two TCI states of a CORESET that is not identified for SFN scheme by RRC
	+ **Supported by**: ZTE, Nokia / NSB, Qualcomm, CMCC, OPPO, Apple, MediaTek, Sony, Ericsson, Xiaomi, LGE, vivo, Huawei / HiSilicon, Spreadtrum, Nokia/NSB, Intel, InterDigital

#### Round-1

**Proposal #1-2:**

* UE doesn’t expect to receive a MAC-CE activating two TCI states for a CORESET that is not configured with SFN scheme.

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| **Company** | **Comment** |
| Moderator | This issue has been discussed in the previous meeting. However due to lack of time was not finalized. Based on the companies’ preference indicated in the last RAN1 meeting, Alt ~~1~~ 2 is selected for proposal. |
| NTT DOCOMO | Support Alt.1. FL Proposal#1-2 seems to be Alt.2. |
| OPPO | Support Alt 2. |
| vivo | Support the proposal.RAN2 has achieved the agreement in RAN2 #116bis-e as follows:* [060] “Enhanced TCI state indication for UE specific PDCCH MAC CE” is applied only if *sfnSchemePdcch* is configured.
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| Lenovo/MotM | Support Alt 1. We think it is beneficial that one MAC-CE updates TCI states for PDCCH transmission in the CC in multi-TRP mode as well as PDCCH transmission in another CC in single-TRP mode simultaneously, which saves some RRC signaling overhead |
| Apple | Support Alt 2. |
| Qualcomm | Support FL proposal #1-2. |
| Ericsson | Fine with the proposal. |
| Samsung | Support Alt1. Since it is agreed to reuse legacy Rel-16 RRC parameters *simultaneousTCI-UpdateList1*, *simultaneousTCI-UpdateList2* for CA operation, Alt1 is beneficial. |
| Spreadtrum | Support FL propose |
| ZTE | Support Alt 2. Besides, we think it can be handled by gNB implement as Rel-16 in which the same case occurs for MTRP PDSCH. |
| Xiaomi | Support FL proposal#1-2 |
| LGE | Support Proposal #1-2.  |
| Nokia/NSB | Support the proposal. (Alt2) |
| Huawei, HiSilicon | Support Alt-2 as the FL’s proposal. |
| CATT | For Alt 1, both SFN-ed and non-SFN-ed CORESETs can be configured flexibly in an indicated CC set and activated with one or two TCI states simultaneously by one single MAC-CE. Hence, we support Alt 1. |
| InterDigital | Support FL proposal. |
| Moderator | Considering agreement in RAN2 suggest agreeing on the Proposal #1-2 (Alt 2) |
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#### Round-2

**Proposal #1-2:**

* UE doesn’t expect to receive a MAC-CE activating two TCI states for a CORESET that is not configured with SFN scheme.

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| **Company** | **Comment** |
| Moderator | The proposal is the same as in the 1st round. Please continue discussion if there are additional comments. |
| Lenovo/MotM | Still support Alt1 for the reasons provided by Lenovo/Samsung/CATT. Based on the comments in the first round, proponents of Alt2 have not provided their motivation to support Proposal #1-2 |
| Qualcomm | Reply to Lenovo:Alt 2 is well aligned with RAN2 agreement. UE specific PDCCH MAC-CE only apply if SFN PDCCH is configured. It means that UE is not expected to receive UE specific PDCCH MAC-CE if SFN PDCCH is not configured by RRC.

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| [060] “Enhanced TCI state indication for UE specific PDCCH MAC CE” is applied only if *sfnSchemePdcch* is configured. |

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### Issue #1-3 (Default beam for PDSCH when time offset less than threshold)

Several companies (vivo [2], DOCOMO [6], Samsung [13], Nokia/NSN [16]) have discussed the issues of default beam assumption for PDSCH reception when time offset is less then threshold. In particular, it was noted that that the cases listed in the table below were not addressed by the previous agreements.

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| **Agreement**If enableTwoDefaultTCI-States is configured and at least one TCI codepoint indicates two TCI states and time offset between the reception of the DL DCI and the PDSCH is less than the threshold timeDurationForQCL, default beam(s) for Rel-17 enhanced SFN PDSCH (scheme 1 or if supported TRP-based pre-compensation) reception:* **Alt 1**: Reuse rule to determine TCI states as defined for Rel-16 PDSCH scheme-1a

This is a UE optional feature |

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| **Case** | **SFN PDSCH configured by RRC** | **enableTwoDefaultTCI-States** | **TCI codepoint indicates two TCI states** | **Dynamic switching** | **Default TCI state** |
| 2 | Yes | Configured | None | Support | If the CORESET with the lowest ID in the latest slot is indicated with two TCI states, UE applies both TCI states of the CORESETOtherwise, UE applies the active TCI state of the CORESET with the lowest ID in the latest slot |
| 3 | Yes | Not configured | / | Support | If the CORESET with the lowest ID in the latest slot is indicated with two TCI states, select the 1st TCI state of the two TCI states of the CORESETOtherwise, apply the active TCI state of the CORESET with the lowest ID in the latest slot |
| 4 | All | Not support | Error case (UE expects that *enableTwoDefaultTCI-States* is configured) |

It was, therefore, proposed to discuss the proposals 1-2 to finalize them.

**Proposal 1:**

When SFN PDSCH is configured by RRC (regardless of whether SFN PDCCH is configured or not), *enableTwoDefaultTCI-States* is configured and there is no TCI codepoint with two TCI states activated by MAC CE, [if UE is capable of the dynamic switching between STRP and SFN transmission,] the time offset between the reception of the DCI and its scheduled PDSCH is less than the threshold *timeDurationForQCL*, the default TCI state for PDSCH is determined as follows

* If enhanced SFN PDCCH transmission scheme 1 or TRP-based pre-compensation is configured and the lowest CORESET ID in the latest slot is indicated with two TCI states, UE applies both TCI states of the CORESET
* Otherwise, UE applies the one active TCI state of the CORESET with the lowest ID in the latest slot
* FFS whether it is optional feature

**Supported by:** DOCOMO, vivo, Nokia/NSB, CATT

**Not supported:** Apple, Qualcomm, Ericsson, Xiaomi, Huawei / HiSilicon, InterDigital

**Proposal 2:**

When SFN PDSCH is configured by RRC (regardless whether SFN PDCCH is configured or not), [if UE is capable of the dynamic switching between STRP and SFN transmission] and *enableTwoDefaultTCI-States* is not configured and the time offset between the reception of the DCI and its scheduled PDSCH is less than the threshold *timeDurationForQCL*, the default TCI state for PDSCH is determined as follows

* For DCI format 1\_1/1\_2, support both configurations with and without TCI state field.
* If enhanced SFN PDCCH transmission scheme 1 is configured and the CORESET with the lowest ID in the latest slot is indicated with two TCI states, UE applies the 1st TCI state of the two TCI states of the CORESET as default beam for PDSCH reception
* Otherwise, UE applies the one active TCI state of the CORESET with the lowest ID in the latest slot

**Supported by:** DOCOMO, vivo, Lenovo/MotM, Xiaomi, Nokia/NSB, CATT

**Not supported:** Apple, Qualcomm, Ericsson, LGE, Huawei / HiSilicon, InterDigital

One company (vivo [2]) has been also proposed to introduce additional NW configuration requirements for *enableTwoDefaultTCI-States* parameter for UE not capable of dynamic switching between sTRP and SFN and PSDCH scheduling offsets less than threshold.

**Proposal 3:**

When SFN PDSCH is configured by RRC, if UE is not capable of dynamic switching between STRP and SFN transmission and the time offset between the reception of the DCI and its scheduled PDSCH is less than the threshold *timeDurationForQCL*, UE expects that *enableTwoDefaultTCI-States* is configured.

**Supported by:** vivo, Lenovo/MotM, Xiaomi

**Not supported:** DOCOMO, Apple, Qualcomm, Ericsson, LGE, Nokia/NSB, Huawei / HiSilicon, CATT, InterDigital

One company (Ericsson [9]) has also mentioned that the agreement mentioned in the beginning of section only covers UE behavior for PDSCH reception when DCI 1\_1/1\_2 is configured with TCI field and suggested to address the remaining cases highlighted in the table below.

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| Time offset between DCI and PDSCH | DCI 1\_0 | DCI 1\_1/1\_2 with “tci-PresentInDCI” enabled | DCI 1\_1/1\_2 with “tci-PresentInDCI” disabled |
| < threshold | No agreement | Yes | No agreement |

**Proposal 4:**

* If single-TRP PDCCH and SFN PDSCH is configured, for PDSCH scheduled by DCI Format 1\_0, if the time offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold *timeDurationForQCL*, UE applies the activated TCI state of the CORESET with the lowest CORESET ID in the latest slot when receiving the PDSCH.
* If single-TRP PDCCH and SFN PDSCH is configured, for PDSCH scheduled by DCI Format 1\_1/1\_2, if the time offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold *timeDurationForQCL*,
	+ For configuration without TCI field, UE applies the activated TCI state of the CORESET with the lowest CORESET ID in the latest slot when receiving the PDSCH.

**Supported by:** Lenovo/MotM, Ericsson, DOCOMO (TCI states of PDSCH in the lowest TCI codepoint), Qualcomm (TCI states of PDSCH in the lowest TCI codepoint), ZTE (two TCI state from two CORESET with two lowest IDs), Xiaomi (*enableTwoDefaultTCI-States* should be clarified), Huawei / HiSilicon (*enableTwoDefaultTCI-States* should be clarified) , InterDigital (with additional discussion)

**Not supported:** CATT, LGE, Nokia/NSB, CATT

#### Round-1

**Proposal #1-3:**

* TBD

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| **Company** | **Comment** |
| Moderator | Proposals 1, 2 were discussed in the previous meeting, but due to lack of time, the discussion was not finalized although some concerns were raised. Further inputs on these proposals and additional proposals 3, 4 are needed. |
| NTT DOCOMO | **Proposal 2:** Support. The previous agreed condition (if *enableTwoDefaultTCI-States* is configured) is only applicable when TCI state field is configured. However, proposal 2 is beneficial when TCI state field is not configured (i.e. 3-bit DCI overhead reduction).We believe we should add “DCI format 1\_0” in the proposal, because it is impossible to differentiate DCI format for default QCL in case of < timeDurationForQCL.**Proposal 1:** we are fine, but we feel it is nice to have. In Rel.16, gNB should configure at least one TCI codepoint with two active TCI states.**Proposal 3:** We have concern. Proposal 3 makes either of “dynamic switching” or “enableTwoDefaultTCI-States” as mandatory. Otherwise, system does not work. However, we think it would be not acceptable by companies.**Proposal 4:** When SFN PDSCH is configured, the scenario is that SFN is assumed for PDSCH. Hence, it is appropriate to assume two default TCI states for PDSCH. However, proposal 4 says UE always assumes one TCI state of CORESET. Alternatively, we can derive two TCI states of PDSCH in the latest TCI codepoint for PDSCH (same as if enableTwoDefaultTCI-States is configured).  |
| OPPO | On proposal 1: The condition “if UE is capable of dynamic switching between STRP and SFN transmission” in the table for case 2 is lost. For the sub-bullet, we may simply say that “UE applies the active TCI state(s) of the CORESET with the lowest ID in the latest slot”.On proposal 2: The condition “if UE is capable of dynamic switching between STRP and SFN transmission” in the table for case 3 is lost. Without this condition, there is overlap between proposal 2 and proposal 3. On proposal 3: The proposal is incomplete. If the CORESET with lowest CORESET ID in the latest slot is indicated with one TCI state, there is only one default QCL assumption for PDSCH, and dynamic switching is still needed. It can be: “…UE expects that enableTwoDefaultTCI-States is configured, and the CORESET with lowest CORESET ID in the latest slot is indicated with two TCI states.”On proposal 4: The two bullets are overlapped with proposal 1/2/3. They should be discussed together. |
| vivo | **Proposal 1:** Support in principle, and we suggest adding “if UE is capable of the dynamic switching between STRP and SFN transmission” in the proposal which has been proposed in our tdoc R1-2201082. Because if UE doesn’t support the dynamic switching between STRP and SFN transmission when SFN PDSCH is configured by RRC, UE would not expect to be indicated by MAC CE with a single TCI state per any of TCI codepoint in the previous agreement. That means all TCI codepoints indicated by MAC CE would be with two TCI states. In this case, the previous agreement has covered it.**Agreement**If enableTwoDefaultTCI-States is configured and at least one TCI codepoint indicates two TCI states and time offset between the reception of the DL DCI and the PDSCH is less than the threshold timeDurationForQCL, default beam(s) for Rel-17 enhanced SFN PDSCH (scheme 1 or if supported TRP-based pre-compensation) reception:* **Alt 1**: Reuse rule to determine TCI states as defined for Rel-16 PDSCH scheme-1a

This is a UE optional feature**Proposal 2:** Support in principle, and we also suggest adding “if UE is capable of the dynamic switching between STRP and SFN transmission” in the proposal.**Proposal 3:** Support. To DOCOMO: In our understanding, Proposal 3 would make either of “dynamic switching” or “*enableTwoDefaultTCI-States*” as mandatory only in these specific conditions in proposal 3. Otherwise, it would be an error case with contradiction.To OPPO: When SFN PDSCH is configured by RRC, if UE is not capable of dynamic switching between STRP and SFN transmission, all TCI codepoints indicated by MAC CE would be with two TCI states, since it was agreed in the previous meeting. Therefore, if *enableTwoDefaultTCI-States* is configured, then this case would transform to “reuse rule to determine TCI states as defined for Rel-16 PDSCH scheme-1a”. |
| Lenovo/MotM | For proposal 1, in case *enableTwoDefaultTCI-States* is configured and no TCI codepoint with two TCI states is activated by MAC CE, the default TCI state could follow the method in proposal 2.Support proposal 2.We are fine with proposal 3.Support proposal 4. |
| Apple | Overall, if there is any chance UE is willing to support HST-SFN, the default TCI rule significantly discourages the UE to support it. Most of the default TCI rule is not needed NR also allows it to be configured. Proposal 1: If no TCI codepoint is activated with two TCI states, why NW configures enableTwoDefaultTCI-States?Proposal 2: How to handle the case when UE is not capable of switching between sTRP and SFN for PDSCH? Why NW cannot configure enableTwoDefaultTCI-States?Proposal 3: time offset between the reception of the DCI and its scheduled PDSCH can be larger than the threshold timeDurationForQCL. In fact, at least for non-fall back DCI 1\_1 and 1\_2, this should be the way to deploy the FR2 |
| Qualcomm | **Proposal 1**: Don’t support. It is counter intuitive that gNB configured ‘enableTwoDefaultTCI-States’ while no TCI codepoint with two TCI states activated by MAC CE.**Proposal 2,3**: Why enableTwoDefaultTCI-States is not configured for SFN PDSCH?**Proposal 4**: Don’t support. The same rule of Rel-16 (lowest TCI codepoint with two TCI states) should be used. |
| Ericsson | We support Proposal 4.What is the motivation for introducing a separate configuration of “enableTwoDefaultTCI-states” if SFN PDSCH has been configured? Is it used to accommodate UE capability if the UE is not capable of dynamic switching? Will a UE capable of supporting SFN PDSCH not capable of supporting two default TCI states? If UE can always support 2 default TCI states, why would we need additional signaling for this?We only need to complete the rules for S-TRP PDCCH + SFN PDSCH. The reason we propose assuming only 1 TCI state associated with CORESET is because the solution doesn’t require association with the codepoint activation of TCI states by MACCE, and therefore more robust for fallback scenarios. Then we try to align the behavior for DCI 1\_1 without TCI field to be the same as DCI 1\_0.  |
| ZTE | For proposal 1/2/3, note that the following agreement was endorsed in #107-e, we have the similar question with companies that what’s the relationship between ‘enableTwoDefaultTCI-States’ and ‘SFN PDSCH configured by RRC’/ ‘no TCI codepoint activated with two TCI states’?

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| ***Agreement****The agreement from RAN1#106b-e meeting is updated as follows**When SFN PDSCH is not configured by RRC and there is no TCI codepoint which indicates two TCI states activated for the PDSCH (i.e. Rel-16 MTRP PDSCH is not configured), for PDSCH reception scheduled by DCI format 1\_0, 1\_1, 1\_2, if the time offset between the reception of the DL DCI and the corresponding PDSCH is smaller than the threshold*timeDurationForQCL,* *For DCI format 1\_1/1\_2, support both configurations with and without TCI state field.*
* *~~[If~~*~~enableTwoDefaultTCIStates~~*~~is not configured,]~~ for both cases with and without TCI state field,*
	+ *If enhanced SFN PDCCH transmission scheme 1 is configured and the lowest CORESET ID in the latest slot is indicated with two TCI states, select the 1st TCI state of the two TCI states of the CORESET as default beam for the PDSCH reception*
		- *~~FFS : Whether above applies for TRP -based pre-compensation if TRP -based pre-compensation is agreed to be support in FR2~~*
	+ *Otherwise, UE applies the one active TCI state of the CORESET  with the lowest*controlResourceSetId  *in the latest slot when receiving the PDSCH*

*It is up to editor how to capture the above agreement* |

For proposal 4, we think it is better to determine two default TCI states for SFN PDSCH even it is scheduled by STRP PDCCH, where these two default beams can be derived from the CORESETs with the first lowest and the second lowest CORESET IDs, respectively. Hence we propose:**Proposal 4:*** If single-TRP PDCCH and SFN PDSCH is configured, for PDSCH scheduled by DCI Format 1\_0, if the time offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold *timeDurationForQCL*, UE applies both of the activated TCI state of the CORESET with the first lowest CORESET ID and the activated TCI state of the CORESET with the second lowest CORESET ID in the latest slot when receiving the PDSCH.
* If single-TRP PDCCH and SFN PDSCH is configured, for PDSCH scheduled by DCI Format 1\_1/1\_2, if the time offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold *timeDurationForQCL*,
	+ For configuration without TCI field, UE applies both of the activated TCI state of the CORESET with the first lowest CORESET ID and the activated TCI state of the CORESET with the second lowest CORESET ID in the latest slot when receiving the PDSCH.
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| Xiaomi | For proposal 1, from our understanding, *enableTwoDefaultTCI-States* is configured only when there is at least one TCI codepoint with two TCI states activated by MAC CE. If there is no TCI codepoint with two TCI states activated by MAC CE, why to configure *enableTwoDefaultTCI-States?*For proposal 2: fine with it if ‘if UE is capable of the dynamic switching between STRP and SFN transmission’ is added into the proposal.For proposal 3: fineFor proposal 4: is it related to the case that enableTwoDefaultTCI-States is not configured, and UE support dynamic switching between STRP and SFN transmission？ |
| LGE | For Proposal 1, it is not clear why enableTwoDefaultTCI-States is configured for the case that there is no TCI codepoint with two TCI states, so we don’t think this proposal is needed. For Proposal 2, we think UE can apply both TCI states of the CORESET as default beam for SFN PDSCH reception similar to the current specification, so we don’t think this proposal is needed.For Proposal 3, we have similar view with Apple, so we don’t think this proposal is needed.For Proposal 4, we think enableTwoDefaultTCI-States can be configured for SFN PDSCH reception, so we don’t think this proposal is needed. |
| Nokia/NSB | Proposal 2: Support, which is useful feature aligned with the most practical operation. We think the proposed scheme is also useful when dynamic switching of S-TRP and SFN transmission is not supported. When UE is traveling through the area with more than 2 TRPs, switching beams from a pair of TRPs to another pair of TRPs can be implemented without RRC re-configuration. Proposal 1: We are fine to support. Similar view as DOCOMO.Proposal 3: We don’t support the proposal. Proposal 4: Similar view as OPPO. The proposal can be part of the other proposals according to the condition.  |
| Huawei, HiSilicon | For proposal 1/2/3, instead of discussing many potential cases, we prefer that the enableTwoDefaultTCI-States should be configured if gNB want to enable SFN PDSCH.We are fine with proposal 4, but it should be with the condition enableTwoDefaultTCI-States not configured, otherwise, UE should use the two TCI states of the CORESET with lowest CORESET ID among those configured with two TCI states, following the legacy. |
| CATT | Proposal 1/2: We agree with FL’s proposal.Proposal 3: It’s too restrictive to always configure *enableTwoDefaultTCI-States* if UE is not capable of dynamic switching between STRP and SFN transmission.Proposal 4: No need to discuss because of overlapping with proposal 1/2/3. |
| InterDigital | Proposals 1/2/3: Do not support. It is not clear why gNB should configure a UE as such.Proposal 4: need further discussion. |
| Moderator | There are concerns on all proposals. At the same time some companies proposed to have mandatory configuration of *enableTwoDefaultTCI-States* when SFN PDSCH is configured. Considering this the following proposal is recommended for the discussion in the next round. Companies are also welcome to explain motivation of supporting SFN PDSCH without *enableTwoDefaultTCI-States***Proposal TBD:*** If SFN PDSCH is configured by RRC, UE expects *enableTwoDefaultTCI-States* configuration

Also proposal 4 is modified with additional alternatives:**Proposal 4a:*** If single-TRP PDCCH and SFN PDSCH is configured, for PDSCH scheduled by DCI Format 1\_0, if the time offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold *timeDurationForQCL*,
	+ Alt 1 UE applies the activated TCI state of the CORESET with the lowest CORESET ID in the latest slot when receiving the PDSCH.
	+ Alt 2 the lowest TCI codepoint with two TCI states
	+ Alt 3 two default TCI are derived from the CORESETs with the first lowest and the second lowest CORESET IDs
* If single-TRP PDCCH and SFN PDSCH is configured, for PDSCH scheduled by DCI Format 1\_1/1\_2, if the time offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold *timeDurationForQCL*, for configuration without TCI field, UE applies
	+ Alt 1 the activated TCI state of the CORESET with the lowest CORESET ID in the latest slot when receiving the PDSCH.
	+ Alt 2 the lowest TCI codepoint with two TCI states
	+ Alt 3 two default TCI are derived from the CORESETs with the first lowest and the second lowest CORESET IDs
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#### Round-2

**Proposal 4a:**

* If single-TRP PDCCH and SFN PDSCH is configured, for PDSCH scheduled by DCI Format 1\_0, if the time offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold *timeDurationForQCL*,
	+ Alt 1 UE applies the activated TCI state of the CORESET with the lowest CORESET ID in the latest slot when receiving the PDSCH.
	+ Alt 2 the lowest TCI codepoint with two TCI states
	+ Alt 3 two default TCI are derived from the CORESETs with the first lowest and the second lowest CORESET IDs
* If single-TRP PDCCH and SFN PDSCH is configured, for PDSCH scheduled by DCI Format 1\_1/1\_2, if the time offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold *timeDurationForQCL*, for configuration without TCI field, UE applies
	+ Alt 1 the activated TCI state of the CORESET with the lowest CORESET ID in the latest slot when receiving the PDSCH.
	+ Alt 2 the lowest TCI codepoint with two TCI states
	+ Alt 3 two default TCI are derived from the CORESETs with the first lowest and the second lowest CORESET IDs

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| **Company** | **Comment** |
| Moderator | Companies are invited to provide their comments including possible way forward for other proposals.  |
| Lenovo/MotM | Support Alt1 and Alt1 |
| Ericsson | Support Alt1 and Alt1 |
| Qualcomm | We are fine with Huawei proposal below.* If SFN PDSCH is configured by RRC, UE expects *enableTwoDefaultTCI-States* configuration

Regarding proposal 4a, we are not convinced that a separate default beam is needed for the case of Single TRP PDDCH + SFN PDSCH. The same rule (Alt 3) should be used. How is that case is different than Rel-16 mTRP (single STP PDCCH + mTRP PDSCH)? In addition, same rule should be used for all DCI formats.

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| **Agreement**If enableTwoDefaultTCI-States is configured and at least one TCI codepoint indicates two TCI states and time offset between the reception of the DL DCI and the PDSCH is less than the threshold timeDurationForQCL, default beam(s) for Rel-17 enhanced SFN PDSCH (scheme 1 or if supported TRP-based pre-compensation) reception:* **Alt 1**: Reuse rule to determine TCI states as defined for Rel-16 PDSCH scheme-1a

This is a UE optional feature |

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### Issue #1-4 (Default beam for PDSCH when time offset larger than threshold)

In the RAN1#107e meeting default beam for PDSCH reception was agreed when SFN is configured for both PDCCH and PDSCH. It was also agreed to support the configuration when TCI field is not present in the DL DCI when the scheduling offset is equal or larger than the threshold. One remaining issue is the scenario when SFN is configured for PDSCH only and whether TCI field should be always present in this case.

**Issue #1-4:**

* When SFN is configured for PDSCH and not configured for PDCCH:
* **Option 1**: TCI field should be always present in DCI formats 1\_1 and 1\_2 for PDSCH transmission with scheduling offset larger than threshold *timeDurationForQCL*
	+ FFS whether the above assumption is applicable for UE not capable of dynamic switching

**Supported by (8)**: Qualcomm, OPPO, Nokia / NSB, Apple, Spreadtrum, Xiaomi, LGE, Nokia/NSB

* **Option 2a**: Support configuration without TCI field. If TCI field is not configured and the time offset between the reception of the DL DCI and the corresponding PDSCH is equal or larger than the threshold *timeDurationForQCL* if applicable*,* UE applies the TCI state of the scheduling CORESET when receiving the PDSCH
	+ FFS whether the above assumption is applicable for UE capable of dynamic switching

**Supported by (6)**: ZTE, HW/HiSi, CATT, Samsung, Lenovo / MotMobility, vivo

* **Option 2b**: Support configuration without TCI field. If TCI filed is not configured and the time offset between the reception of the DL DCI and the corresponding PDSCH is equal or larger than the threshold *timeDurationForQCL* if applicable, UE applies the lowest TCI codepoint with two different TCI states in the activated PDSCH TCI state list for PDSCH reception scheduled by DCI formats 1\_1 and 1\_2

**Supported by (4)**: DOCOMO, Intel, Ericsson,

#### Round-1

**Proposal #1-4:**

* TBD

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| **Company** | **Comment** |
| Moderator | The corresponding issue has been agreed for discussion in the maintenance session. More inputs from other companies are needed. |
| NTT DOCOMO | Support Option 2b. The benefit of Option 2b compared to Option 1/2a, is 3-bit DCI overhead reduction of TCI state field. The condition is when SFN-PDSCH is configured. Hence, gNB’s intention is SFN-PDSCH. For Option 2a, default QCL of PDSCH is 1 TCI state and it becomes always S-TRP PDSCH.  |
| OPPO | Support Option 1. We think TCI field is needed (“*tci-PresentInDCI*” should be enabled by RRC) if gNB wants to schedule SFN transmission for PDSCH. We cannot understand why gNB configures SFN transmission for PDSCH with scheduling offset larger than threshold *timeDurationForQCL*, but configures “*tci-PresentInDCI*” as disabled. |
| vivo | Support Option 2a which follows the default TCI rules in R15/16. |
| Lenovo/MotM | Support Option 2a. It is a unified method with both SFN scheme configured for PDSCH and PDCCH. Besides, it does not require different considerations based on the UE capability for dynamic switching |
| Apple | Support option 1 |
| Qualcomm | Support option 1. It is a simple solution. In addition, it is not clear neither motivated why tci-field is not present.  |
| Ericsson | Support option 2b. |
| Samsung | Support Option 2a. |
| Spreadtrum | Support option 1 |
| ZTE | Support Option 2a. |
| Xiaomi | Support Option 1 |
| LGE | Support option 1 |
| Nokia/NSB | Support Option 1If update option 1 as below, this is inline with Option 2a. * When SFN is configured for PDSCH and not configured for PDCCH:
* **Option 1**: TCI field should be always present in DCI formats 1\_1 and 1\_2 for SFN PDSCH transmission with scheduling offset larger than threshold *timeDurationForQCL*

We are also fine with Option 2b.  |
| Huawei, HiSilicon | Support Option 2a. |
| CATT | To be consistent with legacy rule of following the scheduling PDCCH, our suggestion is Option 2a. Furthermore, similar as SFN-ed PDSCH with SFN-ed PDCCH, the QCL assumption is associated with UE capability of dynamic switching. If UE is capable of dynamic switching between single TRP and SFN, the legacy solutions of default beams for PDSCH can be reused, i.e. the PDSCH can follow TCI state of the scheduling PDCCH.If UE is not capable of dynamic switching and SFN-ed PDSCH is configured by RRC, the UE usually prepares to use two receive beams and enhanced receiver algorithm for SFN-ed PDSCH. If UE still reuse the legacy solutions to follow only one TCI state of scheduling no-SFN PDCCH, which is equivalent to dynamical switching to S-TRP, the demodulation performance of PDSCH indicated with one TCI state will not be guaranteed. Therefore, if the UE is not capable of dynamic switching between single TRP and SFN, PDSCH is not expected to be scheduled by a DCI with TCI state field absent. |
| InterDigital | Support Option 1. |
| Moderator | Option 1 seems has larger number of supporting companies. Suggest we agree on this option. **Proposal #1-4:*** When SFN is configured for PDSCH and not configured for PDCCH:
* **Option 1**: TCI field should be always present in DCI formats 1\_1 and 1\_2 for SFN PDSCH transmission with scheduling offset larger than threshold *timeDurationForQCL*
	+ FFS whether the above assumption is applicable for UE not capable of dynamic switching

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#### Round-2

Void

### Issue #1-5 (UE not capable of sTRP / SFN dynamic switching)

One company (Qualcomm [15]) has mentioned that in the RAN1#106-e meeting, it was agreed that PDSCH scheduled by DCI format 1\_0 follow the QCL assumption of the scheduling CORESET, if the time offset is equal or larger than the threshold *timeDurationForQCL.* However, UE that doesn’t support dynamic switching between single-TRP and SFN scheme (scheme-1 or TRP-based pre-compensation) additional restriction on scheduling CORESET configuration is proposed to be activated only with single TCI state. Two companies (LGE [8], CMCC [11]) has also mentioned that for DCI Format 1\_0, scheduling CORESET should be also activated with two TCI states (as for DCI Formats 1\_1, 1\_2) if a UE supports this feature but is not capable of dynamic switching between single TRP and SFN. At the same time another company (ZTE [3]) has mentioned that in Rel-15/16, single TRP based PDSCH can be scheduled by DCI format 1\_0 since there is no DCI field. In Rel-17, DCI format 1\_0 should also be used to schedule single TRP based PDSCH no matter SFN PDSCH is configured or not, i.e. the function of DCI format 1\_0 should be the same for Rel-15/16/17. Hence if SFN PDSCH is configured and then it is scheduled by DCI format 1\_0, dynamic switching between single TRP and SFN should be supported. Based on above proposals the following alternatives were identified for further discussion regarding support of dynamic scheduling by DCI Format 1\_0.

**Issue #1-5:**

* **Alt 1**: If UE is configured with SFN scheme by RRC and not capable to support dynamic switching between scheme 1 and single-TRP. For unicast PDSCH scheduled by DCI format 1\_0 with scheduling offset equal or larger than threshold *timeDurationForQCL*, the UE does not expect the scheduling CORESET to be activated with single TCI state

**Supported by**: OPPO, Apple, Qualcomm, Spreadtrum, LGE

* **Alt 2**: If SFN PDSCH is configured by RRC, for PDSCH scheduled by DCI format 1\_0, dynamic switching between single TRP and SFN is supported

**Supported by:** Ericsson, ZTE, Nokia / NSB

**Not supported**: DOCOMO, Lenovo/MotM, CATT

#### Round-1

**Proposal #1-5:**

* TBD

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| **Company** | **Comment** |
| Moderator | The issue has been raised in the previous meetings, but no conclusion was reached. More inputs from other companies are needed.  |
| NTT DOCOMO | Before discussing issue#1-5, we have different understanding from ZTE’s view (*In Rel-17, DCI format 1\_0 should also be used to schedule single TRP based PDSCH no matter SFN PDSCH is configured or not, i.e. the function of DCI format 1\_0 should be the same for Rel-15/16/17*):Based on the agreement below, PDSCH scheduled by DCI format 1\_0 has two TCI states when the scheduling CORESET has two active TCI states and >= *timeDurationForQCL*. Hence, we think it is not true that DCI format 1\_0 schedules S-TRP PDSCH in HST scenario. **Agreement (RAN1#106b)**For PDSCH reception scheduled by DCI format 1\_0, [1\_1 and 1\_2], if the time offset between the reception of the DL DCI and the corresponding PDSCH is equal or larger than the threshold *timeDurationForQCL* * Support configuration when there is no TCI field in the DCI scheduling PDSCH
	+ UE applies the state(s) of the scheduling CORESET when receiving the PDSCH
		- if there are two active TCI states for the CORESET, UE applies the both QCL assumption of the CORESET that schedules the PDSCH when receiving the PDSCH
		- otherwise, UE applies the one active TCI state of the CORESET when receiving the PDSCH
* FFS if the time offset between the reception of the DL DCI and the corresponding PDSCH is smaller than the threshold *timeDurationForQCL*

This is a UE optional feature.Regarding to the issue#1-5, is it correct understanding that “PDSCH scheduled by CORESETS associated with CSS Type 0/0A/1/2” is not covered in the proposal?  |
| OPPO | We prefer Alt 1. And we think “PDSCH scheduled by CORESETS associated with CSS Type 0/0A/1/2” should be precluded, which cannot perform with SFN scheme. |
| Lenovo/MotM | Agree with NTT Docomo, the agreement above already implies supporting PDSCH HST-SFN with DCI Format 1\_0 |
| Apple | Support Alt 1 |
| Qualcomm | Support Alt 1.  |
| Ericsson | Support Alt 2. |
| Spreadtrum | Support Alt 1. |
| ZTE | Support Alt 2. |
| Xiaomi | We are confused with ‘unicast PDSCH’ in Alt 1. In addition, it is better to make it clear that the SFN scheme is configured for PDCCH or PDSCH or both. |
| LGE | Support Alt 1 |
| Nokia/NSB | We prefer Alt 2.  |
| CATT | We share similar views with DOCOMO that DCI format 1\_0 should schedule SFN-ed PDSCH in HST scenario if SFN scheme for PDSCH is configured by RRC. |
| Moderator | More discussion is needed on this topic.  |
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#### Round-2

**Proposal #1-5a:**

* **Alt 1**: If UE is configured with SFN scheme by RRC and not capable to support dynamic switching between scheme 1 and single-TRP. For unicast PDSCH scheduled by DCI format 1\_0 with scheduling offset equal or larger than threshold *timeDurationForQCL*, the UE does not expect the scheduling CORESET to be activated with single TCI state

**Supported by**: OPPO, Apple, Qualcomm, Spreadtrum, LGE

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| Moderator | Let’s focus on Alt 1 including possible clarification to “unicast PDSCH”  |
| Lenovo/MotM | Support Alt2. Not clear to us why Alt1 is prioritized given company views in first round |
| Ericsson | Do not support the proposal. UE is expected to receive system information that is sent in DCI 1\_0 with single TCI state. Now with longer time offset, same DCI format, why can’t UE support DCI 1\_0 with C-RNTI? |
| Qualcomm | Reply to Lenovo:Alt 2 means that UE not supporting dynamic switching, DCI format 1\_0 should always schedule SFN PDSCH regardless PDSCH is unicast or common PDSCH. Alt 1 is fine granularity and only limit SFN PDSCH to UE specific data which makes sense. Common PDSCH can be either SFN or single TCI which is discussed separately in issue #1-10.Reply to Ericsson:The proposal doesn’t contradict with receiving system information with single TCI state.  |
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### Issue #1-6 (Default spatial / PL RS for Rel-17 multi-TRP PUSCH/PUCCH)

Two companies (ZTE [3], Samsung [13]) have mentioned that default spatial relation and PL-RS are only defined in the case of single-TRP PUSCH/PUCCH/SRS transmission. However, for multi-TRP based PUCCH/PUSCH/SRS transmissions, default spatial relation and PL-RS are not defined. It is therefore proposed to clarify default assumptions for the corresponding cases.

**Issue #1-6:**

**Default beam and PL RS for multi-TRP PUCCH:**

**Alt 1**: When PL-RS and spatial relation information are not configured and default beam is enabled for the PUCCH transmission, if two TCI states are activated for the CORESET with the lowest ID on the active DL BWP,

* If mTRP PUCCH repetition is configured, the two TCI states activated for the CORESET with the lowest ID on the active DL BWP are used to determine the spatial relation and PL-RS of PUCCH transmission occasions, and each TCI state is associated to one PUCCH transmission occasion group.

**Alt 2**: A new RRC parameter is introduced to enable two default beams and PL-RSs for PUCCH, and if it is configured:

* when only one TCI state is applied for the CORESET with lowest ID, the TCI state is used as the only default spatial relation and PL-RS for PUCCH transmission.
* when two TCI states are applied for the CORESET with lowest ID, both TCI states are used as two default spatial relations and PL-RSs for PUCCH transmission.

**Supported by:** DOCOMO (Alt 1), vivo (Alt 2), Lenovo/MotM (Alt 2), Samsung (Alt 1), ZTE (Alt 1), Nokia/NSB (Alt 1), CATT

**Concerns:** OPPO, Apple, Qualcomm, Ericsson, Spreadtrum, LGE, Huawei / HiSilicon

**Default beam and PL RS for multi-TRP PUSCH:**

**Alt 1:** When the default spatial relation and PL-RS of PUSCH are determined by QCL assumption of CORESET with lowest ID, and two TCI states are activated for the CORESET,

* If mTRP PUSCH repetition is configured, the two TCI states activated for the CORESET with the lowest ID are used as the default spatial relation and PL-RS, and each TCI state is associated to one PUSCH transmission occasion group.

**Alt 2**: UE does not expect that the network configures two SRS resource sets when default beam is enabled for PUSCH transmission scheduled by DCI format 0\_1 and 0\_2

**Supported by:** DOCOMO (Alt 1), vivo (Alt 2), Samsung (Alt 1), ZTE (Alt 1), Nokia/NSB (Alt 1), CATT

**Concerns:** OPPO, Apple, Qualcomm, Ericsson, Spreadtrum, LGE, Huawei / HiSilicon

**Default beam and PL RS for multi-TRP SRS:**

When the default spatial relation and PL-RS of SRS are determined by QCL RS of CORESET with lowest ID, and two TCI states are activated for the CORESET,

* If two SRS resource sets for codebook/non-codebook are configured, the two TCI states activated for the CORESET with the lowest ID are used as the default beam and PL-RS of SRS, and each TCI states is associated to one SRS resource set

**Supported by:** DOCOMO, Lenovo/MotM, Samsung, ZTE, CATT

**Concerns:** OPPO, Apple, Qualcomm, Ericsson, Spreadtrum, LGE, Huawei / HiSilicon

#### Round-1

**Proposal #1-6:**

* TBD

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| **Company** | **Comment** |
| Moderator | The corresponding issues have been raised in the previous meeting, but no conclusion was made.  |
| NTT DOCOMO | Support both proposals.For PUCCH, slightly prefer Alt.1For PUSCH, prefer Alt.1For SRS, support in principle. |
| OPPO | We don’t support the proposal for this issue. * For PUSCH, the default spatial relation and PL-RS of PUSCH are determined by QCL assumption of CORESET with lowest ID only for DCI format 0\_0. However, PUSCH repetition for mTRP is not supported by DCI format 0\_0.
* For PUCCH, when mTRP PUCCH repetition is configured, gNB should configure two spatial relation information or two sets of PC parameters for the PUCCH. The case without these configurations has not been discussed/agreed in 8.1.2.1
* If two SRS resource sets for codebook/non-codebook are configured for PUSCH repetition, two spatial relations should be configured for the SRS in FR2. Otherwise, how can UE derive two default PL-RS/spatial relation information when SFN PDCCH is not configured?

In a word, we think this issue should be firstly discussed in 8.1.2.1 for non-SFN case, e.g. when SFN PDCCH is not configured, how can UE derive two default PL-RS/spatial relation information? |
| vivo | **For PUCCH:**We prefer Alt 2. MTRP PUCCH is indicated by MAC CE with two spatial relations without specific RRC configuration. Therefore, for Alt 1, UE don’t know whether MTRP PUCCH repetition is configured. Moreover, in Alt 2, both cases i.e., the CORESET indicated with two or one TCI state(s) are considered, which have covered the Alt 1 in principle. **For PUSCH:**We prefer Alt 2 as a simpler way. |
| Lenovo/MotM | For PUCCH, we support Alt 2.For PUSCH, we think the default beam and pathloss RS should be determined **jointly** by the TCI states of the CORESET with the lowest ID and the 2 bits field which indicates the association SRS resource sets of the PUSCH.For SRS, we support the proposal. |
| Apple | In general, do not support to mix the feature designed in two agendas, i.e.,The PUSCH/PUCCH enhancement designed in 8.1.2.1The SFN enhancement designed in 8.1.2.4If we need to support, PL and spatial relation can be explicitly configured by the NW |
| Qualcomm | Don’t support. |
| Ericsson | Don’t support. This optimization for default beam is not needed for maintenance phase. |
| Samsung | Support FL proposals.Support Alt1 for PUCCH and PUSCH. |
| Spreadtrum | Not support. Issue#1-6 is for new use case, and it is too late to introduce it in maintenance stage. |
| ZTE | Basically, we think the case of default beam/ PL-RS for MTRP PUCCH/PUSCH/SRS is existing as well as valid. For MTRP PUCCH, although two spatial relations/ two PC parameter sets are activated for a PUCCH resource via MAC CE, it doesn’t preclude to configure no spatial relation/ PC set of the PUCCH resource. For MTRP PUSCH, although DCI format 0\_0 based scheduling is not supported, it can be happened that the associated PUCCH which followed by the PUSCH is not configured with spatial relation. For two SRS sets when MTRP PUSCH operation, there is no agreement/conclusion states that configured spatial relation of the SRS is mandatory.In light of the above, we support:* MTRP PUCCH: Alt 1.
* MTRP PSCH: Alt 1.
* MTRP SRS: Support.
 |
| Xiaomi | We want to clarify that Alt 2 for PUCCH and PUSCH are also talking about PUCCH and PUSCH repetition? |
| LGE | We share the similar view with Apple, so we don’t think this proposal is needed. |
| Nokia/NSB | Support Alt 1 for both PUCCH and PUSCH. Regarding to M-TRP SRS, we are open to discuss. But, this should be aligned with M-TRP PDCCH + M-TRP PUSCH transmission. We don’t see any discussion in URLLC session. So, it should be aligned with URLLC agreement.  |
| Huawei, HiSilicon | We don’t support the further optimization. |
| CATT | We are fine with both proposals. And for each UL RS/channel, we support the two TCI states activated for the CORESET with the lowest ID are used as the default spatial relation and PL-RS, and each TCI state is associated to one UL resource from one TRP. |
| Moderator | Several companies have concern and think it is not essential change. No more discussion on this issue.  |
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#### Round-2

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| **Company** | **Comment** |
| Moderator | Companies are free to provide comments regarding possible way forward on this issue |
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### Issue #1-7 (BFR issues)

When SFN is configured for PDCCH, several enhancements for BFRQ were proposed in the previous meetings:

* UE capability for the larger number of BFD RS for the implicit BFD RS
* The rules for selecting multiple BFD RSs for implicit BFD RS configuration.
* Explicit BFD RS configuration
* NBI RS configuration
* Applicability of BFR enhancements

**Proposal 1:**

For the implicit BFD RS, the number of monitored BFD RSs X is UE capability

* X = 2, 3, 4

**Supported**: LGE, DOCOMO, Nokia/NSB (X = 2, 4), CATT, NEC, CATT, Samsung (OK to discuss), ZTE

**Not supported**: vivo, Lenovo/MotM, Qualcomm, Xiaomi, Huawei/HiSilicon, Spreadtrum

**Proposal 2:**

The rules for selecting multiple BFD RSs for implicit BFD RS configuration is supported.

* **Alt 1**: CORESET activated with two TCI states can be detected with higher priority
* **Alt 2**: UE selects X RS provided for active TCI states for PDCCH receptions in CORESETs associated with the search space sets in an order from the shortest monitoring periodicity. If more than one CORESETs are associated with search space sets having same monitoring periodicity, the UE determines the order of the CORESET from the highest CORESET index. If the CORESET selected based on the above rule is activated with two TCI states, how to calculate radio link quality for RLM/BFD is up to RAN4 discussion per RAN1#107e agreement.
* **Alt 2a**: UE selects X RS provided for active TCI states for PDCCH receptions in CORESETs associated with the search space sets in an order from the shortest monitoring periodicity. If more than one CORESETs are associated with search space sets having same monitoring periodicity, the UE determines the order of the CORESET from the highest CORESET index. If the CORESET selected based on the above rule is activated with two TCI states, it is up to UE implementation to select one RS as BFD-RS.
* **Alt 3**: When configured with two CORESETs with one or two active TCI States and the number of monitored BFD-RSs is 2, UE selects one RS from one CORESET and one RS from another CORESET. When supporting number of monitored BFD-RSs as 3 or 4 based on UE capability:
	+ If all CORESETs are SFN-CORESETs, one BFD RS pair for SFN CORESET is counted as two BFD RSs and remaining one or two BFD-RSs are selected from first TCI state (for X = 3 if supported) or both TCI states (for X = 4 if supported) of SFN CORESET, respectively.
	+ If CORESETs are a mix of SFN-CORESET(s) and non-SFN CORESET(s),
		- if X = 3 (if supported), one BFD RS pair for SFN CORESET is counted as two BFD RSs and remaining one BFD-RSs are selected from TCI state of non-SFN CORESET.
		- if X = 4 (if supported), one BFD RS pair for SFN CORESET is counted as two BFD RSs and remaining two BFD-RSs are selected from the TCI state of non-SFN CORESET and one TCI state from the remaining CORESET.
	+ **Supported**: DOCOMO (1 or 2), Nokia/NSB (3), CATT (1 or 3), ZTE(2), Xiaomi (1 or2), LGE (1 or 3), NEC (1), Samsung (1or 2)
	+ **Not supported**: Spreadtrum, vivo, Lenovo/MotM, Qualcomm, Huawei/HiSilicon (2),

**Proposal 3:**

If enhanced SFN PDCCH transmission scheme (scheme 1 or TRP-based pre-compensation) is configured and two TCI states are activated for at least one CORESET, support the following configuration of RS for BFD

* **Alt 2-1**: Support defining CSI-RS resource or SSB pairs as BFD RS
	+ FFS other details
* **Supported by**: ZTE, CATT, Xiaomi, Lenovo / MotMob, Apple, DOCOMO, NEC, Samsung (OK to discuss)
* **Not supported**: vivo, Qualcomm, Spreadtrum, LGE, Nokia/NSB, Huawei / HiSilicon

**Proposal 4:**

When two TCI states are activated for a CORESET, NBI RS can be also configured

* Two new beam identification CSI-RS resource sets / new beam identification CSI-RS resource pairs or SSB pairs
* **Supported**: ZTE, Nokia/NSB, Xiaomi (for Scell?), NEC, Lenovo / MotMob, DOCOMO, CATT, Apple
* **Not supported**: vivo, Qualcomm,, LGE, vivo, Huawei / HiSilicon, Spreatrum, Samsung (OK to discuss), Spreadtrum, LGE

**Proposal 5:**

When two TCI states are activated for a CORESET, BFR enhancements are applicable to

* CBRA/CFRA based BFR on SpCell in Rel.15.
* BFR MAC CE based BFR on Scell in Rel.16.
* CBRA BFR on SpCell (with BFR MAC CE on Msg.3/A) in Rel.16.
* **Supported**: DOCOMO, vivo, Lenovo/MotM, Apple, Qualcomm, Samsung (OK to discuss), Spreadtrum (with clarification), ZTE, Xiaomi (with clarification), LGE (with clarification), Nokia/NSB, Huawei / HiSilicon, NEC, CATT
* **Not supported**:
* Note: the “enhancement” means at least using RS from two TCI states for implicit BFD

#### Round-1

**Proposal #1-7:**

* TBD

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| **Company** | **Comment** |
| Moderator | Additional inputs from other companies are needed.  |
| NTT DOCOMO | Proposal 1: support X = 2, 3, 4 as UE capability.Proposal 2: support. * Support either Alt.1 or Alt.2.
* For Alt.2a, “it is up to UE implementation to select one RS as BFD-RS” seems not aligned with RAN1#107e agreement (how to calculate radio link quality for RLM/BFD is up to RAN4 discussion per).
* For Alt.3, we don’t understand why we should select “one RS from one CORESET and one RS from another CORESET”. In SFN, two BFD RS can be associated with one CORESET.

Proposal 3: support.Proposal 4: support.Proposal 5: support. |
| vivo | **Proposal 1:** Not support. Prefer to keep up to two BFD-RS. If both CORESETs are indicated with two TCI states, the same two TCI states can be used.**Proposal 2:** Not support. When both CORESETs are indicated with two TCI states, the same two TCI states can be used. When one CORESET is indicated with two TCI states 1&2, another CORESET can be indicated with TCI state 1 or 2. In this way, we don’t need any additional rules for selecting.**Proposal 3:** Not support. Prefer to reuse the current configuration.**Proposal 4:** Not support**Proposal 5:** Support |
| Lenovo/MotM | For proposal 1, we prefer X=2 only, since X=3,4 have potential standard impact with no clear gainFor proposal 2, we think it does not need further discussion for X=2 since the legacy scheme can be reusedWe support proposal 3/4/5 |
| Apple | Proposal 1First of all, implicit BFD RS with CORESET configured with two TCI states need to be UE optional feature. Then we can agree on XProposal 2:We do not see the need of any additional rule. It is up for UE implementation as we discussed in the past from our CRProposal 3:We can consider it as long as it is UE optional feature Proposal 4:We can consider it as long as it is UE optional feature Proposal 5:We are fine as long as it is UE optional feature, i.e., implicit BFD RS with CORESET configured with two TCI states |
| Qualcomm | **Proposal 1,2,3 and 4**: We don’t support increasing the number of BFD-RS (either implicit or explicit) neither defining RS pairs for NBI-RS.**Proposal 5**: Support |
| Samsung | Proposal 1: We are okay with the proposal.Proposal 2: Support Alt1 or Alt2. Further, we would like to clarify our understanding.* Regarding Alt1, our understanding is that prioritizing CORESET with two TCIs means that BFD RSs are selected among CORESETs with two TCIs first (by shorter monitoring periodicity first and higher CORESET index with same periodicity) and further selected among CORESETs with a single TCI secondly.
* Regarding Alt2, our understanding is that if the CORESET with two TCIs is selected based on the rule in Alt2 and two more BFD-RSs can be selected, then two reference RSs from two TCIs of the CORESET can be selected if both two reference RSs are periodic.
* We have similar view with Docomo on Alt3.

Proposal 3: We are open to discuss.Proposal 4: We are open to discuss.Proposal 5: We are open to discuss. |
| Spreadtrum | Proposal 1: prefer to keep X=2Proposal 2/3/4: not supportProposal 5: not clear about ‘BFR enhancement’ in the main bullet. Clarification is needed. |
| ZTE | Proposal 1: Support. At least, 2 RS is not enough.Proposal 2: Alt 2.Proposal 3: Support.Proposal 4: Support.Proposal 5: Support. |
| Xiaomi | Proposal 1: prefer X = 2Proposal 2: fine with Alt 1 or Alt 2Proposal 3: support Proposal 4: support at least for ScellProposal 5: the application of enhancement should be discussed one by one. |
| LGE | For Proposal 1, support.For Proposal 2, Alt 1 or Alt 3 is preferred.For Proposal 3, not support. For Proposal 4, not support. For Proposal 5, we have similar view with Spreadtrum, it seems that the clarification for BFR enhancements is needed.  |
| Nokia/NSB | P1: Support. Limit the X = 2, 4. P2: Alt.3. Update depending on the X agreement. P3: Not support. P4: Support P5: Support |
| Huawei, HiSilicon | We don’t support proposal 1, 2, 3 and 4 to increase the number of BFD-RS, or to define CSI-RS resource or SSB pairs. |
| NEC | Proposal 1: Support. Proposal 2: Prefer Alt 1. Proposal 3: Support. Proposal 4: Support Proposal 5: Support |
| CATT | Proposal 1: support X = 2, 3, 4 as UE capability.Proposal 2: support Alt.1 or Alt.3. Because we think SFN-ed CORESET should be selected first if SFN-ed PDCCH is configured by RRC.Proposal 3/4/5: support. |
| Moderator | Situation is similar to the last RAN1 meeting. It seems only the last proposal can be agreed with clarifications**Proposal #1-7:**When two TCI states are activated for a CORESET, BFR enhancements are applicable to* CBRA/CFRA based BFR on SpCell in Rel.15.
* BFR MAC CE based BFR on Scell in Rel.16.
* CBRA BFR on SpCell (with BFR MAC CE on Msg.3/A) in Rel.16.
* Note: the “enhancement” means at least using RS from two TCI states for implicit BFD
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#### Round-2

**Proposal #1-7:**

When two TCI states are activated for a CORESET, BFR enhancements are applicable to

* CBRA/CFRA based BFR on SpCell in Rel.15.
* BFR MAC CE based BFR on Scell in Rel.16.
* CBRA BFR on SpCell (with BFR MAC CE on Msg.3/A) in Rel.16.
* Note: the “enhancement” means at least using RS from two TCI states for implicit BFD

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| **Company** | **Comment** |
| Moderator | Companies are free to provide comments regarding possible way forward for the remaining proposals related to BFR.  |
| Lenovo/MotM | Support |
| Ericsson | We would like to see the whole proposal before agreeing to it. Maybe proponent companies can provide more information about what exactly the enhancement is. |
| Qualcomm | Support |
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### Issue #1-8 (RLM issues)

In RAN1#107e, whether/how to enhance RLM RS selection rule considering CORESET activated with two TCI states was proposed, however, due to lack of time was not discussed. Two companies (DOCOMO [6], Nokia/NSB [16]) have raised similar question in this meeting regarding selection priority of RLM RS and the following proposal was made.

**Issue #1-8:**

* For implicit configuration of failure detection RS for BFD and RLM, apply the same selection rule for RLM-RS and BFD-RS.

#### Round-1

**Proposal #1-8:**

* TBD

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| **Company** | **Comment** |
| Moderator | More inputs are required including more detailed proposal if any. The issue can be also discussed after BFR is finalized. |
| NTT DOCOMO | Support, and agree to come back after BFR is finalized. |
| Lenovo/MotM | We are fine with Proposal#1-8 |
| Apple | We are fine |
| Samsung | In current specification, since BFD-RS selection is up to UE and there is a specific selection rule for RLM RS, if a rule based implicit BFD-RS selection is agreed, we are fine with the proposal. |
| Spreadtrum | Maybe we should wait issue#1-7 |
| ZTE | We tend to agree with FL’s assessment. |
| Xiaomi | Fine  |
| LGE | We are fine to come back after BFR if finalized.  |
| Nokia/NSB | We support it, and also agree with Moderator’s assessment.  |
| NEC | We are fine with this. |
| CATT | Support in principle. |
| Moderator | It is unlikely that specification-based rule to be agreed for BFR. Considering this, there is no need to discuss this issue in this meeting.  |
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#### Round-2

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### Issue #1-9 (SFN for CORESETS associated with CSS Type 0/0A/1/2)

One company (Qualcomm [15]) has mentioned that PDCCH candidates in CSS type 0/0A/1/2 should not be associated with SFN CORESET, since CSS type 0/0A/1/2 are used for scheduling PDSCH carrying broadcast messages (SIB1, OSI, paging, MSG2/4 or paging). For TPR-based pre-compensation scheme, it is not expected that network can pre-compensate such PDCCH as different UEs may experience different Doppler frequency shifts. Other companies (OPPO [4], Lenovo/MotMob [14]) have mentioned that such association should be allowed, but for PDCCH reception only one TCI state should be used by the UE.

**Issue #1-9**:

* Alt 1: UE doesn’t expect PDCCH candidates in CSS type 0/0A/1/2 to be associated with CORESET activated with two TCI states.
* Alt 2: If PDCCH candidates in CSS 0/0A/1/2 are associated with CORESET that activated with two TCI states, the first TCI state is applied for the CSS reception

####  Round-1

**Proposal #1-9**:

* TBD

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| **Company** | **Comment** |
| Moderator | This issue has been discussed in the previous meeting. Inputs from other companies are needed.  |
| NTT DOCOMO | We have concern on Alt.1. For CORESET with both CSS and USS, there is no need to exclude to activate two TCI states for the CORESET, so that the CORESET can schedule SFN-PDSCH by USS. We support Alt.2. |
| OPPO | We support Alt 2 for configuration flexibility of SFN transmission for CORESET. |
| vivo | Support Alt 2 |
| Lenovo/MotM | Support Alt2 since it can be used in a scenario in which the CORESET associated with CSS is the same as the CORESET associated with USS with two TCI states for SFN transmission. This is related with issue#1-12 and can be discussed together |
| Apple | No need to discuss. Do not support neither Alt |
| Qualcomm | Support Alt 1. |
| Samsung | Support Alt2. |
| Spreadtrum | We think this issue is related to issue #1-12. If proposal for issue#1-12 is supported, actually it means PDCCH candidates in CSS 0/0A/1/2 can be associated with CORESET that activated with two TCI states, since typically CSS0/0A/1/2 is associated with CORESET#0. Further, if PDCCH candidates in CSS 0/0A/1/2 are associated with CORESET that activated with two TCI states, the two TCI state can used for UE reception, and how to use can be up to UE’s implementation like CSS type 3. |
| ZTE | Basically, we think the CORESET0 acts more important role in communication because the UE gets common PDCCH in CORESET0. Otherwise, the robustness of UE-specific CORESET is higher than CORESET0, which is not in line with Rel-16 related design and also deviates from Rel-17 FeMIMO WID. Hence we suggest to support the following alternative:* Alt 3: If PDCCH candidates in CSS 0/0A/1/2 are associated with CORESET that activated with two TCI states, both TCI states are applied for the CSS reception
 |
| Xiaomi | Prefer Alt 2 |
| LGE | Support Alt 2.  |
| Nokia/NSB | Support Alt 2.  |
| Huawei, HiSilicon | Support Alt2. We have agreed that CSS type 3 can be associated with SFN CORESET, if CSS 0/0A/1/2 can’t be associated with SFN CORESET, which means CSS type 3 and CSS 0/0A/1/2 can’t be associated with the same CORESET, i.e. CORESET#0, which would be a great restriction on the gNB implementation. |
| NEC | Prefer Alt 2. |
| CATT | Support Alt 2. |
| Moderator | The proposal was updated to #1-9a with new option (Alt 3). Based on current preference majority prefers Alt 2.**Proposal #1-9a**:* Alt 1: UE doesn’t expect PDCCH candidates in CSS type 0/0A/1/2 to be associated with CORESET activated with two TCI states.

**Supported by**: Qualcomm, * Alt 2: If PDCCH candidates in CSS 0/0A/1/2 are associated with CORESET that activated with two TCI states, the first TCI state is applied for the CSS reception

**Supported by**: DOCOMO, OPPO, vivo, Lenovo/MotMob, Samsung, Xiaomi, LGE, Nokia/NSB, Huawei / HiSilicon, NEC, CATT* Alt 3: If PDCCH candidates in CSS 0/0A/1/2 are associated with CORESET that activated with two TCI states, both TCI states are applied for the CSS reception

**Supported by**: Spreadtrum, ZTE |
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#### Round-2

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| **Company** | **Comment** |
| Moderator | Companies are welcome to provide comments on possible way forward. From GTW it seems Alt 3 would be the outcome in case Alt 1 or Alt 2 could not be agreed.  |
| Lenovo/MotM | Support Alt2. For CSS 0/0A/1/2, the monitoring occasion is determined based on association with SSB and corresponding TCI state. If there are two TCI states used for receiving CORESET associated with CSS 0/0A/1/2, it wouldn’t be clear which TCI state is used or how to determine monitoring occasion.  |
| Ericsson | Support Alt 3. |
| Qualcomm | Some clarification is needed regarding Alt 3.Does it mean that gNB will always configure SFN CORESET for CSS reception if UE support SFN PDCCH? Or does it mean that depending on gNB implementation/configuration, the associated CORESET of the CSS could be SFN or single TCI. We don’t like to have two different UE behaviors based on gNB configuration or implementation. This uncertainty complicates UE design as UE should account for both designs whether the associated CORESET of CSS is SFN or not. |
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### Issue #1-10 (PDSCH scheduled by CSS Type 0/0A/1/2)

One company (OPPO [4]) has mentioned that DCI format 1\_0 in CSS will follow the TCI state of the scheduling CORESET or the CORESET with lowest ID according to the scheduling offset. If the DCI is used to scheduling broadcast information, SFN transmission cannot be applied to the scheduled PDSCH even when the associated CORESET is configured with two TCI states. In this case, one of the TCI states for the CORESETs should be applied to the PDSCH reception.

**Issue #1-10**:

For PDSCH scheduled by CSS 0/0A/1/2

* If the scheduling offset is larger than or equal to *timeDurationForQCL*, the first TCI state of the scheduling CORESET is applied for the PDSCH reception
* If the scheduling offset is smaller than *timeDurationForQCL*, the first TCI state of the CORESET with lowest ID in the same BWP is applied for the PDSCH reception
* Note: if only one TCI state is configured for the CORESET, the TCI state is applied to the PDSCH reception.
* Note: For PDSCH scheduled by CSS type 3 associated with CORESET configured with scheme 1, both TCI states can be applied for the PDSCH reception.

#### Round-1

**Proposal #1-10**:

* TBD

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| **Company** | **Comment** |
| NTT DOCOMO | Fine with the proposal. For the 1st bullet, we should add “if applicable”, after *timeDurationForQCL*. |
| OPPO | We support the proposal. |
| Lenovo/MotM | We are fine with the solution listed in issue #1-10 |
| Qualcomm | Some clarification is needed. Usually, UE follows SSB of serving cell when receiving PDSCH scheduled by CSS 0/0A/1/2. This means that first TCI states of the CORESET should be linked to that SSB?

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| **Clause 5.1 – 38.214** “When receiving PDSCH scheduled with SI-RNTI or P-RNTI, the UE may assume that the DM-RS port of PDSCH is quasi co-located with the associated SS/PBCH block with respect to Doppler shift, Doppler spread, average delay, delay spread, spatial RX parameters when applicable” |

 |
| ZTE | Not needed.Note that these kinds of broadcast PDSCH is scheduled by DCI format 1\_0 for which default beam behavior has been considered in previous discussion, it makes no sense to consider PDSCH scheduled by CSS as a special case.  |
| Nokia/NSB  | We are fine with the proposal. |
| Huawei, HiSilicon | Fine with the proposal. |
| CATT | We support the proposal. |
| Moderator | The proposal was updated to 1-10a. Proponents please address concerns from ZTE and Qualcomm. **Proposal #1-10a**:For PDSCH scheduled by CSS 0/0A/1/2* If the scheduling offset is larger than or equal to *timeDurationForQCL* if applicable, the first TCI state of the scheduling CORESET is applied for the PDSCH reception
* If the scheduling offset is smaller than *timeDurationForQCL* if applicable, the first TCI state of the CORESET with lowest ID in the same BWP is applied for the PDSCH reception
* Note: if only one TCI state is configured for the CORESET, the TCI state is applied to the PDSCH reception.
* Note: For PDSCH scheduled by CSS type 3 associated with CORESET configured with scheme 1, both TCI states can be applied for the PDSCH reception.

**Supported by**: DOCOMO, OPPO, Lenovo/MotMob, Nokia, Huawei / HiSilicon, CATT**Concerns:** ZTE, Qualcomm |
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#### Round-2

**Proposal #1-10a**:

For PDSCH scheduled by CSS 0/0A/1/2

* If the scheduling offset is larger than or equal to *timeDurationForQCL* if applicable, the first TCI state of the scheduling CORESET is applied for the PDSCH reception
* If the scheduling offset is smaller than *timeDurationForQCL* if applicable, the first TCI state of the CORESET with lowest ID in the same BWP is applied for the PDSCH reception
* Note: if only one TCI state is configured for the CORESET, the TCI state is applied to the PDSCH reception.
* Note: For PDSCH scheduled by CSS type 3 associated with CORESET configured with scheme 1, both TCI states can be applied for the PDSCH reception.

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| **Company** | **Comment** |
| Moderator | The proposal was updated to 1-10a. Proponents please address concerns from ZTE and Qualcomm raised in the 1st round.  |
| Lenovo/MotM | Support |
| Ericsson | Don’t support. Both TCI states can be applied to CSS if CORESET is SFNed. |
| Qualcomm | This should be discussed after issue 1-9 is concluded.  |
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### Issue #1-11 (SRS configuration enhancement)

One company (Nokia/NSB [16]) has observed that single SRS transmission toward one TRP may degrade the frequency offset estimation in the other TRP. To support SRS-based frequency pre-compensation, the SRS transmission should have different RS for spatial relation and path loss calculation. In Rel-16, each SRS resource can be configured with its own spatial relation information. However, only one set of power control parameters (pathloss RS, alpha, P0) is configured for a SRS resource set.

**Issue #1-11:**

* For SRS based frequency offset estimation, UE should be configured with two SRS resources to different TRPs, where each SRS resource is configured with at least a different PL-RS.

#### Round-1

**Proposal #1-11:**

* TBD.

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| **Company** | **Comment** |
| Moderator | More inputs are needed. |
| NTT DOCOMO | Fine in principle. |
| Lenovo/MotM | Support |
| Apple | Do not support in general, SRS resource with that usage?  |
| Qualcomm | Why not configuring two SRS sets, one per each TRP following Rel-17? |
| Samsung | We think that configuring mTRP UL repetition feature (i.e., configuring two SRS resource sets) by gNB is sufficient since both HST-SFN and mTRP UL repetition are Rel-17 features (similar view with Qualcomm). |
| ZTE | We share the similar with QC/Samsung that configure two SRS resource sets is preferable. |
| Nokia/NSB | Support the proposal.* For SRS based frequency offset estimation, UE should be configured with two SRS resources to different TRPs, where each SRS resource is configured with at least a different PL-RS.
	+ FFS: alpha and P0.

@Apple, SRS resource usage should be “codebook/non-codeook”. Then, only single SRS Resource set can be configured. @ QC,ZTE and Samsung. Do you think M-TRP PUSCH repetition should be pre-requisite for the pre-compensation scheme. Other than M-TRP PUSCH repetition, there is no option for configuring two SRS resource sets. We are open to introduce any way to support two SRS resource sets, which is easier option. But, not support for mandating M-TRP PUSCH repetition.  |
| Huawei, HiSilicon | We share similar view with QC/Samsung. |
| NEC | Prefer two SRS resource sets. |
| CATT | No need to discuss. |
| Moderator | This proposal needs more discussion. The updates to the proposal are provided. **Proposal #1-11a:** * Alt 1: For SRS based frequency offset estimation, UE should be configured with two SRS resources with usage “codebook” or “non-codebook”, where each SRS resource is configured with at least a different PL-RS corresponding to different TRPs.
	+ FFS: alpha and P0.
* Alt 2: UE capable of SFN scheme B also support two SRS resource sets with usage “codebook” or “non-codebook”
	+ FFS whether it new or the existing mTRP capability for PUSCH
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#### Round-2

**Proposal #1-11a:**

* Alt 1: For SRS based frequency offset estimation, UE should be configured with two SRS resources with usage “codebook” or “non-codebook”, where each SRS resource is configured with at least a different PL-RS corresponding to different TRPs.
	+ FFS: alpha and P0.
* Alt 2: UE capable of SFN scheme B also support two SRS resource sets with usage “codebook” or “non-codebook”
	+ FFS whether it new or the existing mTRP capability for PUSCH

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| **Company** | **Comment** |
| Moderator | Some companies suggested to use two SRS resource sets to address the issue raised by Nokia / NSB. This option has been added for the next round of discussion |
| Lenovo/MotM | Support Alt1 |
| Ericsson | We are OK with Alt 2. |
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### Issue #1-12 (LS reply on MAC CE application to CORESET 0)

In the LS on "Enhanced TCI state indication for UE specific PDCCH MAC CE” [R1-2200886], RAN2 has asked RAN1 whether MAC CE can be applied to any CORESET (including CORESET zero).

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| **Question: RAN2 would like to ask whether “Enhanced TCI state indication for UE specific PDCCH MAC CE” can be applied to CORESET zero or not.** |

**Issue #1-12:**

* **Alt 1:** Enhanced TCI state indication for UE specific PDCCH MAC CE can be applied to CORESET zero.

**Supported by**: Ericsson, vivo, ZTE, Intel, OPPO, Lenovo / MotMob, Apple, CMCC, Samsun, Nokia / NSB, Huawei / HiSilicon, NTT DOCOMO

* **Alt 2:** The Enhanced TCI state indication for UE-specific PDCCH MAC CE can’t be applicable to CORESET zero.

**Supported by**: Qualcomm

Considering majority view the following proposal was made.

#### Round-1

**Proposal #1-12:**

* Enhanced TCI state indication for UE specific PDCCH MAC CE can be applied to any CORESET including CORESET zero.

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| **Company** | **Comment** |
| NTT DOCOMO | Support Alt.1. |
| OPPO | Support the proposal.  |
| vivo | Support |
| Lenovo/MotM | Support Alt 1. If PDCCH monitored by USS or Type3 CSS is transmitted on CORESET 0, enhanced TCI state indication for UE specific PDCCH MAC CE can be applied to CORESET zero based on available agreement |
| Qualcomm | We think that use-case for SFN CORESET#0 should be clarified with respect to PDCCH candidates in CSS type 0/0A/1/2.  |
| Ericsson | Supports |
| Samsung | Support FL proposal #1-12. |
| Spreadtrum | Support |
| ZTE | Support Alt 1. |
| Xiaomi | Support the proposal |
| LGE | Support Proposal #1-12 |
| Nokia/NSB | Support. |
| Huawei, HiSilicon | Support. |
| NEC | Support  |
| CATT | Support Alt 1. |
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#### Round-2

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## Maintenance of the current specification version

This section contains issues related to the agreements made during work item phase that were not captured or captured with errors in the specification.

### Issue #2-1 (Configuration of the transmission schemes)

Several agreements were made in the previous meeting regarding restriction in configuration of SFN schemes for PDCCH, PDSCH and CA scenarios. However, the corresponding agreements were not correctly reflected in TS 38.214. Several companies have proposed TPs to correct these issues.

**TP#1 (Qualcomm [15])**

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| **38.214 CR – Clause 5.1**If a UE is configured with *sfnSchemePdcch* set to*'*sfnSchemeB*'* for a DL BWP or the UE does not report its capability of [*nonSfnPdsch-sfnPdcch*], the UE shall be configured with *sfnSchemePdsch* set to the same scheme as configured for *sfnSchemePdcch* |

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| TP – clause 5.1 When a UE is configured with both sfnSchemePdsch and sfnSchemePdcch, the UE shall expect that sfnSchemePdsch and sfnSchemePdcch are set to the same scheme, either 'sfnSchemeA' or 'sfnSchemeB' for all component carriers in the same band.  |

**TP#2 (vivo [2])**

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| **TS 38.214****5.1 UE procedure for receiving the physical downlink shared channel**< Unchanged parts are omitted >When a UE is configured with higher layer parameter *sfnSchemePdsch* set to either *'*sfnSchemeA*'* or *'*sfnSchemeB*'* for a DL BWP and - if the UE reports its capability of [*dynamicSFN*], the UE is indicated with one or two TCI state(s) in a codepoint of the DCI field *'Transmission Configuration Indication'* in DCI format 1\_1/1\_2, or- otherwise, the UE is not expected to be indicated with one TCI state per any of TCI codepoint by MAC CE, and the UE is indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication'* in DCI format 1\_1/1\_2, andthe UE procedure for receiving the PDSCH upon detection of a PDCCH follows clause 5.1 and the QCL assumption for the PDSCH as defined in clause 5.1.5.When a UE is configured with both *sfnSchemePdsch* and *sfnSchemePdcch*, the UE shall expect that *sfnSchemePdsch* and *sfnSchemePdcch* are set to the same scheme, either *'*sfnSchemeA*'* or *'*sfnSchemeB*'*.If a UE is configured with sfnSchemePdcch set to 'sfnSchemeA' for a DL BWP and activated with two TCI states by MAC CE, and the UE does not report its capability of [nonSfnPdsch-sfnPdcch], the UE does not expect to be indicated with one TCI state in a codepoint of the DCI field 'Transmission Configuration Indication' in DCI format 1\_1/1\_2.If a UE is configured with sfnSchemePdcch set to 'sfnSchemeB' for a DL BWP and activated with two TCI states by MAC CE, the UE does not expect to be indicated with one TCI state in a codepoint of the DCI field 'Transmission Configuration Indication' in DCI format 1\_1/1\_2.When a UE is configured with *sfnSchemePdsch* and/or *sfnSchemePdcch* for a DL BWP, the UE shall expect that the *sfnSchemePdsch* and/or *sfnSchemePdcch* configuration are the same in the other DL BWP other than initial BWP [and BWP-DownlinkCommon]. < Unchanged parts are omitted > |

**TP#3 (Spreadtrum [7])**

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| **TS 38.214**-----------------------------Unchanged part omitted--------------------------When a UE is configured with both *sfnSchemePdsch* and *sfnSchemePdcch*, the UE shall expect that *sfnSchemePdsch* and *sfnSchemePdcch* are set to the same scheme, either *'*sfnSchemeA*'* or *'*sfnSchemeB*'*.If a UE reports its capability of [TBD], the UE can be configured with *sfnSchemePdcch set* to *'*sfnSchemeA*'* when not configured with *sfnSchemePdsch*.------------------------------------------End of Text Proposal#1 for TS 38.214------------------------------------ |

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| **TS 38.214**-----------------------------Unchanged part omitted--------------------------When a UE is configured with *sfnSchemePdsch* and/or *sfnSchemePdcch* for a DL BWP, the UE shall expect that the *sfnSchemePdsch* and/or *sfnSchemePdcch* configuration are the same in the other DL BWP other than initial BWP [and BWP-DownlinkCommon] across all CCs in a band. ------------------------------------------End of Text Proposal#2 for TS 38.214------------------------------------ |

**TP#4 (Xiaomi [12])**

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| **-------------------------- Start of Text Proposal for TS 38.214 --------------------------****<Unchanged parts omitted>**5.1 UE procedure for receiving the physical downlink shared channel…When a UE is configured with both *sfnSchemePdsch* and *sfnSchemePdcch*, the UE shall expect that *sfnSchemePdsch* and *sfnSchemePdcch* are set to the same scheme, either *'*sfnSchemeA*'* or *'*sfnSchemeB*'*.When a UE is configured with *sfnSchemePdsch* and/or *sfnSchemePdcch* for a ~~DL BWP~~ CC, the UE shall expect that the *sfnSchemePdsch* and/or *sfnSchemePdcch* configuration are the same in the other ~~DL BWP other than initial BWP [and BWP-DownlinkCommon]~~ CC in a same frequency band if the UE is configured with CA.…**<Unchanged parts omitted>****-------------------------- End of Text Proposal for TS 38.214 --------------------------** |

#### Round-1

**TP#2-1 (Consolidated)**

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| **TS 38.214****<Unchanged parts are omitted>**5.1 UE procedure for receiving the physical downlink shared channel…When a UE is configured with higher layer parameter *sfnSchemePdsch* set to either *'*sfnSchemeA*'* or *'*sfnSchemeB*'* for a DL BWP and - if the UE reports its capability of [*dynamicSFN*], the UE is indicated with one or two TCI state(s) in a codepoint of the DCI field *'Transmission Configuration Indication'* in DCI format 1\_1/1\_2, or- otherwise, the UE is not expected to be indicated with one TCI state per any of TCI codepoint by MAC CE, and the UE is indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication'* in DCI format 1\_1/1\_2, andthe UE procedure for receiving the PDSCH upon detection of a PDCCH follows clause 5.1 and the QCL assumption for the PDSCH as defined in clause 5.1.5.When a UE is configured with both *sfnSchemePdsch* and *sfnSchemePdcch*, the UE shall expect that *sfnSchemePdsch* and *sfnSchemePdcch* are set to the same scheme, either *'*sfnSchemeA*'* or *'*sfnSchemeB*'*.If a UE is configured with sfnSchemePdcch set to 'sfnSchemeA' for a DL BWP and activated with two TCI states by MAC CE, and the UE does not report its capability of [nonSfnPdsch-sfnPdcch], the UE does not expect to be indicated with one TCI state in a codepoint of the DCI field 'Transmission Configuration Indication' in DCI format 1\_1/1\_2.If a UE is configured with sfnSchemePdcch set to 'sfnSchemeB' for a DL BWP and activated with two TCI states by MAC CE, the UE does not expect to be indicated with one TCI state in a codepoint of the DCI field 'Transmission Configuration Indication' in DCI format 1\_1/1\_2.When a UE is configured with *sfnSchemePdsch* and/or *sfnSchemePdcch* for a ~~DL BWP~~ CC, the UE shall expect that the *sfnSchemePdsch* and/or *sfnSchemePdcch* configuration are the same in the other ~~DL BWP other than initial BWP [and BWP-DownlinkCommon]~~ CC in a same frequency band if the UE is configured with CA.…**< Unchanged parts are omitted >** |

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| **Company** | **Comment** |
| Moderator  | Please provide comments on TP#2-1 |
| NTT DOCOMO | For TP#2-1, we are fine.For TP#3, not support. We don’t need to specify all conditions of UE capabilities in 38.214. |
| OPPO | We are fine with the TP2-1. |
| vivo | Support the TP#2-1, excluding the part of the last paragraph, since it mismatches with the meaning of the previous agreement:**Agreement**Enhanced SFN (scheme 1 or TRP-based pre-compensation scheme) for PDCCH and PDSCH is configured by using separate per-BWP RRC parameters* In Rel-17, all downlink BWPs (except initial BWP and FFS: BWP-DownlinkCommon) within a CC should be the same configuration of SFN scheme

We suggest some small modification for it as follows: When a UE is configured with *sfnSchemePdsch* and/or *sfnSchemePdcch* ~~for a DL BWP~~, the UE shall expect that the *sfnSchemePdsch* and/or *sfnSchemePdcch* configuration are the same in ~~the other~~ all DL BWPs within a CC other than initial BWP ~~[and BWP-DownlinkCommon],~~ and the UE shall expect that the *sfnSchemePdsch* and/or *sfnSchemePdcch* configuration are the same in all CCs in a same frequency band if the UE is configured with CA. |
| Lenovo/MotM | We are fine with TP#2-1 |
| Apple | We are fine with TP#2-1. We are also fine with the vivo proposed change |
| Qualcomm | For the first part of the TP related to SFN schemes configuration, we think the original text by the editor is clearer and more compact. It clearly spills out the PDSCH is configured with SFN when UE doesn’t support ‘nonSfnPdsch-sfnPdcch’ or when UE configured with SFN PDCCH. However, the proposed text by vivo just limit the restriction of TCI codepoint for DCI format 1\_1 and 1\_2. It doesn’t cover the cases when SFN PDSCH is scheduled by DCI format 1\_0 and when tci-field not present and PDSCH follow scheduling CORESET.

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| If a UE is configured with *sfnSchemePdcch* set to*'*sfnSchemeB*'* for a DL BWP or the UE does not report its capability of [*nonSfnPdsch-sfnPdcch*], the UE shall be configured with *sfnSchemePdsch* set to the same scheme as configured for *sfnSchemePdcch* |

For the second part, the proposed text should not remove the part excepting the initial BWP from SFN configuration as per RAN1 agreement. |
| Samsung | Support the 2nd part of TP#1 (from Qualcomm), and TP#2 (from vivo). |
| Spreadtrum | Ok for FL’s proposal |
| ZTE | Fine with TR#2-1 |
| Xiaomi | Support the TP#2-1 and also fine with the change proposed by vivo. |
| LGE | For the first part of the TP, we have similar view with QC, so the original text by the editor is preferred. For the second part of the TP, we are fine with the modified version from vivo.  |
| Huawei, HiSilicon | Fine with FL’s proposal. |
| CATT | We are fine with the TP2-1. |
| Moderator | It seems there are different preferences on how to capture agreements related to the first part of TP. Alt 1: “If a UE is configured with sfnSchemePdcch set to 'sfnSchemeA' for a DL BWP and activated with two TCI states by MAC CE, and the UE does not report its capability of [nonSfnPdsch-sfnPdcch], the UE does not expect to be indicated with one TCI state in a codepoint of the DCI field 'Transmission Configuration Indication' in DCI format 1\_1/1\_2.If a UE is configured with sfnSchemePdcch set to 'sfnSchemeB' for a DL BWP and activated with two TCI states by MAC CE, the UE does not expect to be indicated with one TCI state in a codepoint of the DCI field 'Transmission Configuration Indication' in DCI format 1\_1/1\_2.”Alt 2: “If a UE is configured with *sfnSchemePdcch* set to*'*sfnSchemeB*'* for a DL BWP or the UE does not report its capability of [*nonSfnPdsch-sfnPdcch*], the UE shall be configured with *sfnSchemePdsch* set to the same scheme as configured for *sfnSchemePdcch*”Also, views are needed whether the second part of TP proposed by vivo is acceptable“When a UE is configured with *sfnSchemePdsch* and/or *sfnSchemePdcch* ~~for a DL BWP~~, the UE shall expect that the *sfnSchemePdsch* and/or *sfnSchemePdcch* configuration are the same in ~~the other~~ all DL BWPs within a CC other than initial BWP ~~[and BWP-DownlinkCommon],~~ and the UE shall expect that the *sfnSchemePdsch* and/or *sfnSchemePdcch* configuration are the same in all CCs in a same frequency band if the UE is configured with CA”To be discussed in the 2nd round |
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#### Round-2

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| **Company** | **Comment** |
| Moderator | Based on the comments received in the 1st round, further discussion is needed on the TP. Companies are invited to provide preference on the two alternatives for the first part of TP.Alt 1 (vivo’s proposal): “If a UE is configured with sfnSchemePdcch set to 'sfnSchemeA' for a DL BWP and activated with two TCI states by MAC CE, and the UE does not report its capability of [nonSfnPdsch-sfnPdcch], the UE does not expect to be indicated with one TCI state in a codepoint of the DCI field 'Transmission Configuration Indication' in DCI format 1\_1/1\_2.If a UE is configured with sfnSchemePdcch set to 'sfnSchemeB' for a DL BWP and activated with two TCI states by MAC CE, the UE does not expect to be indicated with one TCI state in a codepoint of the DCI field 'Transmission Configuration Indication' in DCI format 1\_1/1\_2.”Alt 2 (Editor’s version): “If a UE is configured with *sfnSchemePdcch* set to*'*sfnSchemeB*'* for a DL BWP or the UE does not report its capability of [*nonSfnPdsch-sfnPdcch*], the UE shall be configured with *sfnSchemePdsch* set to the same scheme as configured for *sfnSchemePdcch*”Also, views are needed whether the second part of TP proposed by vivo is acceptable “When a UE is configured with *sfnSchemePdsch* and/or *sfnSchemePdcch* ~~for a DL BWP~~, the UE shall expect that the *sfnSchemePdsch* and/or *sfnSchemePdcch* configuration are the same in ~~the other~~ all DL BWPs within a CC other than initial BWP ~~[and BWP-DownlinkCommon],~~ and the UE shall expect that the *sfnSchemePdsch* and/or *sfnSchemePdcch* configuration are the same in all CCs in a same frequency band if the UE is configured with CA” |
| vivo | We support Alt 1.Try dividing Alt2 (Editor’s version) into two parts to analyze its bugs:**Part 1:** If a UE is configured with *sfnSchemePdcch* set to*'*sfnSchemeB*'* for a DL BWP, the UE shall be configured with *sfnSchemePdsch* set to the same scheme as configured for *sfnSchemePdcch*”**Part 2:** If a UE does not report its capability of [*nonSfnPdsch-sfnPdcch*], the UE shall be configured with *sfnSchemePdsch* set to the same scheme as configured for *sfnSchemePdcch*”Regarding Part 1: If a UE is configured with *sfnSchemePdcch* set to'sfnSchemeB', but only one TCI state is indicated for PDCCH, then PDCCH would work in STRP scheme rather TRP-based pre-compensation scheme. In this situation, *sfnSchemePdsch* is not necessary if PDSCH also intends to be transmitted in STRP scheme. Therefore, “UE shall be configured with *sfnSchemePdsch* set to the same scheme as configured for *sfnSchemePdcch*” is not compact. It depends on whether two TCI states are indicated for PDCCH.Regarding Part 2: “UE does not report its capability of [*nonSfnPdsch-sfnPdcch*]” means UE doesn’t support the combination of scheme 1 PDCCH and STRP PDSCH. In this situation, it also depends on whether two TCI states are indicated for PDCCH. If only one TCI state is indicated for PDCCH, UE doesn’t need to be configured with *sfnSchemePdsch* set to the same scheme as configured for *sfnSchemePdcch*”.Regarding QC’s concern on the case when SFN PDSCH is scheduled by DCI format 1\_0 and when tci-field not present and PDSCH follow scheduling CORESET, it has been covered in section 5.1.5 in spec 38.214 v17.0.0:

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| “For PDSCH scheduled by DCI format 1\_0, 1\_1, 1\_2, when a UE is configured with *sfnSchemePdcch* set to 'sfnSchemeA' and *sfnSchemePdsch* is not configured, and there is no TCI codepoint with two TCI states in the activation command, and if the time offset between the reception of the DL DCI and the corresponding PDSCH is equal or larger than the threshold *timeDurationForQCL* if applicable and the CORESET which schedules the PDSCH is indicated with two TCI states, the UE assumes that the TCI state or the QCL assumption for the PDSCH is identical to the first TCI state or QCL assumption which is applied for the CORESET used for the PDCCH transmission within the active BWP of the serving cell.” |

In the above mentioned paragraph, *sfnSchemePdcch* being set to 'sfnSchemeB' is excluded when *sfnSchemePdsch* is not configured in spec. That implies the combination of TRP-based pre-compensation PDCCH and STRP PDSCH is also not supported for the default TCI case.------------------------------------------Regarding the second part of TP:“When a UE is configured with *sfnSchemePdsch* and/or *sfnSchemePdcch* for a ~~DL BWP~~ CC, the UE shall expect that the *sfnSchemePdsch* and/or *sfnSchemePdcch* configuration are the same in the other ~~DL BWP other than initial BWP [and BWP-DownlinkCommon]~~ CC in a same frequency band if the UE is configured with CA.” only captures the following agreement:**Agreement**For intra-band CA, UE doesn’t expect configurations of different SFN schemes in different CCsHowever, the following agreement is not captured:**Agreement**Enhanced SFN (scheme 1 or TRP-based pre-compensation scheme) for PDCCH and PDSCH is configured by using separate per-BWP RRC parameters* In Rel-17, all downlink BWPs (except initial BWP and FFS: BWP-DownlinkCommon) within a CC should be the same configuration of SFN scheme

Our revision is proposed to cover the both agreements. |
| Lenovo/MotM | Prefer the TP in Round 1 |
| Qualcomm | Reply to vivo:* For both part 1 and part 2, it is wired that gNB configures SFN for PDCCH but indicate only one TCI state for PDCCH.
* In the suggested TP, is the ‘activated two TCI states by MAC-CE’ statement refers to PDSCH or PDDCH?
* There is miss-understanding. The TP highlighted in the reply covers the UE behavior of SFN-PDDCH + Singe TRP PDSCH when tci-field no present. This is not our concern. The main issue that the suggested TP doesn’t describe the 5 support combination schemes while the editor TP does.

The second part of the TP, our preference is to capture the CA restriction at the text that describes the same SFN scheme is configured for both PDDCH and PDSCH and don’t mix it with the other text of restricting the same SFN scheme across all BWPs except initial BWP. Suggest the following TP:

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| When a UE is configured with both sfnSchemePdsch and sfnSchemePdcch, the UE shall expect that sfnSchemePdsch and sfnSchemePdcch are set to the same scheme, either 'sfnSchemeA' or 'sfnSchemeB' for all component carriers in the same frequency band. |

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### Issue #2-2 (QCL for aperiodic CSI-RS reception with SFN Scheme B)

One company (Huawei / HiSilicon [1]) has mentioned that default beam for aperiodic CSI-RS reception has been agreed to support scheme 1 or TRP-based pre-compensation. However, the default beam for aperiodic CSI-RS reception with TRP-based pre-compensation was not captured in the spec.

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| **Agreement**If enhanced SFN PDCCH transmission scheme (scheme 1 or if TRP-based pre-compensation is supported in FR2) is configured and CORESET is indicated with two TCI states, and scheduling offset for AP CSI-RS is less than the threshold and *enableTwoDefaultTCIStates* is not configured* If there is no other DL signal on the same symbol, use one of two TCI states as default beam for aperiodic CSI-RS reception, i.e.
	+ using one TCI state of the CORESET with the lowest CORESET ID in the latest slot as default beam for aperiodic CSI-RS reception. If there are two activated TCI states for the CORESET with the lowest CORESET ID, one of two TCI states will be selected, i.e. always selects the first TCI state if the CORESET has two TCI states

If there is other DL signal on the same symbol, reuse Rel-15/16 mechanism |

#### Round-1

**TP#2-2**

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| **TS 38.214** < Unchanged parts are omitted > - else if a UE is configured with *sfnSchemePdcch* set to *'*sfnSchemeA' or *'*sfnSchemeB', it is not configured with *enableTwoDefaultTCI-States,* and the two TCI states are activated for the CORESET by the activation command as described in clause 6.1.3.x of [10, TS 38.321]- if there is any other DL signal with an indicated TCI state in the same symbols as the CSI-RS, the UE applies the QCL assumption of the other DL signal also when receiving the aperiodic CSI-RS. The other DL signal refers to PDSCH scheduled with an offset larger than or equal to the threshold *timeDurationForQCL,* as defined in [13, TS 38.306], periodic CSI-RS, semi-persistent CSI-RS, aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* scheduled with offset larger than or equal to the UE reported threshold *beamSwitchTiming* when the reported value is one of the values {14,28,48} and when *enableBeamSwitchTiming* is not provided or the *NZP-CSI-RS-ResourceSet* is configured with the higher layer parameter *trs-Info* , aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* configuredwith the higher layer parameter *repetition* set to 'off' or configured without the higher layer parameters *repetition* and *trs-Info* scheduled with offset larger than or equal to 48 when the UE provides *beamSwitchTiming-r16* and *enableBeamSwitchTiming* is provided, aperiodic CSI-RS in a *NZP-CSI-RS-ResourceSet* configuredwith the higher layer parameter *repetition* set to 'on' scheduled with offset larger than or equal to the UE reported threshold *beamSwitchTiming-r16* and *enableBeamSwitchTiming* is provided;- else if, the UE applies the first one of two TCI states indicated for the CORESET with the lowest CORESET ID in the latest slot within the active BWP of the cell in which the CSI-RS is to be received when receiving the aperiodic CSI-RS, < Unchanged parts are omitted >< End of text proposal 38.214 v17.0.0 Section 5.2> |

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| **Company** | **Comment** |
| Moderator  | Please provide comments on TP#2-2 |
| NTT DOCOMO | Support |
| OPPO | We are fine with the TP.  |
| vivo | Support |
| Lenovo/MotM | Support |
| Apple | We are fine with TP |
| Qualcomm | Support |
| Samsung | Support |
| Spreadtrum | Support |
| ZTE | Support |
| Xiaomi | Support  |
| LGE | Support |
| Nokia/NSB | Support. |
| Huawei, HiSilicon | Support |
| CATT | We are fine with the TP. |
| Moderator | No concerns on TP#2-2 |
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#### Round-2

**TP#2-2 is proposed for endorsement**

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| Ericsson | We have concern on this TP. Sorry we didn’t comment on last round, I was hoping we can get the usage of *enableTwoDefaultTCI-States* first. Current TP may give the wrong impression that SFN scheme B PDCCH + S-TRP PDSCH is supported. We suggest adjusting the TP this way:- else if a UE is configured with *sfnSchemePdcch* set to *'*sfnSchemeA' or both *sfnSchemePdcch* and *sfnSchemePdcsh* set to *'*sfnSchemeB', it is …. |

### Issue #2-3 (DCI Formats 0\_0, 1\_1, or 1\_2, for SFN PDSCH)

One company (NTT DOCOMO [6]) has mention that if *enableTwoDefaultTCI-States* is configured, the two default TCI states are derived from active TCI states for PDSCH, similar to Rel-16 single DCI based M-TRP operation. However, Rel-17 SFN the specification should be applied to PDSCH scheduled by DCI format 1\_0/1\_1/1\_2, while for single DCI based M-TRP in Rel.16, to PDSCH scheduled by DCI format 1\_1/1\_2 only.

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| **Agreement**If enableTwoDefaultTCI-States is configured and at least one TCI codepoint indicates two TCI states and time offset between the reception of the DL DCI and the PDSCH is less than the threshold timeDurationForQCL, default beam(s) for Rel-17 enhanced SFN PDSCH (scheme 1 or if supported TRP-based pre-compensation) reception:* **Alt 1**: Reuse rule to determine TCI states as defined for Rel-16 PDSCH scheme-1a

This is a UE optional feature |

Therefore, it is proposed to clarify that the specification is applied to PDSCH scheduled by DCI format 1\_0.

#### Round-1

**TP#2-3**

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| **TS 38.214**5.1.5 Antenna ports quasi co-location[…]Independent of the configuration of *tci-PresentInDCI* and *tci-PresentDCI-1-2* in RRC connected mode, if the offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold *timeDurationForQCL* and at least one configured TCI state for the serving cell of scheduled PDSCH contains *qcl-Type* set to 'typeD', […]- If a UE is configured with *enableTwoDefaultTCI-States*, and at least one TCI codepoint indicates two TCI states, the UE may assume that the DM-RS ports of PDSCH or PDSCH transmission occasions of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) associated with the TCI states corresponding to the lowest codepoint among the TCI codepoints containing two different TCI states. This is applied to PDSCH scheduled by DCI format 1\_0, 1\_1, or 1\_2, if UE is configured with *sfnSchemePdsch*. When the UE is configured by higher layer parameter *repetitionScheme* set to 'tdmSchemeA' or is configured with higher layer parameter *repetitionNumber*, and the offset between the reception of the DL DCI and the first PDSCH transmission occasion is less than the threshold *timeDurationForQCL,* the mapping of the TCI states to PDSCH transmission occasions is determined according to clause 5.1.2.1 by replacing the indicated TCI states with the TCI states corresponding to the lowest codepoint among the TCI codepoints containing two different TCI states based on the activated TCI states in the slot with the first PDSCH transmission occasion. In this case, if the 'QCL-TypeD' in both of the TCI states corresponding to the lowest codepoint among the TCI codepoints containing two different TCI states is different from that of the PDCCH DM-RS with which they overlap in at least one symbol, the UE is expected to prioritize the reception of PDCCH associated with that CORESET. This also applies to the intra-band CA case (when PDSCH and the CORESET are in different component carriers) |

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| **Company** | **Comment** |
| Moderator  | Please provide comments on TP#2-3 |
| NTT DOCOMO | Support. The same specification text is applied to default QCL of Rel.16 S-DCI M-TRP and Rel.17 HST, however, there is following difference. It should be clarified, otherwise it is not possible to understand.* Rel-17 SFN: text is applied to PDSCH scheduled by DCI format 1\_0/1\_1/1\_2
* Rel-16 single DCI based M-TRP: text is applied to PDSCH scheduled by DCI format 1\_1/1\_2 only
 |
| Lenovo/MotM | Support |
| Apple | We are fine |
| Qualcomm | We are fine in principle. However, this TP may depend on the outcome discussion of issue 1-3 (Proposal 4 by Ericsson). In principle, we support using same default beam rule for SFN PDSCH scheduled by all DCI formats 1\_0/1\_1/1\_2. |
| Samsung | Support in principle. |
| Spreadtrum | Support |
| ZTE | Basically, we share the similar understanding with FL that single TRP based PDSCH is mandatory when scheduled by DCI format 1\_0, which should be the same for Rel-17. Hence we can accept this with the following update:This is applied to PDSCH scheduled by DCI format 1\_1, or 1\_2, if UE is configured with *sfnSchemePdsch*.  |
| Xiaomi | We are fine |
| LGE | We are fine with the TP. |
| Nokia/NSB | Support in principle. Applicability for DCI format 1\_0 is pending to other discussion. |
| LGE | We are fine with the TP. |
| CATT | In our opinion, there is no restriction on applying the above procedure to some certain DCI formats. Moreover, we have the different understanding from DOCOMO’s view on Rel-16 M-TRP scheme. Based on current Rel-16 specs, the text for default beams of Rel-16 MTRP PDSCH doesn’t restrict which DCI format can schedule PDSCH. When the offset between the DCI and PDSCH less than threshold, the RRC *enableTwoDefaultTCI-States* is configuredandat least one TCI codepoint indicates two TCI states, the QCL assumptions of Rel-16 MTRP PDSCH can apply the TCI states corresponding to the lowest codepoint among the TCI codepoints containing two different TCI states based on the activated TCI states in the slot with the first PDSCH transmission occasion, even if the PDSCH is scheduled by DCI format 1\_0.Hence, we think there is no need to add description of DCI formats that can schedule SFN-ed PDSCH. |
| Moderator | Let’s come back to TP after discussion on the issues related to DCI Format 1\_0 |
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#### Round-2

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| **Company** | **Comment** |
| vivo | We think it is not needed to add description for DCI format 1\_0/1\_1/1\_2 if UE is configured with *sfnSchemePdsch*. For Rel-16 MTRP, there is no restriction on DCI format in this default TCI case, when a UE is configured with *enableTwoDefaultTCI-States*, and at least one TCI codepoint indicates two TCI states. |
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### Issue #2-4 (QCL assumptions for CSI-RS)

One company (vivo [2]) mentioned that RAN1 has made agreement below on TCI state for CSI-RS reception when CSI-RS other than those configured with repetition set to 'on' is overlapping in the time domain with CORESET with two TCI states. However, the description of “the first TCI state of the CORESET as the default TCI assumption” in the agreement is not appropriate considering the description in the current spec TS 38.214, because this is not a default beam issue, but an issue to guarantee the same beam for CSI-RS and PDCCH.

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| **Agreement**If CSI-RS other than those configured with repetition set to 'on' is overlapping in the time domain with CORESET with two TCI states, support the first TCI state of the CORESET as the default TCI assumption for the CSI-RS. |

In order to avoid the confusion, TP was proposed to reflect the real meaning more clearly and keep the similar description as what in Rel-16 spec 38.214.

#### Round-1

**TP#2-4**

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| **TS 38.214****5.1.6.1 CSI-RS reception procedure**< Unchanged parts are omitted >For a CSI-RS resource associated with a *NZP-CSI-RS-ResourceSet* with the higher layer parameter *repetition* set to 'on', the UE shall not expect to be configured with CSI-RS over the symbols during which the UE is also configured to monitor the CORESET, while for other *NZP-CSI-RS-ResourceSet* configurations, if the UE is configured with a CSI-RS resource and a search space set associated with a CORESET activated with one TCI state in the same OFDM symbol(s), the UE may assume that the CSI-RS and a PDCCH DM-RS transmitted in all the search space sets associated with CORESET are quasi co-located with 'typeD', if 'typeD' is applicable. If the CORESET is activated with two TCI states, UE may assume that quasi co-location with ‘typeD’ in the first TCI state of the CORESET is the same as the ~~default~~ quasi co-location with ‘typeD’ ~~QCL assumption~~ for the CSI-RS, if 'typeD' is applicable. This also applies to the case when CSI-RS and the CORESET are in different intra-band component carriers, if 'typeD' is applicable. Furthermore, the UE shall not expect to be configured with the CSI-RS in PRBs that overlap those of the CORESET in the OFDM symbols occupied by the search space set(s).< Unchanged parts are omitted > |

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| **Company** | **Comment** |
| Moderator  | Please provide comments on TP#2-4 |
| NTT DOCOMO | We are not sure why the TP is needed. Also, for the detail of proposed TP, we are not sure the meaning of “QCL type D in the first TCI state of CORESET is the same as QCL type D for CSI-RS”. Does it mean “QCL type D RS for 1st TCI state of CORESET and CSI-RS is the same”? Or, it means “CSI-RS is type D QCLed with 1st TCI state of CORESET”?  |
| OPPO | We think the TP is not needed. |
| vivo | To DOCOMO: the original meaning of this TP is your second understanding, i.e., “CSI-RS is type D QCLed with 1st TCI state of CORESET”.The motivation of this TP is to avoid the confusion about “default QCL assumption” in the paragraph, which is not matched very well here. We think the wording could be revised to a more appropriate version.If companies think the wording in the above TP is not very clear, maybe we can try the following revision:UE may assume that quasi co-location source RS with ‘typeD’ in the first TCI state of the CORESET ~~as the default~~ ~~QCL assumption for~~ and the CSI-RS is quasi co-located with ‘typeD’, if 'typeD' is applicable.  |
| Lenovo/MotM | We are open for discussion. In addition to the case of CORESET activated with two TCI states, FDM-ed based CORESET used for PDCCH repetition can be discussed together so as to derive a unified solution |
| Qualcomm | No strong opinion here. However, we think that suggest TP edits may not be needed. The previous statement already gives the details of TypeD association for single TCI-CORESET (highlighted below). Then, next statement clarify the case which TCI states is used for TypeD association when CORESET is activated with two TCI states.

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| …while for other *NZP-CSI-RS-ResourceSet* configurations, if the UE is configured with a CSI-RS resource and a search space set associated with a CORESET in the same OFDM symbol(s), the UE may assume that the CSI-RS and a PDCCH DM-RS transmitted in all the search space sets associated with CORESET are quasi co-located with 'typeD', if 'typeD' is applicable. |

 |
| Spreadtrum | Agree with vivo’s intention to avoid ‘default QCL assumption’ in spec. Fine with the update from vivo. |
| ZTE | Not needed due to the similar view with QC. |
| Xiaomi | The previous statement is OK for us. |
| LGE | We are fine with the TP. |
| CATT | Agree with DOCOMO and OPPO, no need to discuss. |
| Moderator | There are several companies who expressed concerns on this TP. |
| vivo2 | To Moderator:Could we continue to discuss this issue shortly in Round-2?We are ok to keep the current description of “default QCL assumption”, if it is not confusing for companies. However, we think “activated with one TCI state” is still needed to be added in the spec. Otherwise, “CSI-RS and a PDCCH DM-RS…are quasi co-located with 'typeD'” would be misleading, considering the CORESET can be activated with one or two TCI states.< Unchanged parts are omitted >For a CSI-RS resource associated with a *NZP-CSI-RS-ResourceSet* with the higher layer parameter *repetition* set to 'on', the UE shall not expect to be configured with CSI-RS over the symbols during which the UE is also configured to monitor the CORESET, while for other *NZP-CSI-RS-ResourceSet* configurations, if the UE is configured with a CSI-RS resource and a search space set associated with a CORESET activated with one TCI state in the same OFDM symbol(s), the UE may assume that the CSI-RS and a PDCCH DM-RS transmitted in all the search space sets associated with CORESET are quasi co-located with 'typeD', if 'typeD' is applicable.< Unchanged parts are omitted > |
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#### Round-2

void

### Issue #2-5 (Default beam for PUCCH)

One company (ZTE [3]) has mentioned that the default spatial relation and PL-RS of single-TRP PUCCH/PUSCH/SRS transmission has been agreed in RAN1#106 e-meeting for the case when SFN PDCCH transmission is configured, but in current specification, the related agreements were not captured. Hence, the following text proposal was made.

#### Round-1

**TP#2-5**

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| **38.213: 9.2.2 PUCCH Formats for UCI transmission**<Unchanged part omitted>If a UE- is not provided *pathlossReferenceRSs* in *PUCCH-PowerControl*, - is provided *enableDefaultBeamPL-ForPUCCH*, and - is not provided *PUCCH-SpatialRelationInfo*, and- is not provided coresetPoolIndex value of 1 for any CORESET, or is provided coresetPoolIndex value of 1 for all CORESETs, in ControlResourceSet and no codepoint of a TCI field, if any, in a DCI format of any search space set maps to two TCI states [5, TS 38.212]a spatial setting for a PUCCH transmission from the UE is same as a spatial setting for PDCCH receptions by the UE in the CORESET with the lowest ID on the active DL BWP of the PCell, if the CORESET has two activated TCI states, as described in clause 10.1, the UE determines the spatial setting based on the first TCI state. For a PUCCH transmission over multiple slots, a same spatial setting applies to the PUCCH transmission in each of the multiple slots.<Unchanged part omitted> |

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| **Company** | **Comment** |
| Moderator  | Please provide comments on TP#2-5 |
| NTT DOCOMO | Support. |
| OPPO | Fine with the TP. |
| vivo | Support |
| Lenovo/MotM | Support the TP |
| Apple | We are fine |
| Qualcomm | Support |
| Samsung | In addition to the above TP, similar with issue #2-6, we think that describing either UE capability or corresponding RRC parameter is needed. |
| Spreadtrum | Support |
| ZTE | Support |
| Xiaomi | Support the TP |
| LGE | Support |
| Nokia/NSB | Support |
| Huawei, HiSilicon | Fine with the TP |
| CATT | We are fine with this TP. |
| Moderator | Suggest agreeing on the current version of TP to capture the agreement. Whether UE capability should be also added can be discussed in the next meeting.  |
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#### Round-2

TP#2-5 is proposed for endorsement

### Issue #2-6 (UE capability for default beam for PUCCH)

One company (Spreadtrum [7]) has mentioned that there was agreement to support default beam and PL RS determination for PUCCH and SRS based on the first TCI state of the CORESET, up to UE capability. In RAN1#107b-e meeting, during UE feature discussion, RAN1 has already agreed to introduce UE FG ‘Default UL beam setup for SFN’ to reflect the feature. However, the corresponding agreement was not reflected in the specification.

#### Round-1

**TP#2-6**

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| **TS 38.213**-----------------------------Unchanged part omitted--------------------------- If the UE- is not provided *pathlossReferenceRSs*, and- is not provided *PUCCH-SpatialRelationInfo,* and- is provided *enableDefaultBeamPL-ForPUCCH*, and - is not provided coresetPoolIndex value of 1 for any CORESET, or is provided coresetPoolIndex value of 1 for all CORESETs, in ControlResourceSet and no codepoint of a TCI field, if any, in a DCI format of any search space set maps to two TCI states [5, TS 38.212]  the UE determines a RS resource index $q\_{d}$ providing a periodic RS resource configured with *qcl-Type* set to 'typeD' in the TCI state or the QCL assumption of a CORESET with the lowest index in the active DL BWP of the primary cell. If the CORESET has two activated TCI states, as described in clause 10.1, and the UE reports [Default UL beam setup for SFN], the UE determines the RS resource index $q\_{d}$ based on the first activated TCI state. For a PUCCH transmission over multiple slots, a same $q\_{d}$ applies to the PUCCH transmission in each of the multiple slots.-----------------------------Unchanged part omitted-------------------------------------------------------Unchanged part omitted-------------------------- the UE determines a RS resource index $q\_{d}$ providing a periodic RS resource configured with *qcl-Type* set to 'typeD' in- the TCI state or the QCL assumption of a CORESET with the lowest index in the active DL BWP, if CORESETs are provided in the active DL BWP of serving cell $c$. If the CORESET has two activated TCI states, as described in clause 10.1, and the UE reports [Default UL beam setup for SFN], the UE determines the RS resource index $q\_{d}$ based on the first TCI state.- the active PDSCH TCI state with lowest ID [6, TS 38.214] in the active DL BWP, if CORESETs are not provided in the active DL BWP of serving cell $c$------------------------------------------End of Text Proposal#3 for TS 38.213-------------------------------------- |

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| **Company** | **Comment** |
| Moderator  | Please provide comments on TP#2-6 |
| NTT DOCOMO | Not agree. We don’t need to specify condition of UE capabilities in 38.213.Default spatial relation in Rel.16 is optional UE capability, but the condition of reporting UE capability is not specified in 38.213. It is enough to specify the description of UE capability in TS38.306. |
| OPPO | If we add the UE capability in this way, we may need similar description in many other places in the spec for all default TCI states. |
| Lenovo/MotM | Support |
| Apple | We are fine |
| Qualcomm | Thanks, Spreadtrum for careful review and recommendation! However, we agree with OPPO and DOCOMO that the extra clarification may not be needed. |
| Samsung | We think that describing either UE capability or corresponding RRC parameter is needed. |
| Spreadtrum | @DOCOMO, OPPO,For Rel-16, new RRC parameters such as ‘*enableDefaultBeamPL-ForPUCCH*’ are introduced to enable the default behavior when UE reports capability. But for Rel-17, no new RRC signaling is introduced. So we think whether to enable default behavior can be directly based on UE capability. It can make the spec more clear. Otherwise, it seems the default behavior is not related to UE capability. Actually many similar UE capability description can be found in spec.  |
| ZTE | Not needed due to the similar view with DOCOMO/OPPO. |
| Xiaomi | Not needed |
| LGE | We are fine with the TP. |
| Huawei, HiSilicon | Share similar view with DOCOMO/OPPO, it’s not needed. |
| CATT | Support in principle. And we think if this capability is supported in this way, whether to add a new RRC signaling like ‘*enableDefaultBeamPL-ForPUCCH*’ also need to be discussed for more flexibility. |
| Moderator | There are several companies who expressed concerns on this TP. |
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#### Round-2

void

### Issue #2-7 (FFS on BWP-DownlinkCommon)

Two companies (CMCC [11], Xiaomi [12]) have mentioned that BWP-DownlinkCommon is not actual BWP and should removed from the agreement and specification. At the same time one company (Ericsson [9]) has mentioned that the content of BWP-DownlinkCommon, includes cell specific configurations, and “per BWP” configuration it can only make sense that the BWP is BWP-DownlinkDedicated and it is proposed to remove “FFS:” from the agreement. Considering slight majority for the first option to implement common understanding, the following TP is proposed.

#### Round-1

**TP#2-7**

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| **TS 38.214**----------------- Start of TP ----------------5.1 UE procedure for receiving the physical downlink shared channel**<**Unchanged text is omitted>When a UE is configured with *sfnSchemePdsch* and/or *sfnSchemePdcch* for a DL BWP, the UE shall expect that the *sfnSchemePdsch* and/or *sfnSchemePdcch* configuration are the same in the other DL BWP other than initial BWP ~~[and BWP-DownlinkCommon]~~. **<**Unchanged text is omitted>----------------- End of TP ---------------- |

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| **Company** | **Comment** |
| Moderator  | Please provide comments on TP#2-7 |
| NTT DOCOMO | OK. |
| OPPO | Agree with the TP. |
| vivo | Support |
| Lenovo/MotM | Support |
| Apple | We are fine |
| Qualcomm | Support |
| Ericsson | Support. We need to inform RAN2 about this clarification in the RRC parameter update to RAN2. This would address the open issue nr1 in RAN2 FeMIMO open issue R2-2202001.**Open issue 1:** There is FFS for sfnSchemePdsch in PDSCH-Config to be applicable for BWP-DownlinkCommon.  |
| Samsung | Support. |
| Spreadtrum | Support |
| Xiaomi | Support  |
| LGE | Support  |
| Nokia/NSB | Support |
| Huawei, HiSilicon | Support |
| CATT | Support |
| Moderator | No concerns on TP#2-7 |
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#### Round-2

TP#2-7 is proposed for endorsement

# References

[1] R1-2200933, Remaining issues on HST multi-TRP deployment in Rel-17, Huawei, HiSilicon

[2] R1-2201082, Maintenance on HST-SFN schemes, vivo

[3] R1-2201189, Remaining issues on multi-TRP HST enhancements, ZTE

[4] R1-2201227, Enhancements on HST-SFN deployment, OPPO

[5] R1-2201332, Discussion on remaining issues on Rel-17 HST-SFN, CATT

[6] R1-2201467, Remaining issues on HST-SFN deployment, NTT DOCOMO, INC.

[7] R1-2201538, Discussion on enhancements on HST-SFN deployment, Spreadtrum Communications

[8] R1-2201571, Enhancements on HST-SFN deployment, LG Electronics

[9] R1-2201618, Finalizing Multi-TRP HST-SFN enhancements, Ericsson

[10] R1-2201686, Maintenance of HST-SFN enhancements, Intel Corporation

[11] R1-2201848, Remaining issues of enhancements on HST-SFN deployment, CMCC

[12] R1-2201945, Remaining issues on HST-SFN deployment enhancement, Xiaomi

[13] R1-2202000, Maintenance on Rel-17 HST-SFN, Samsung

[14] R1-2202088, Enhancements for HST-SFN deployment, Lenovo

[15] R1-2202126, Enhancements on HST-SFN deployment, Qualcomm Incorporated

[16] R1-2202494 (R1-2202320), Maintenance of enhancements for HST-SFN deployment, Nokia, Nokia Shanghai Bell

# Appendix (Summary of the agreements)

The agreements made in RAN1#102e, RAN1#103e and RAN1#104e, RAN1#105e meetings are provided below.

## **RAN1#102-e meeting**

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| **Agreement**For the discussion purpose consider the following categorization of the enhanced DL transmission schemes* **Scheme 1**:
	+ TRS is transmitted in TRP-specific / non-SFN manner
	+ DM-RS and PDCCH/PDSCH from TRPs are transmitted in SFN manner
* **Scheme 2**:
	+ TRS and DM-RS are transmitted in TRP-specific / non-SFN manner
	+ PDSCH from TRPs is transmitted in SFN manner

**Agreement**Study the following aspects of the enhanced transmission schemes:* **For scheme 1**:
	+ Target DL physical channels, i.e., PDSCH only or PDSCH + PDCCH
	+ Whether more than 2 QCL/TCI states are required and corresponding signaling details
	+ Whether and how to indicate scheme 1 for differentiation with Rel-16 non-SFNed transmission schemes with multiple QCL/TCI states
	+ QCL relationship between TRS and DMRS ports
	+ Note: Other schemes/aspects are not precluded
* **For scheme 2**:
	+ Association of each MIMO layer of PDSCH to DM-RS antenna ports
	+ Whether more than 2 QCL/TCI states are required and corresponding signaling details
	+ Whether and how to indicate scheme 2 for differentiation with Rel-16 non-SFNed transmission schemes with multiple QCL/TCI states

Note: Other schemes/aspects are not precluded |

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| **Agreement**Study TRP-based frequency offset pre-compensation including the following aspects:* Aspects related to indication of the carrier frequency determined based on the received TRS resource(s) in the 1st step
	+ **Option 1**: Implicit indication of the Doppler shift(s) using uplink signal(s) transmitted on the carrier frequency acquired in the 1st step
		- Indication for QCL-like association of the resource(s) received in the 1st step with UL signal transmitted in the 2nd step
		- Type of the uplink reference signals / physical channel used in the 2nd step, necessity of new configuration and corresponding signaling details
	+ **Option 2**: Explicit reporting of the Doppler shift(s) acquired in the 1st step using CSI framework
		- FFS: Indication for QCL-like association of the resource(s) received in the 1st step with UL signal transmitted in the 2nd step
		- CSI reporting aspects, configuration, quantization, signalling details, etc.
* New QCL types/assumption for TRS with other RS (e.g., SS/PBCH), when TRS resource(s) is used as target RS in TCI state
* New QCL types/assumptions for TRS with other RS (e.g., DM-RS), when TRS resource(s) is used as source RS in the TCI state
* Target physical channels (e.g., PDSCH only or PDSCH/PDCCH) and reference signals that should be supported for pre-compensation
* Signalling/procedural details on whether/how the pre-compensation is applied to target channels
* Whether multiple sets of TRS and pre-compensation on TRS is needed in 3rd step.

Note: Other aspects/schemes are not precluded |

## **RAN1#103-e meeting**

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| **Agreement**Support at least the following configuration for HST scenario in Rel-17* The same DMRS port(s) can associate with multiple TCI states
	+ FFS other details

Note: DMRS and PDCCH/PDSCH from different TRPs are transmitted in SFN manner**Agreement**At most two TCI states are supported for HST scenario in Rel-17* FFS: Whether to support more than two TCI states for FR2
* FFS configuration/signalling details of the TCI states

Note: DMRS and PDCCH/PDSCH from different TRPs are transmitted in SFN manner**Agreement**When the same DMRS port(s) are associated with two TCI states containing TRS as source reference signal, at least one variant is supported for Rel-17 HST-SFN scenario based on further evaluations* **Variant A**: One of the TCI state can be associated with {*average delay*, *delay spread*} and another TCI states can be associated with {*average delay, delay spread, Doppler shift, Doppler spread*} (i.e., QCL-TypeA)
* **Variant B**: One of the TCI state can be associated with {*average delay, delay spread*} and another TCI state with {*Doppler shift, Doppler spread*} (i.e., QCL-TypeB)
* **Variant C**: One of the TCI state can be associated with {*delay spread*}  and another TCI states can be associated with {*average delay, delay spread, Doppler shift, Doppler spread*} (i.e., QCL-TypeA)
* **Variant E**: Both TCI states can be associated with {*average delay, delay spread, Doppler shift, Doppler spread*} (i.e., QCL-TypeA)
* FFS: Indication method to apply QCL, e.g., via new QCL-type, or reuse existing QCL-type while UE to ignore certain QCL properties
* Note: Each TCI state in the above variants may be additionally associated with {Spatial Rx parameter} (i.e., QCL-TypeD)
* Note: Companies are encouraged to provide evaluation results for the above variants based on agreed EVM from RAN1#102e meeting
* Note: Above variants are applicable to scheme 1 and/or TRP based pre-compensation as a reference for evaluation.
* This agreement is for the purpose of evaluation and does not imply the support or lack of support of scheme 1 and/or TRP based pre-compensation
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| **Agreement**For PDCCH reliability enhancements, support SFN scheme + Alt 1-1.* FFS: TCI state activation for CORESET, impact on default beam, BFD resource for BFR

Where the Alt 1-1 is agreed as:Alt 1-1: One PDCCH candidate (in a given SS set) is associated with both TCI states of the CORESET. |

## **RAN1#104-e meeting**

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| **Agreement**Scheme 1 is supported in Rel-17 * TRS is transmitted in TRP-specific / non-SFN manner
* DM-RS and PDCCH/PDSCH from TRPs are transmitted in SFN manner
* FFS other details

 **Agreement**For scheme 1 and SFN transmission of PDCCH support Variant E for QCL assumption in TCI state when TRS is used as source RS **Agreement**Two TCI states are supported for scheme 1 in FR2**Agreement*** Support MAC CE activation of two TCI states for PDCCH
* FFS other details

**Conclusion**The decision on support of specification based TRP pre-compensation scheme for HST-SFN scenario to be made in RAN1#104-e-bis meeting. To facilitate RAN1 decision, companies are encouraged to provide evaluation results according to the agreed evaluation assumptions. The evaluations not compliant with agreed assumptions will not be considered by RAN1 in the decision process.**Agreement**For HST-SFN scenario:* Support semi-static (RRC based) switching of scheme 1 (PDSCH) with 2a, 2b, 3, 4
* FFS all other details including RRC signaling, possible RAN4 impact (if any), etc.
 |

## **RAN1#104b-e meeting**

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| **Agreement**Introduce enhanced MAC CE signaling for PDCCH activating two TCI states for SFN-based PDCCH transmission* The corresponding MAC CE includes at least the following fields
	+ Serving cell ID
	+ CORESET ID
	+ Two TCI state IDs
* FFS whether for CA scenario additionally support RRC configured set of the serving cells which can be addressed by a single MAC CE
* FFS whether or not enhanced MAC CE signaling is applicable to a CORESET configured with CORESETPoolindex

Send LS to RAN2 to inform about agreement on support of enhanced MAC CE for CORESET in Rel-17. LS is endorsed in R1-2104064**Agreement**Specification-based TRP Doppler pre-compensation scheme is supported in Rel-17 for FR1 with one or both:* UL RS based Doppler estimation by gNB
	+ FFS: Details including UL RS enhancement
* DL RS based Doppler feedback by UE
	+ FFS: Details
	+ FFS: Whether UE capability needs to be introduced
* Whether to support one or both will be decided later

**Agreement*** Support dynamic (DCI-based) switching of scheme 1 (PDSCH) with single-TRP scheme by TCI state field in DCI format 1\_1/1\_2
	+ This feature is UE optional
* FFS all other details including RRC signalling, possible RAN4 impact (if any), etc.

**Working Assumption**All QCL source RS resource types as defined in TCI state for Rel-16 multi-TRP are supported for scheme 1**Agreement**Support semi-static (RRC-based) switching of scheme 1 (PDSCH) with Rel-16 scheme 1a* FFS: Whether dynamic switching is additionally supported

**For future meeting:**Companies to consider Proposal #3-8a in FL summary (R1-2104020) for future meetings.Companies to consider Proposal #3-10 in FL summary (R1-2104020) for future meetings.**Agreement**Scheme 1 for PDSCH is identified by* New RRC parameter and the number of TCI states indicated by DCI
	+ FFS RRC configuration details, e.g., per BWP or per CC
	+ FFS whether or not restriction to a single CDM group for DM-RS is also supported
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## **RAN1#105-e meeting**

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| **Agreement**Confirm the following working assumption from RAN1#104b-e:All QCL source RS resource types as defined in TCI state for Rel-16 multi-TRP are supported for scheme 1.**Agreement**UE is not expected to be indicated by MAC CE with single TCI state per any of TCI codepoint , if UE is configured with scheme 1 PDSCH by RRC , but not capable to support dynamic switching between scheme 1 and single-TRP by TCI state field in DCI Format 1\_1/1\_2**Agreement**For specification based TRP-based frequency offset pre-compensation scheme* Support dynamic (DCI -based) switching with single-TRP scheme by TCI state field in DCI format 1\_1/1\_2
	+ This feature is UE optional
	+ UE is not expected to be indicated by MAC CE with single TCI state per any of TCI codepoint , if UE is configured with TRP-based frequency PDSCH by RRC , but not capable to support dynamic switching between TRP-based frequency and single-TRP by TCI state field in DCI Format 1\_1/1\_2
* Support semi-static (RRC based) switching with Rel-16 schemes 1a, 2a, 2b, 3, 4
* Support semi-static (RRC based) switching with Rel-17 scheme 1 (PDSCH)

**Agreement**Enhanced MAC CE signaling is not applicable to any of the configured CORESETs in a BWP if the CORESETs are configured with different *CORESETPoolindex* values in the BWP.**Working Assumption**For TRP-based pre-compensation, Variant A (based on RAN1#103-e meeting agreement) are supported as QCL types/assumption, when the same DMRS port(s) are associated with two TCI states.* FFS: Additional support of Variant B

**Agreement*** For TRP-based pre-compensation QCL assumptions is provided to the UE by using the existing QCL type(s) with certain QCL parameters dropped from the indicted QCL type
	+ FFS rule or signalling to determine which TCI state with dropped QCL parameters
* UE does not expect to be configured different SFN schemes (scheme 1 or TRP pre-compensation) for both PDCCH and PDSCH.
	+ FFS whether this restriction is per UE or per CC
* UE does not expect to be configured different SFN schemes (scheme 1 or TRP pre-compensation) for different CORESETs.
	+ FFS whether this restriction is per UE or per CC

**Agreement**Enhanced SFN PDCCH transmission scheme (scheme 1 or TRP-based pre-compensation) is identified by the number of TCI states activated per CORESET and RRC parameter* FFS: Configuration detail of RRC parameter
	+ Including whether the same RRC parameter is used for PDCCH and PDSCH

**Agreement**If enhanced SFN PDCCH transmission scheme (scheme 1 or TRP -based pre-compensation) is configured and a CORESET is activated with two TCI states and UE is configured with enableTwoDefaultTCI-States and time offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold timeDurationForQCL, down-select rule to determine default beam(s) for Rel-17 SFN PDSCH reception in RAN1#106-e:* **Alt 1**: Reuse rule to determine TCI states as defined for Rel-16 PDSCH scheme-1a
* **Alt 2**: Introduce new rules to determine TCI states based on two TCI state(s) of the CORESET

**Agreement**If enhanced SFN PDCCH transmission scheme (scheme 1 or TRP-based pre-compensation) is configured and two TCI states are activated for at least one CORESET, support the following configuration of RS for BFD* Down-select one alternative for implicit configuration
	+ **Alt 1-2**: RS of CORESETs with both single and two TCI states are used
	+ **Alt 1-3**: RS of CORESETs with only two TCI states are used
* Down-select one alternative for explicit configuration
	+ **Alt 2-1**: Support defining CSI-RS resource or SSB pairs as BFD RS
		- FFS other details
	+ **Alt 2-2**: Reuse the existing Rel-15/Rel-16 approach for BFD RS configuration
* Note: down-selection can be done separately for Rel-15/16 cell specific BFR and Rel-17 TRP-specific BFR, Rel-17 TRP-specific BFR to be discussed under AI 8.1.2.3
 |

## **RAN1#106e meeting**

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| **Agreement**Support the following combination of the transmission schemes* Single-TRP PDCCH + Rel-17 Scheme 1 PDSCH
* Single-TRP PDCCH + Rel-17 TRP-based pre-compensation PDSCH
* FFS: Other combinations of the transmission scheme

Note: The PDSCH corresponds to the PDSCH scheduled by DCI formats 1\_1 and 1\_2.**Agreement**For Rel-17 TRP-based pre-compensation scheme, indication of carrier frequency for uplink transmission (Doppler frequency reporting) in TRP-based pre-compensation scheme is supported using * **Option 1** Implicit from RAN1#102-e agreement
	+ FFS enhancements to SRS (e.g multiple SRS resource in a set) to improve the accuracy of frequency estimation

For Option1, some companies raised concerns that there is no consensus on the benefit and the applicability of this scheme in FDD.For Option1, some companies raised concerns that there is no benefit in low SNR scenarios.**Agreement**For TRP -based pre-compensation* Alt-1: QCL parameters are dropped from the second TCI state of the indicated TCI codepoint containing two TCI states

**Conclusion**For Variant A and B (if supported)* For frequency offset pre-compensation QCL -like association of the resource(s) received in the 1st step with UL signal transmitted in the 2nd step is supported by implementation without specification impact

**Agreement**Confirm working assumption from RAN1#105e meeting without modification:For TRP -based pre-compensation, Variant A (based on RAN1#103-e meeting agreement) is supported as QCL types/assumption, when the same DMRS port(s) are associated with two TCI states.* FFS: Support of Variant B

**Agreement**In CA scenario support RRC configured set of the serving cells which can be addressed by a single MAC CE for activation of two TCI states of CORESET with the same CORESET ID for all the BWPs in the indicated CCs set* FFS: Whether to reuse Rel-16 RRC parameters or introduce new RRC parameters.
* FFS: UE capability
* FFS: Whether/How to update the CORESET that is not configured to SFN scheme in the indicated CCs set

**Agreement**If enableTwoDefaultTCI-States is configured and at least one TCI codepoint indicates two TCI states and time offset between the reception of the DL DCI and the PDSCH is less than the threshold timeDurationForQCL, default beam(s) for Rel-17 enhanced SFN PDSCH (scheme 1 or if supported TRP-based pre-compensation) reception:* **Alt 1**: Reuse rule to determine TCI states as defined for Rel-16 PDSCH scheme-1a

This is a UE optional feature**Agreement**For PDSCH reception scheduled by DCI format 1\_0, [1\_1 and 1\_2], if the time offset between the reception of the DL DCI and the corresponding PDSCH is equal or larger than the threshold *timeDurationForQCL* * Support configuration when there is no TCI field in the DCI scheduling PDSCH
	+ UE applies the state(s) of the scheduling CORESET when receiving the PDSCH
		- if there are two active TCI states for the CORESET, UE applies the both QCL assumption of the CORESET that schedules the PDSCH when receiving the PDSCH
		- otherwise, UE applies the one active TCI state of the CORESET when receiving the PDSCH
* FFS if the time offset between the reception of the DL DCI and the corresponding PDSCH is smaller than the threshold *timeDurationForQCL*

This is a UE optional feature.**Agreement**If enhanced SFN PDCCH transmission scheme (scheme 1 or if TRP-based pre-compensation is supported in FR2) is configured and CORESET is indicated with two TCI states, and scheduling offset for AP CSI-RS is less than the threshold and *enableTwoDefaultTCIStates* is not configured* If there is no other DL signal on the same symbol, use one of two TCI states as default beam for aperiodic CSI-RS reception, i.e.
	+ using one TCI state of the CORESET with the lowest CORESET ID in the latest slot as default beam for aperiodic CSI-RS reception. If there are two activated TCI states for the CORESET with the lowest CORESET ID, one of two TCI states will be selected, i.e. always selects the first TCI state if the CORESET has two TCI states
* If there is other DL signal on the same symbol, reuse Rel-15/16 mechanism

**Agreement**If enhanced SFN PDCCH transmission scheme (scheme 1 or TRP-based pre-compensation) is configured and two TCI states are activated for at least one CORESET, support the following configuration of RS for BFD* For implicit configuration
	+ **Alt 1-2**: RS of CORESETs with both single and two TCI states are used

FFS: The maximum number of BFD RS and details on RS determination**R1-2108548** Summary#3 of AI: 8.1.2.4 Enhancements on HST-SFN deployment Moderator (Intel Corporation)**Agreement**If enhanced SFN PDCCH transmission scheme (scheme 1 or if TRP-based pre-compensation is supported in FR2) is configured, and if the CORESET with the lowest ID in the active DL BWP is indicated with two TCI states * If PL-RS and spatial relation information are not configured for PUCCH and enableDefaultBeamPL-ForPUCCH is configuredin FR2
	+ For single-TRP PUCCH transmission, select the first TCI state of the CORESET as default beam and PL RS
* If PUSCH scheduled by DCI format 0\_0 and *enableDefaultBeamPL-ForPUSCH0-0* is configured in FR2, and if PUCCH resource is not configured on active UL BWP in the cell or if spatial relation is not configured in any PUCCH resource on active UL BWP in the cell,
	+ For single-TRP PUSCH transmission scheduled by DCI format 0\_0, select the first TCI state of the CORESET as default beam and PL RS
* If PL-RS and spatial relation information are not configured for SRS and *enableDefaultBeamPL-ForSRS* is configured in FR2
	+ For single-TRP SRS resource, select the first TCI state of the CORESET as default beam and PL RS
* FFS other details, if any
* These are UE optional features

**Agreement**When a CORESET is activated with two TCI states which overlaps with another CORESET, support extension of Rel-15 prioritization rule for PDCCH monitoring of PDCCH candidates in overlapping monitoring occasions with different QCL-TypeD* FFS: Prioritization rule considers CORESETs indicated with 1 and/or 2 TCI states
* Supports identifying two QCL-TypeD properties for multiple overlapping CORESETs
	+ UE capability is introduced
* FFS other details
* FFS: Strive to have same / similar solution as discussed under AI 8.1.2.1

**Conclusion**No RAN1 specification impact on how to calculate hypothetical BLER for BFD |

## **RAN1#106b-e meeting**

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| **Working Assumption**Reuse legacy Rel-16 RRC parameters *simultaneousTCI-UpdateList1, simultaneousTCI-UpdateList2* to define set of the serving cells which can be addressed by a single MAC CE for activation of two TCI states of CORESET with the same CORESET ID for all the BWPs.**Agreement**If CSI-RS other than those configured with repetition set to 'on' is overlapping in the time domain with CORESET with two TCI states, support the first TCI state of the CORESET as the default TCI assumption for the CSI-RS.**Agreement**Support combination of Rel-17 SFN PDCCH scheme 1 and single-TRP PDSCH * This is optional UE feature
* Note: The support of such combination scheme is for URLLC use-case only.

**Agreement**Enhanced SFN (scheme 1 or TRP-based pre-compensation scheme) for PDCCH and PDSCH is configured by using separate per-BWP RRC parameters* In Rel-17, all downlink BWPs (except initial BWP and FFS: BWP-DownlinkCommon) within a CC should be the same configuration of SFN scheme

**Agreement**When SFN PDSCH is not configured by RRC, for PDSCH reception scheduled by DCI format 1\_0, 1\_1, 1\_2, if the time offset between the reception of the DL DCI and the corresponding PDSCH is smaller than the threshold *timeDurationForQCL,** For DCI format 1\_1/1\_2, support both configurations with and without TCI state field.
* [If *enableTwoDefaultTCIStates* is not configured,] for both cases with and without TCI state field,
	+ If enhanced SFN PDCCH transmission scheme 1 is configured and the lowest CORESET ID in the latest slot is indicated with two TCI states, select the 1st TCI state of the two TCI states of the CORESET as default beam for the PDSCH reception
		- FFS: Whether above applies for TRP-based pre-compensation if TRP-based pre-compensation is agreed to be support in FR2
	+ Otherwise, UE applies the one active TCI state of the CORESET with the lowest *controlResourceSetId* in the latest slot when receiving the PDSCH

**Agreement**For CSS associated with SFN CORESET, study the following alternatives and down-select in RAN1#107e:* Alt 2: UE doesn’t expect PDCCH candidates in CSS to be associated with CORESET activated with two TCI states, except for CSS type 3 associated with CORESET configured with scheme 1
* Alt 3: If PDCCH candidates in CSS 0/0A/1/2/3 are associated with CORESET that activated with two TCI states, the first TCI state is applied for the CSS reception, except for CSS type 3 associated with CORESET configured with scheme 1.
	+ For CSS type 3 associated with CORESET configured with scheme 1,  both TCI states can be applied for the CSS reception.

 **Agreement**When CORESET is indicated with two TCI states* One BFD RS pair for SFN CORESET is counted as two BFD RSs
* FFS: Increase the maximum number of monitored BFD RSs to X.
	+ X is UE capability
	+ X = 2, 3, 4, FFS other values of X

**Agreement**When two TCI states are activated for a CORESET, NBI RS can be configured as follows* **Alt 4-1**: Using the existing Rel-15 NBI configuration based on single SSB / CSI-RS resource
* **FFS addition support of** **Alt 4-2**: two new beam identification CSI-RS resource sets / new beam identification CSI-RS resource pairs or SSB pairs
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## **RAN1#107-e meeting**

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| **Agreement**Confirm the working assumption from RAN1 #106b-e meeting to reuse legacy Rel-16 RRC parameters *simultaneousTCI-UpdateList1*, *simultaneousTCI-UpdateList2* to define set of the serving cells which can be addressed by a single MAC CE for activation of two TCI states of CORESET with the same CORESET ID for all the BWPs.**Agreement**For intra-band CA, UE doesn’t expect configurations of different SFN schemes in different CCs**Agreement**TRP-based pre-compensation scheme for PDSCH / PDCCH is supported in both FR1 and FR2 with UE capability at least per FR* Note: While majority of the companies support above, only one company has shown benefit on TRP-based pre-compensation scheme for PDSCH in FR2 with 200m ISD. Evaluation methodology and results can be found in R1-2101450.

**Agreement**When a CORESET is activated with two TCI states which overlaps with another CORESET, support PDCCH monitoring of PDCCH candidates in overlapping monitoring occasions with QCL-TypeD properties identified according to prioritization rule* Reuse Rel-15 prioritization to identify the first CORESET, i.e., SS type > serving cell index > SS set ID
	+ If the CORESET has two TCI states with QCL-typeD, both QCL-typeD are identified**.**
	+ If the CORESET has one TCI state with QCL-typeD, the second QCL-typeD is not identified

**Agreement**When SFN PDSCH is not configured by RRC and there is no TCI codepoint which indicates two TCI states activated for the PDSCH (i.e. Rel-16 MTRP PDSCH is not configured) and SFN transmission scheme 1 is configured for PDCCH, for PDSCH reception scheduled by DCI format 1\_0, 1\_1, 1\_2 without TCI field, if the time offset between the reception of the DL DCI and the corresponding PDSCH is equal or larger than the threshold t*imeDurationForQCL* if applicable and the CORESET which schedules the PDSCH is indicated with two TCI states, the default TCI state is defined as the first TCI state of the CORESET**Agreement**The agreement from RAN1#106b-e meeting is updated as followsWhen SFN PDSCH is not configured by RRC and there is no TCI codepoint which indicates two TCI states activated for the PDSCH (i.e. Rel-16 MTRP PDSCH is not configured), for PDSCH reception scheduled by DCI format 1\_0, 1\_1, 1\_2, if the time offset between the reception of the DL DCI and the corresponding PDSCH is smaller than the threshold *timeDurationForQCL,** For DCI format 1\_1/1\_2, support both configurations with and without TCI state field.
* ~~[If~~*~~enableTwoDefaultTCIStates~~*~~is not configured,]~~ for both cases with and without TCI state field,
	+ If enhanced SFN PDCCH transmission scheme 1 is configured and the lowest CORESET ID in the latest slot is indicated with two TCI states, select the 1st TCI state of the two TCI states of the CORESET as default beam for the PDSCH reception
		- ~~FFS : Whether above applies for TRP -based pre-compensation if TRP -based pre-compensation is agreed to be support in FR2~~
	+ Otherwise, UE applies the one active TCI state of the CORESET  with the lowest *controlResourceSetId*in the latest slot when receiving the PDSCH
* It is up to editor how to capture the above agreement

**Agreement**If PDCCH candidates in CSS 3 are associated with CORESET that is activated with two TCI states and configured with enhanced SFN scheme 1 or TRP based pre-compensation, both TCI states can be applied for the CSS reception. * FFS: Whether/How specification change is needed is up to the editor

**Agreement**For a CORESET with two activated TCI states, for implicit BFD RS, how to calculate radio link quality for RLM /BFD is up to RAN4 discussion* Send LS to let RAN4 to let them know about two possible options of radio link quality estimation for RLM /BFD using each RS or RS pair of CORESET activated with two TCI states. RAN1 has discussed both options, but was not able to reach a consensus. Inform that it is up to RAN4 to specify the most appropriate option. LS is endorsed in R1-2112829.

**Agreement**When SFN PDSCH and SFN PDCCH are configured by RRC , for PDSCH reception scheduled by DCI formats 1\_1 and 1\_2, and, if applicable the time offset between the reception of the DL DCI and the corresponding PDSCH is equal or larger than the threshold *timeDurationForQCL* * Support configuration when there is no TCI field in the DCI scheduling PDSCH
	+ UE applies the TCI state(s) of the scheduling CORESET when receiving the PDSCH
		- If there are two active TCI states for the CORESET , UE applies both QCL assumptions of the CORESET that schedules the PDSCH when receiving the PDSCH
		- otherwise, if there is one active TCI state for the CORESET , UE applies the one active TCI state of the CORESET when receiving the PDSCH

This feature is UE optional capability* If UE doesn’t support this capability, UE is expected to be configured with TCI state field
* UEs supporting this feature and are not capable of dynamic switching between single TRP and SFN , the CORESET that schedules PDSCH by DCI formats 1\_1 and 1\_2 (FFS DCI format 1\_0) should be activated with two TCI states.

FFS for maintenance: if SFN PDCCH is not configured |