**3GPP TSG RAN WG1 #104b-e R1-2103892**

**e-Meeting, April 12th – 20th, 2021**

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator summary#3 for multi-beam enhancement: Round 2

**Document for:** Discussion and Decision

## Summary of companies’ inputs

### Issue 1 (Rel.17 unified TCI framework for intra-cell beam management)

Table 1 Summary: issue 1

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| **#** | **Issue** | **Companies’ views** |
| 1.3 | Switching between joint and separate DL/UL TCI* Alt1. A UE can be dynamically indicated with either joint DL/UL TCI or separate DL/UL TCI
* Alt2A. A UE can be configured with either joint DL/UL TCI or separate DL/UL TCI via RRC signaling
* Alt2B. A UE can be configured with either joint DL/UL TCI, separate DL/UL TCI, or both via RRC signaling
* Alt3. A UE can be configured with either joint DL/UL TCI or separate DL/UL TCI via MAC CE signaling
 | **Alt1 (17)**: Lenovo/MoM, Nokia/NSB, Spreadtrum, CATT, APT/FGI, Xiaomi, Sony, AT&T, Apple, MTK, ZTE, Futurewei, Convida, Intel**Alt2A (6)**: Ericsson, NTT Docomo, LGE, NEC, Huawei, HiSi**Alt2B (2)**: vivo, ZTE**Alt3 (11)**: CMCC, Samsung, NTT Docomo, Huawei, HiSi, CATT, Xiaomi, Intel, Qualcomm, NEC, Convida. |
| 1.6 | Setting of UL PC parameters except for PL-RS (P0, alpha, closed loop index): In addition to association with UL channel/RS,* Alt1. The setting of (P0, alpha, closed loop index) is also associated with UL or (if applicable) joint TCI state
* Alt2. The setting of (P0, alpha, closed loop index) is included with UL or (if applicable) joint TCI state
* Alt3. The setting of (P0, alpha, closed loop index) is neither associated with nor included in UL or (if applicable) joint TCI state
* Alt4. The setting of (P0, alpha, closed loop index) is determined as in Rel-16 without enhancement
 | **Alt1 (11)**: Lenovo, CMCC (PUCCH), Nokia/NSB, NTT Docomo, Spreadtrum, CATT, ZTE, OPPO (PUSCH, PUCCH), Qualcomm, Futurewei**Alt2 (6)**: IDC, Samsung, Intel (at least PUCCH), Apple, Qualcomm, LGE**Alt3 (5)**: Fraunhofer IIS/HHI, CMCC (PUSCH – SRI, SRS – SRSResourceSet), Ericsson (for P0 and alpha), Sony, **Alt4 (5)**: vivo, OPPO (SRS), MTK, Huawei, HiSi |
| 1.7 | Path-loss measurement (PL RS):* Alt1. PL-RS can be included in UL TCI state or (if applicable) joint TCI state.
	+ FFS: Whether it is always included or not. If not included, PL-RS is the periodic DL-RS used as a source RS for determining spatial TX filter or the PL RS used for the UL RS in UL or (if applicable) joint TCI state.
* Alt2. PL-RS can be associated with (but not included in) UL TCI state or (if applicable) joint TCI state
	+ FFS: Exact association mechanism
	+ FFS: Whether it is always associated or not. If not associated, PL-RS is the periodic DL-RS used as a source RS for determining spatial TX filter or the PL RS used for the UL RS in UL or (if applicable) joint TCI state
* Alt3. The periodic DL-RS used as a source RS for determining spatial TX filter can be used as PL-RS. In case the periodic DL-RS used as a source RS for determining spatial TX filter is not used as PL-RS, reuse Rel.16 procedure with the same signaling structure (MAC CE+SRI field in UL-related DCI) to indicate PL-RS for UL transmission with minimum enhancement (e.g. pertaining to the use for PUCCH, or using default PL-RS)
	+ PL-RS is not additionally configured in or associated to UL TCI state or (if applicable) joint TCI state
* Alt4. UE calculates path-loss based on periodic DL RS configured as the source RS or a periodic QCL-Type-D/spatialRelationInfo source of the source RS in UL TCI state or (if applicable) joint TCI state
	+ FFS: Whether UE can calculate path-loss based on DL periodic RS for path-loss calculation for UL RS in the UL TCI
 | **Alt1 (10)**: IDC, Fraunhofer IIS/HHI, Ericsson (if UL RS in TCI state), NTT Docomo, OPPO, Intel (at least PUCCH), Qualcomm, AT&T, LGE**Alt2 (14)**: Lenovo/MoM, CMCC, NTT Docomo, Huawei, HiSi, Spreadtrum, CATT, ZTE, MTK, Futurewei, Sony, Nokia/NSB**Alt3 (1)**: vivo**Alt4 (3)**: Ericsson (if DL RS in TCI state), Samsung, Apple,  |

**From round 1:**

**Table 2**

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| **Proposal 1.2**: On Rel.17 unified TCI framework, in RAN1#105-e, further discuss to down-select or combine from the following two alternatives for switching between joint and separate DL/UL TCI (note: the text below is based on the agreed description in RAN1#104-e): * Alt1. A UE can be dynamically indicated with either joint DL/UL TCI or separate DL/UL TCI among the activated TCI states
	+ Details on dynamic indication are FFS
* Alt3. A UE can be configured with either joint DL/UL TCI or separate DL/UL TCI via MAC CE signaling
	+ Details on how this is signaled in relation to TCI activation are FFS

FFS: The support for joint DL/UL TCI and/or separate DL/UL TCI in terms of UE capability FFS: Functionality/mode corresponding to either joint DL/UL TCI, separate DL/UL TCI, or dynamically switching between joint and separate is enabled by RRC**(New) Proposal 1.4**: On the setting of UL PC parameters except for PL-RS (P0, alpha, closed loop index) for Rel.17 unified TCI framework, for each of PUSCH, PUCCH, and SRS, in RAN1#105-e, strive to down-select or combine from the following alternatives:* Alt1. The setting of (P0, alpha, closed loop index) is also associated with UL or (if applicable) joint TCI state
* Alt2. The setting of (P0, alpha, closed loop index) is included with UL or (if applicable) joint TCI state
* Alt4. The setting of (P0, alpha, closed loop index) is determined as in Rel-16 without enhancementNote: It has been agreed that the setting of (P0, alpha, closed loop index) is associated with UL channel or UL RS (therefore the setting is channel- and signal-specific)

In RAN1#105-e, for each of the PUSCH, PUCCH, and SRS, if no consensus can be reached among the above 3 alternatives, the setting of (P0, alpha, closed loop index) will neither be associated with nor included in UL or (if applicable) joint TCI state.**Proposal 1.5**: On Rel.17 unified TCI framework, in RAN1#105-e, further discuss to down select or combine from the following two alternatives for PL-RS (note: the text below is based on the agreed description in RAN1#104-e): * Alt1. PL-RS can be included in UL TCI state or (if applicable) joint TCI state.
* Alt2. PL-RS can be associated with (but not included in) UL TCI state or (if applicable) joint TCI state
	+ FFS: Exact association mechanism
* Depending on the final outcome, FFS on exact association mechanism and whether to support a unified mechanism for the setting of (P0, alpha, closed loop index) and PL-RS, if PL-RS can be associated with (but not included in) UL TCI state or (if applicable) joint TCI state

The support of the above PL-RS (the outcome of the above down selection or combining) is a UE optional feature.* If not supported, or if a UE is configured with neither PL-RS in UL/joint TCI state nor the association between PL-RS and UL/joint TCI state, the UE estimates path-loss based on the periodic DL-RS provided as a source RS for determining spatial TX filter [or the PL-RS used for the UL RS provided as a source RS for determining spatial TX filter] in UL or (if applicable) joint TCI state
	+ [FFS: How to select between the periodic DL-RS and the PL-RS used for the UL RS]
* FFS: maximum number of active PL-RS per band

The above behavior is optionally supported by the UE for Rel-17 unified TCI framework. |

**Table 3**

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| **Current state of proposal 1.4 and rationale for the new proposal 1.4:**At least the following companies repeatedly stated that they cannot accept FL proposal 1.4 in round 0/1 (based on Alt1, i.e. the majority view): Ericsson (Alt3 for all), IDC (Alt2 for all), Intel (Alt2 for all), OPPO (SRS), Samsung (Alt2 for all), vivo (PUSCH, SRS).It has been agreed in RAN1#104-e that “(t)he setting of (P0, alpha, closed loop index) is at least associated with UL channel or UL RS”. This is equivalent to saying that the setting is channel- and signal-specific (PUSCH, PUCCH, and SRS have separate settings).The problem raised in down-selecting among Alt1, 2, 3, and 4 (to be finalized in RAN1#104b-e) can be reformulated as follows: In addition to the agreement that the setting of (P0, alpha, closed loop index) is associated with UL channel or UL RS (specific for each of PUSCH, PUCCH, and SRS), is association between such setting and UL TCI state needed? * Note that Alt1, Alt2, and (to some extent) Alt4 propose some form of association between the said setting and UL TCI state (“UL beam”). Inclusion (Alt2/4) is a special case (perhaps the strongest form) of association. Alt3, on the other hand, states that the agreement is already sufficient, i.e. there is no need for associating the setting with UL TCI state.
* Therefore, if no consensus can be reached among Alt1/2/4, Alt3 is automatically the outcome since no association scheme between the UL PC parameter setting and UL TCI state can be agreed.

From Table 1 and the discussion thus far, although the majority of companies prefer to add some form of association between the setting and the UL TCI state (Alt1+2+4 proponents), consensus cannot be reached despite the majority view of Alt1. Therefore, to respect the majority (one more chance) while trying to ensure timely (despite already missing an established deadline) completion of Issue 1, a new FL proposal 1.4 was made (see above). The proponents of Alt1/2/4 are encouraged to discuss offline and strive for consensus by RAN1#105-e. If such an attempt fails, Alt3 will be the outcome.  |

Table 4 Additional inputs: issue 1

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| **Company** | **Input** |
| Mod V00 | Proposal 1.2: The text is stable but Ericsson and IDC voiced opposition (too early). MTK has attempted to address the concern. **Any view?***Ericsson: Do not support. This is somewhat premature: it would seem reasonably clear how the NW would signal a joint TCI state to the UE (one DCI codepoint corresponds to one joint TCI state, and if the codepoint is indicated, the UE would switch to that new joint TCI state). But we have not agreed on how separate DL/UL TCI would be signalled, so we don’t see how we can discuss switching between them. Suggest that we first agree on how to signal separate DL/UL TCI.**IDC: We agree with Ericsson that agreeing this proposal is premature. Hope to have the agreement after having more details on unified TCI framework.**MTK: Response to Ericsson: To our understanding, this proposal is just a down-selection from a previous agreement. In the previous agreement, some alternatives support a semi-statically configuration between joint DL/UL TCI and separate DL/UL TCI. In this proposal, the semi-static mechanism is ruled out, and dynamic switching is supported (either by DCI or MAC-CE). We think this is the intention of this proposal. Regarding how to signal separate DL/UL TCI, we agree that it is necessary to be discussed, but it would be the next level design. The two alternatives in this proposal just provide the directions how we can design the signaling.*New proposal 1.4: Please check Table 2 for the rationale of the new proposal 1.4. **Any view?**Proposal 1.5: Two pending issues:* The cyan text (PL-RS for UL RS as an option): **Any view (and reason)?**
	+ Propose to keep: Fraunhofer IIS/HHI
	+ Propose to remove: ZTE, Qualcomm (complicate implementation by rules for possible combinations), MTK (new behavior with potential issues), OPPO
* Proposal from Futurewei to replace the “default” scheme: **Any view (and reason)?**
	+ Support current “default” scheme:
	+ Support Futurewei’s “default” scheme:
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### Issue 2 (L1/L2-centric inter-cell mobility)

Table 5 Summary: issue 2

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| **#** | **Issue** | **Companies’ views** |
| 2.1 | Support CSI-RS associated with/configured for non-serving cell(s) as a measurement RSNote: Supporting this implies the support of Rel-15 CSI-RSRP as beam metric/reporting | CSI-RS for mobility/RRM associated with NSC:* **Yes (6)**: Huawei, HiSi, ZTE, CATT, Sony, LGE
* **No (7)**: Samsung, Nokia/NSB, OPPO, MTK, Xiaomi, Qualcomm

CSI-RS for BM configured for NSC:* **Yes (8)**: Ericsson, Nokia/NSB, APT/FGI, Futurewei, Huawei, HiSi
* **No (4)**: Samsung, OPPO, MTK, Xiaomi,

CSI-RS for tracking (TRS) configured for NSC:* **Yes (4)**: Nokia/NSB, IDC (add PCI in TRS), Futurewei
* **No (5)**: OPPO, MTK, Xiaomi, Huawei, HiSi
 |
| 2.5 | Can beam reporting associated with non-serving cell(s) be mixed with that with serving-cell in one reporting instance? | **Yes (14)**: vivo, Ericsson, Samsung, Spreadtrum, CATT, Intel, LGE, Apple, MTK, APT/FGI, Sony, ZTE (Up to config.), Futurewei, Xiaomi, NTT Docomo, Huawei. HiSi (up to configuration)**No (3)**: ASUSTeK, Nokia/NSB |
| 2.9 | Support for event-triggered (UE-initiated) inter-cell SS-RSRP reporting | **Yes (14)**: Huawei, HiSi, Qualcomm, Sony, Apple, Samsung, Xiaomi, ASUSTeK, IDC (inter-cell BFR), ZTE, Lenovo/MoM, Futurewei, CATT**No (3)**: Ericsson, Nokia/NSB |
| 2.10 | Timing assumption (e.g. time of arrival and time of the measurement) for measurement of non-serving cell measurement RS  | TA/TAG of SC and configured NSC(s) shall be the **same**: XiaomiTA/TAG of SC and configured NSC(s) can be **different**: vivo (UE can report), Intel, Apple (with PDCCH ordered NSC PRACH, no TAG), Qualcomm, CATT (TA difference is configured), APT/FGI, Sony, ZTE, Futurewei, Huawei, HiSi, LG, Ericsson |

From round 1, the previous proposal 2.1 is split into three:

**Table 6**

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| **Proposal 2.1**: On Rel.17 multi-beam measurement/reporting enhancements for L1/L2-centric inter-cell mobility and inter-cell mTRP, * On the value of K (defined in RAN1#104-e as the number of beam qualities associated at least with non-serving cell(s) can be reported in a single CSI reporting instance),
	+ FFS: the supported maximum value(s) of K, select from {4, 8, 16}
	+ FFS: whether the maximum value of K is a UE capability
* [Periodic,] semi-persistent, and aperiodic measurement/reporting are supported.
* For aperiodic reporting, in one reporting instance, depending on NW configuration, beam(s) associated with a non-serving cell can be mixed with that associated with serving-cell
	+ FFS: How to report the K beams and corresponding qualities if the Tx power among the non-serving cell and with serving-cell is not the same
	+ Note: The supported numbers of non-serving cells (in terms of measurement/reporting) have not yet been decided. The above description doesn’t imply only one non-serving cell is allowed to be configured for measurement. Nor does this imply that only one non-serving cell is allowed in one reporting instance.
* [For L1-RSRP measurement and at least aperiodic reporting, support MAC CE based dynamic activation/deactivation of a subset of higher-layer-configured (for measurement) measurement for non-serving cell SSBs, e.g., additionally activated non-serving cell information for SSBs to be measured, or activated non-serving cell SSBs ]

**Proposal 2.2**: On Rel.17 multi-beam measurement/reporting enhancements for L1/L2-centric inter-cell mobility and inter-cell mTRP, in addition to NW-initiated measurement/reporting, event-based (UE-initiated) measurement/reporting without CSI request from the NW is supported* FFS: Definition of triggering event
* Treated with lower priority
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Table 7 Additional inputs: issue 2

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| **Company** | **Input** |
| Mod V00 | Proposal 2.1: Please share your view on the following issues:* Grey (max K values): **any other proposals for candidate max K values?**
* Cyan (periodic): MTK proposed to keep **periodic FFS (do not see the need for NSC measurement/reporting). Any view (agree, disagree - reasoning)?**
* Purple (activation): Ericsson raised concern that it is “too early”. **Any view (agree, disagree - reasoning)?**

Proposal 2.2: Given the majority view, this proposal may have a chance. Some companies voiced some concerns (Ericsson, Nokia/NSB) on **the lack of event definition and benefits. Could the proponents elaborate on this and see if they can resolve the concern?** |
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### Issue 4 (MP-UE)

The following text is almost stable from Round 1:

**Table 11**

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| **Proposal 4.1**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection, for CSI/beam measurement/reporting, down select and/or modify from the following candidates:* Opt1-1: A panel entity is referring to reported CSI-RS and/or SSB resource index in a beam reporting instance
	+ The correspondence between a panel entity and a reported CSI-RS and/or SSB resource index is indicated to NW
	+ FFS: Detailed design of the correspondence including the conveyed information
	+ Note: the correspondence between a CSI-RS and/or SSB resource index and a panel entity is determined by the UE (analogous to Rel-15/16)
* Opt1-2: A panel entity is referring to a new panel ID within CSI/beam reporting configuration or reports
	+ FFS: Detailed design of the new panel ID including the information conveyed by the new panel ID
	+ Note: The association between the new panel ID and the panel entity is determined by the UE
* Opt1-3: No additional specification support
* The duration in which the above panel entity reference is valid and the respective setting are FFS
* Note: “panel entity” is only used for discussion purpose
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Table 12 Additional inputs: issue 4

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| **Company** | **Input** |
| Mod V00 | The text of proposal 4.1 is almost stable. There was one input from vivo at the end of the round 1 (see above). **Are the proponents of Opt1-1 ok with vivo’s suggestion? Please comment.***Vivo: The reason is that the alignment between UE and NW could be through different signaling. The panel for CSI measurement could be indicated from NW based on some UE side MPE report or active panel status report.****Proposal 4.1****: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection,* * *For CSI/beam measurement/reporting, down select and/or modify from the following candidates:*
	+ *Opt1-1: A panel entity is referring to reported CSI-RS and/or SSB resource index in a beam reporting instance*
		- *The correspondence between a panel entity and a reported CSI-RS and/or SSB resource index is ~~indicated~~ aligned with ~~to~~ NW through indication.*
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### Issue 5 (MPE mitigation)

Table 13 Summary: issue 5

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| **#** | **Issue** | **Companies’ views** |
| 5.1 | Whether to support at least one the following:* {Rel.16 P-MPR based (beam/panel-level)} + {A}, where A is either Opt1A, Opt1B, Opt1C, or Opt1D:
	+ Option 1A: Virtual PHR or a modified version associated with each activated UL TCI or, if applicable, joint TCI
	+ Option 1B: {SSBRI(s)/CRI(s) and/or panel indication}
	+ Option 1C: {SSBRI(s)/CRI(s) and/or panel indication} + virtual PHR or a modified version associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured)
	+ Option 1D: No additional reporting quantity
* {SSBRI(s)/CRI(s) and/or panel indication} + {A}, where A is either Opt2A, Opt2B, Opt2A+ Opt2B, or Option 2C
	+ Option 2A: L1-RSRP [L1-SINR] or a modified version that accounts for MPE effect associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured)
	+ Option 2B: Virtual PHR or a modified version associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured)
	+ Option 2C: No additional reporting quantity
 | Rel-16 P-MPR based:* **Option 1A (6)**: Nokia/NSB, NTT Docomo, OPPO, Lenovo/MoM
* **Option 1B (2)**: Sony, Intel
* **Option 1C (3)**: ZTE, Apple, Qualcomm
* **Option 1D (6)**: vivo, Spreadtrum, MTK, Xiaomi, Huawei, HiSi

SSBRI/CRI-based:* **Option 2A (8)**: CMCC, Ericsson (*UL-RSRP = L1-RSRP – PDL + PUL*), Samsung (modified RSRP), NTT Docomo, CATT (scaled RSRP), MTK, Sony, LGE
* **Option 2B (4)**: CATT, ZTE, Convida, Qualcomm
* **Option 2A+2B** (in one report) (3): Nokia/NSB, Apple
* **Option 2C (2)**: Spreadtrum, Xiaomi
* **Other option**(s): IDC (TCI state group indication + gNB confirmation)
 |
| 5.4 | Reporting mechanism  | **UE-initiated (event-triggered) without NW triggering via CSI request (9):** Sony, Qualcomm, Samsung, Nokia/NSB (BFR like), ZTE, Huawei, HiSi, NTT Docomo **NW triggering via CSI request (just as the regular A-CSI) (5):** Spreadtrum, MTK, Ericsson, NTT Docomo, Qualcomm |

The following text is almost stable from Round 1:

**Table 14**

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| **Proposal 5.1**: On Rel.17 enhancements to facilitate MPE mitigation, in RAN1#104b-e, further discuss to down-select at least one or combine from the following options:* Opt 1A. {Rel.16 P-MPR based (beam/panel-level)} + Virtual PHR or a modified version
	+ The modified version may be associated with each activated UL TCI or, if applicable, joint TCI, or associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured) from candidate pool, if reported.
	+ FFS: how to determine the virtual PHR or the modified version.
* Opt 1D. {Rel.16 P-MPR based (beam/panel-level)}
* Opt 2A. {SSBRI(s)/CRI(s) and/or panel indication} + L1-RSRP [L1-SINR] or a modified version that accounts for MPE effect associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured)
	+ FFS: How panel-level L1-RSRP [L1-SINR] is reported if L1-RSRP [L1-SINR] is associated with panel
	+ FFS: Whether/how to account for MPE effect in L1-RSRP [L1-SINR] report, e.g. by using scaled L1-RSRP [L1-SINR]
	+ FFS: Whether/how to enhance existing beam reporting format to support Option 2A
	+ FFS: When multiple SSBRIs/CRIs and their corresponding metrics are reported in the same reporting instance, whether to allow mixture between the SSBRI(s)/CRI(s)) intended for MPE mitigation and for DL beam reporting
	+ [Note: If Opt2A is selected and there is no consensus on a modified L1-RSRP definition, at least the Rel-15 L1-RSRP definition is reused and virtual PHR may be added]

FFS: If gNB confirmation of MPE-based UE reporting is supportedFFS: If differential report is supported when multiple UL beams are reported in the same report**Proposal 5.2**: On Rel.17 enhancements to facilitate MPE mitigation, in addition to NW-initiated, the supported UE reporting scheme is UE-initiated (event-triggered, without CSI request)* FFS: Definition of triggering event
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Table 15 Additional inputs: issue 5

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| **Company** | **Input** |
| Mod V00 | Proposal 5.1: The wording is stable except for the Note. Some companies mentioned whether it is better to keep, remove, or revise the Note. From FL perspective, the Note is just fine the way it is. **Please share your inputs if any**. Otherwise I will consider this acceptable.Proposal 5.2: The wording is stable. Some companies suggest to make NW-initiated FFS while some other companies can agree to this proposal only when NW-initiated is also supported. So having both is a good compromise. **Is the current wording acceptable as is** (please do not repeat making NW-initiated FFS – there are enough supporters)? |
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# References

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| --- | --- | --- | --- |
| 1 | R1-2103830 | Moderator summary for offline discussion on multi-beam enhancement: SSB and SRS as QCL Type-D source RS | Moderator (Samsung) |
| 2 | R1-2103220 | Moderator summary for multi-beam enhancement | Moderator (Samsung) |
| 3 | R1-2103854 | Moderator summary#2 for multi-beam enhancement: Round 1 | Moderator (Samsung) |