**3GPP TSG RAN WG1 #106-e R1-2108321**

**e-Meeting, August 16th – 27th, 2021**

Source: Moderator (CATT)

Title: Moderator summary #1 on M-TRP simultaneous transmission with multiple Rx panels

Agenda Item: 8.1.2.3

Document for: Discussion and Decision

1. Background

This document summarizes company contributions in agenda 8.1.2.3, M-TRP simultaneous transmission with multiple Rx panels. Given there are only three meetings left, the summary will focus on essential issues the FL consideres necessary to complete Rel.17, and issues with high company interests. Issues that are optimization in nature will be revisted at a later stage.

1. Beam measurement/reporting

**Action item:** Companies are invited to provide their preferences in **Table I** below.

**Table I**: list of issues and company positions

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| **#** | **Issue and proposals** | **Summary** |
| 1.1 | max # of beams (M) increased beyond 2     * BM reporting Option 1 * BM reporting Option 2 | Option 1: ZTE (M = 1/2/3/4) , NTT DOCOMO  No:  Option 2: Lenovo/MoM, NTT DOCOMO  No: NEC |
| 1.2 | Aperiodic CMR resource configuration   * **Alt1**: One resource set list is included in the resource setting to indicate multiple CMR set IDs, and two indexes are included in the corresponding triggering state to indicate two of the multiple CMR set IDs * **Alt2**: Two resource set lists are included in the resource setting each indicates multiple CMR set IDs, and two indexes are included in the corresponding triggering state each indicating one of the multiple resource set IDs in each resource set list, respectively | Alt-1: MediaTek, NTT DOCOMO, ZTE  Alt-2: MedaiTek, CATT |
| 1.3 | SSBRI/CRI ordering in CSI-report   * **Alt1**: 1st SSBRI/CRI corresponds to CMR set with smaller set ID, and 2nd SSBRI/CRI corresponds to CMR set with larger set ID * **Alt2**: 1st SSBRI/CRI corresponds to 1st CMR set in resource setting, and 2nd SSBRI/CRI corresponds to 2nd CMR set in resource setting * **Alt-3**: 1st SSBRI/CRI corresponds to CMR set with higher RSRP, 2nd SSBRI/CRI corresponds to CMR set with lower RSRP * **Alt**-4: Introduce 1-bit indicator of the associated CMR set for the 1st CRI/SSBRI in the report, and same CMR set order as 1st beam group can be assumed for all beam groups.   Note: Best beam is assumed to be the 1st CRI/SSBRI in 1st beam group | Alt-1: mediaTek, NEC  Alt-2: MediaTek, CATT, Intel, DOCOMO, QC, NEC, Sony, Nokia/NSB, LGE  Alt-3: MediaTek  Alt-4: Spreadtrum,OPPO |
| 1.4 | UCI reduction   * Alt-1: Differential reporting across all beam groups in a CSI-report   + Including 1-bit indicator of the CMR set associated with the largest RSRP value in all groups     - NOTE: best beam is assumed in the 1st group   + **Alt-1.1**: 1-bit indicating CMR set with higher RSRP value (e.g. 0 indicating 1st SSBRI/CRI from 1st CMR set, 1 indicating 1st SSBRI/CRI from 2nd CMR set); UCI payload partitioning = 7/4 bits for 1st/2nd SSBRI/CRI in first beam group; 4 bits for all beams in other groups;   + **Alt-1.2**: 1-bit indicating the mapping position of 7-bit highest RSRP value, e.g., UCI payload partitioning (7/4 bits or 4/7 bits) for reporting RSRP values corresponding to 1st/2nd SSBRI/CRI in first beam group; 4 bits in all other groups; * Alt-2: Differential reporting within each beam group in a CSI-report   + For each group, including an 1-bit indicator of CMR set associated with the largest RSRP value in the group * Alt-3: No UCI reduction * Alt-4: Differential reporting within each CMR resource set in a CSI-report | Alt-1: HW/HiSilicon, Lenovo/MoM, NEC, OPPO, MediaTek, DOCOMO, vivo, ZTE, Xiaomi, Nokia/NSB, TCL, Futurewei,   * Alt-1.1: MediaTek, ZTE(2nd preference) * Alt-1.2: NEC   Alt-2: ZTE  Alt-3: CATT, QC  Alt-4: Sony, LGE |
| 1.5 | UE reporting of information related to Rx panel/antenna-group   * Alt-1: UE reports panel ID / antenna-group ID or the reporting setting is associated with panel ID/antenna-group ID   + the reporting setting is associated with panel ID/ antenna-group ID * Alt-2: UE indicates if reported beams are associated to different RX spatial filters, or maximum number of supported layers corresponding to DL RS in a group, or whether two beams in a beam pair can be used for spatial multiplexing or diversity   + **Alt-2.1**: whether beams are associated to different Rx filters/panels (Apple, Xiaomi, Ericsson, CATT, Intel)   + **Alt-2.2**: whether beams are received with spatial multiplexing or diversity ([ ])   + **Alt-2.3**: maximum number of supported layer per DL RS in a group (MediaTek) * Alt-3: Postpone * Alt-4: Not support | Alt-1 (3): LGE, DOCOMO (BM option 1), InterDigital,  Alt-2 (10): ZTE, Samsung, Qualcomm, CMCC, MediaTek, Apple, LGE, Xiaomi, Ericsson, CATT  Alt-3 (3): Nokia/NSB, Sony  Alt-4 (4): OPPO |
| 1.6 | gNB indication of Rx panel hypothesis   * E.g. whether beam pairs in a group are used for spatial multiplexing or diversity | Support: Intel, QC, Nokia/NSB, CATT  No: |
| 1.7 | Support L1-SINR report   * support measurement of interference arising from the other beam in the reported beam group * FFS: IMR resource assumption, e.g.   + reuse CMR of other beam in the beam group (LGE)   + explicit IMR configuration (TCL/Nokia/NSB), including ZP and/or NZP IMR | * Support (18): ZTE, CATT, Lenovo/MoM, Spreadtrum, Qualcomm, Intel, LGE, Xiaomi, TCL, Nokia/NSB, Sony, ETRI, NTT DOCOMO, Ericsson, Futurewei, AT&T * No (3): OPPO, Apple, vivo |
| 1.8 | Whether to adopt additional beam measurement/reportion option   * Option 1: * In a CSI-report, UE can report N>1 pair/groups and M>=1 beams per pair/group, * Different beams in different pairs/groups can be received simultaneously * Option 3: * UE report M(M>=1) beams in N (N>1) CSI-reports corresponding to N report setting * Different beams in different CSI-reports can be received simultaneously * Association mechanism FFS | * Option 1: ZTE (with group ID and/or panel ID report), OPPO, DOCOMO, Sony * No: CMCC, Apple, Ericsson, Qualcomm, InterDigital, Nokia/NSB * Option 3: CATT, Nokia/NSB, vivo * No: CMCC, Apple, Ericsson, Qualcomm, NTT DOCOMO, InterDigital |

* 1. Increasing M beyond 2 (issue 1.1)

Void

* 1. Aperiodic CMR configuration (issue 1.2)

Obsevation: The following agreement was made in the first GTW session. One open issue is how to associate RRC parameter *CSI-AssociatedReportConfigInfo* with two CMR resource sets, and their corresponding QCL information.

**Agreement**

*For aperiodic report of beam reporting option 2,*

* *When associated with aperiodic resource setting, extend the existing RRC parameter CSI-AssociatedReportConfigInfo to be configured with two CMR resource sets where each may be configured with their corresponding QCL information.*
  + *FFS: Detailed association scheme*
* *When associated with periodic/semi-persist resource setting, the resource setting comprises two CMR resource sets.*

Offline proposal

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| Company | views |
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* 1. SSBRI/CRI ordering in CSI-report (issue 1.3)

Observation:

* The ordering of two beams in a reported beam group needs to be defined. Three alternatives are provided in Table I based on company proposals. As several companies pointed out, this issue may be dependent on whether differential report is supported (section 2.4), which was earlier agreed in the first GTW session (agreement captured in section 5.6). Companies are invited to share their views on the following offline proposal.

Offline proposal

* For option 2 with differential reporting
  + The 1st SSBRI/CRI is associated with the 1st **configured/triggered** CMR resource set in the resource setting, and the 2nd SSBRI/CRI is associated with the 2nd configured/triggered CMR resource set in the resource setting.

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| Company | Views |
| Qualcomm | For issue 1.3, we support Alt2, which seems the simplest one. |
| NEC | We see no difference in the possible consequences to adopt Alt1 or Alt2. Thus we can support either one of them. |
| Apple | We support Alt2. |
| NTT DOCOMO | For issue 1.3, we support Alt2. |
| Lenovo/MotM | We think issue 1.3 can be discussed together with issue 1.4, since different alternatives in issue 1.3 correspodning to different UCI reduction schemes in issue 4. |
| Spreadtrum | In our understanding, the Alt.1 for issue 1.4 in the table provides another alt to identify CMR set, copy and paste below:   * Alt-1: Differential reporting across all beam groups in a CSI-report   + Including 1-bit indicator of the CMR set associated with the largest RSRP value in all groups     - NOTE: best beam is assumed in the 1st group   In details, the CRI/SSBRI associated with the reference RSRP, which is always the first CRI/SSBRI in the report and also can be assumed in the 1st group, needs to be explicitly indicated to be assocaied with which CMR set with 1-bit indicator, and then another CRI/SSBRI in the 1st group naturally could be assumed to correspond to another CMR set. For other beam groups in the CSI report, the same CMR order as the 1st beam group could be assumed. Thus, we suggest to add Alt.4 for issue 1.3 below.  SSBRI/CRI ordering in CSI-report   * **Alt1**: 1st SSBRI/CRI corresponds to CMR set with smaller set ID, and 2nd SSBRI/CRI corresponds to CMR set with larger set ID * **Alt2**: 1st SSBRI/CRI corresponds to 1st CMR set in resource setting, and 2nd SSBRI/CRI corresponds to 2nd CMR set in resource setting * **Alt-3**: 1st SSBRI/CRI corresponds to CMR set with higher RSRP, 2nd SSBRI/CRI corresponds to CMR set with lower RSRP * **Alt**-4: Introduce 1-bit indicator of the associated CMR set for the 1st CRI/SSBRI in the report, and same CMR set order as 1st beam group can be assumed for all beam groups.   Note: Best beam is assumed to be the 1st CRI/SSBRI in 1st beam group |
| vivo | We think this issue is dependent on issue 1.4. |
| LGE | Alt 2 is the simple solution and fine for us. |
| Sony | For SSBRI/CRI ordering, we also support Alt.2. If N > 1 groups are reported, L1-RSRP differential reporting can be facilliated by Alt.2 with simple extension. |
| MediaTek | We also think Issue 1.3 and Issue 1.4 are correlated.  For example, if differential reporting is done across all beam groups in a CSI-report (Alt1 in Issue 1.4), then the 1st beam group in the CSI-report (contains the beam with the largest RSRP) should follow Alt3. For other beam groups, they can follow either Alt1 or Alt2.   |  | | --- | | SSBRI/CRI with the largest RSRP in the CSI-report corresponds to CMR set #x in beam group 1 | | SSBRI/CRI corresponds to CMR set #y in beam group 1 | | SSBRI/CRI corresponds to the 1st CMR set in resource setting (or CMR set with smaller set ID) in beam group 2 | | SSBRI/CRI corresponds to the 2nd CMR set in resource setting (or CMR set with larger set ID) in beam group 2 | | SSBRI/CRI corresponds to the 1st CMR set in resource setting (or CMR set with smaller set ID) in beam group 3 | | SSBRI/CRI corresponds to the 2nd CMR set in resource setting (or CMR set with larger set ID) in beam group 3 | | SSBRI/CRI corresponds to the 1st CMR set in resource setting (or CMR set with smaller set ID) in beam group 4 | | SSBRI/CRI corresponds to the 2nd CMR set in resource setting (or CMR set with larger set ID) in beam group 4 | |
| ZTE | We think that it is depended on whether or how to introduce differential L1-RSRP reporting. If introducing, we think that the mapping can be indicated by set ID corresponding to the absolute RSRP. |
| InterDigital | Support Alt2. |
| Samsung | Support Alt2 as baseline. |
| Mod | Propose to adopt alt-2 (at least for the case without differential reporting, if supported in Rel.17).  Propose to further discuss when differential reporting is configured/supported. |
| Huawei, HiSilicon | Support the latest offline proposal |
| OPPO | Prefer to first decide if differential reporting is used in Option 2 or not, then we can dicuss the design of SSBRI/CRI ordering. |
| Xiaomi | We also think issue 3 should be discussed together with issue 4. If differential reporting is reported, the 1st SSBRI/CRI should be associated with the abosolute RSRP and 1 bit is needed to indicate its CMR set. If without differential reporting, we think there is no difference between Alt 1 and Alt 2, thus Alt 1 or Alt 2 is OK to us. |
| Nokia/NSB | Support Alt2. |
| MediaTek | We can decide whether differential reporting (or non-differential reporting) is supported or not first. |
| Lenovo/MotM | Support the latest offline proposal. |
| TCL | Support the latest offline proposal. |
| CMCC | Support the latest offline proposal. |
| ZTE | The FL proposal is very confusing. Let’s decide whether differential reporting can be supported firstly. Then, we can discuss this issue. |
| NTT DOCOMO | The offline proposal seems not needed. Let’s decide whether to support differential reporting first. |
| Ericsson | Regarding the offline proposal, we prefer to avoid different solutions for cases without differential reporting and with differential reporting. So it may be better to first decide whether differential reporting should be supported or not. Then, we can downselect one Alternative based on the outcome of that discussion. |
| Futurewei | Support the latest offline proposal. |
| Mod | This can be discussed after 2.4. |
| Qualcomm | We are fine for the latest offline proposal based on the assumption. |
| Qualcomm | Support latest offline proposal |
| NEC | With the new agreement made in GTW ‘0 indicating 1st SSBRI/CRI from 1st CMR set, 1 indicating 1st SSBRI/CRI from 2nd CMR set’, it seems we need to follow that   * + When the 1-bit indicator is set to ‘0’, the 1st SSBRI/CRI is associated with the 1st **configured/triggered** CMR resource set in the resource setting, and the 2nd SSBRI/CRI is associated with the 2nd configured/triggered CMR resource set in the resource setting.   + When the 1-bit indicator is set to ‘1’, the 1st SSBRI/CRI is associated with the 2nd **configured/triggered** CMR resource set in the resource setting, and the 2nd SSBRI/CRI is associated with the 1st configured/triggered CMR resource set in the resource setting. |
| MediaTek | **Agreement**  Differential reporting across all beam groups in a CSI-report   * Including 1-bit indicator of the CMR set associated with the largest RSRP value in all groups   + NOTE: best beam is assumed in the 1st group   + 1-bit indicating CMR set with higher RSRP value (e.g. 0 indicating 1st SSBRI/CRI from 1st CMR set, 1 indicating 1st SSBRI/CRI from 2nd CMR set); UCI payload partitioning = 7/4 bits for 1st/2nd SSBRI/CRI in first beam group; 4 bits for all beams in other groups;   Suppot the offline proposal for beam groups other than the 1st group in a CSI-report (how to report the 1st beam group was agreed in the previous agreement):  Offline proposal   * For option 2 with differential reporting   + In each beam group other than the first beam group in a CSI-report, the 1st SSBRI/CRI is associated with the 1st **configured/triggered** CMR resource set in the resource setting, and the 2nd SSBRI/CRI is associated with the 2nd configured/triggered CMR resource set in the resource setting. |

* 1. UCI reduction scheme (issue 1.4)

void

* 1. UE panel/antenna related feedback (issue 1.5)

Observation:

* On UE panel/antenna related feedback, two high level alternatives were discussed in the previous meeting with a list of candidates itemized in Table I. A few companies noted that panel-ID (alt-1) is currently under discussioin in AI 8.1.1.

Offline proposal

* Discuss whether to support UE panel/antenna related feedback for M-TRP beam reporting option 2, and if so, down select from the following three options, by RAN1#106b-e
  + Alt-2.1: whether beams are associated to different Rx filters/panels
  + Alt-2.2: whether beams are received with spatial multiplexing or diversity
  + Alt-2.3: maximum number of supported layer per DL RS in a group

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| Company | Views |
| Qualcomm | Support Alt2, which does not require any panel ID. So no need to correlate with 8.1.1, which is also for UL |
| Apple | Support Alt2. We do not need to wait for 8.1.1 decision since both AIs are based on different BM framework. |
| NTT DOCOMO | If proposal in issue 1.6 is supported, do we need proposal of Alt2 in issue 1.5?  We think gNB indication of beam selection purpose is more reasonable. gNB knows the scheduling information and which type of 2 beams are needed from UE. |
| Lenovo/MotM | Support to delay this discussion until panel-ID related issue in AI 8.1.1. is more stabilized. |
| Spreadtrum | Support to delay this discuss, and wait for AI8.1.1. |
| LGE | Support Alt 1. If Alt 1 is supported, some functionality of Alt 2 can be naturally supported, e.g., whether beams are associated to different Rx filters/panels. Also, reported panel ID can be used by gNB for scheduling panel specific DL/UL transmission. We are also fine with waiting for AI 8.1.1 and delay the discussion. |
| Sony | For Alt-1, we think it somehow overlaps with MP-UE operation in 8.1.1. It is better to be discussed and decided in 8.1.1.  For Alt-2.1, whether M beams within a group can be received by UE with different/same Rx beam/panels is up to UE implementation. We don’t see a strong motivation for such dynamic reporting.  So given other details of group-based beam reporting unsettled, we would suggest to postpone it when other essential issues are fully addressed. |
| MediaTek | Okay to postpone |
| ZTE | We think that this discussion should be treated with high priority, considering that we have no progress for a few meeting (even no agreement of listing candidates) |
| InterDigital | Support Alt1. We are also fine to wait for decisions from AI 8.1.1. |
| OPPO | Support Alt4:  Regarding the number of maximal number of layers: the UE is not able to calculate such information during beam measurement and reporting. That shall be part of CSI measurement.  Regarding panel ID: we do not see such information is needed as the two beams reported in one group can be received simulataneouly.  Same or different Rx filter: that is part of UE implementation. Furthermore, people seems to think such information can be used by the system to estimate the RANK. That shall be part of CSI measurement. |
| Xiaomi | We think this issue is different from MPUE in AI 8.1.1, which is used for efficient DL/UL scheduling. While here consider both single panel UE and Multi-panel UE, thus Alt 2 is sufficient. |
| Nokia/NSB | We don’t prefer making decision for Panel ID only for M-TRP BM optimization. It should be discussed with common TCI framework.  The main motivation of alt 2 is covered by M-TRP CSI reporting. No need for duplicating the same functions for BM and CSI reporting. Instead, gNB can configure a restriction that the reported beam pair to be the same or different spatial filters as in Issue 1.6. |
| CMCC | Support Alt2. It would be helpful for gNB scheduling, e.g., gNB could schedule the beam pairs with low interference to other UEs or with low blocking probability.  We think there is no need to wait for 8.1.1 decision. |
| ZTE | We share the same views with CMCC that this discussion should be treated with high priority |
| Ericsson | We support Alt-2. Among the sub-alternatives under Alt-2, our preference is either Alt-2.1 or Alt-2.3 |
| Intel | Support Alt-2 |
| Mod | Please share your views, and preferences on the options, for the 2nd online discussion. |
| Apple | Support Alt-2.1 |
| OPPO | Prefer not to report UE panel/antenna related information. In beam reporting option 2, the reported beams can be received simulatenously. That is sufficient information. We understand the motivation for reporting UE panel/antenna related information is to provde some RANK-related information. In our view, such information shall be part of CSI measurement. Furthermore, how to use panel/antenna to receive those beams are part of UE implementation. |
| MediaTek | Support only Alt2.1 |

* 1. gNB indication of UE panel related hypothesis (issue 1.6)

Observation:

* Related to UE hypothesis on Rx panels when performing beam measurement, it is possible that gNB provides indication/configuration of such panel-related hypotheis.
* Intel/Qualcomm/DOCOMO/CATT support such gNB configuration. Apple thinks this can be supported for CSI feedback, but not beam feedback.

Offline proposal

* Discuss whether to support gNB indication/configuration of Rx panel/antenna related hypothesis for beam reporting option 2, and if so, down select from the following three options, by RAN1#106b-e
  + Alt-2.1: whether beams are associated to different Rx filters/panels
  + Alt-2.2: whether beams are received with spatial multiplexing or diversity
  + Alt-2.3: maximum number of supported layers per DL RS in a group

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| Company | Views |
| Qualcomm | We support the proposal. The intention from gNB is an important input for UE to select the beam(s), e.g. if the purpose is for diversity, UE may report two gNB beams creating the max combine SINR, which may be received by single Rx beam. |
| Apple | In our view, this should be something like gNB indication of transmission scheme assumption for beam report, and it is better that this is used for CSI report instead of beam report. |
| NTT DOCOMO | If proposal in issue 1.6 is supported, do we need proposal of Alt2 in issue 1.5?  We think gNB indication of beam selection purpose is more reasonable. gNB knows the scheduling information and which type of 2 beams are needed from UE. |
| Nokia/NSB | Share view with Qualcomm and DOCOMO. We support this over Alt2 in issue 1.5. |
| NTT DOCOMO | To moderator:  Yes, your observation is correct for DCM. We support such gNB configuration instead of UE reporting Alt2 in issue 1.5. |
| Ericsson | We are open to discuss this issue further. But the current observation is a bit too general. We need to discuss what specific gNB indication is needed. |
| Mod | Based on Ericsson question, copied UE panel related information in issue 1.4 to possible gNB-indicated/configured UE hypothesis. |
| Intel | yes, we believe gNB assistance is needed, otherwise how will the UE know which beam pairs to report, it will likely have all types of beam pairs that it has measured (diversity and spatial multiplexing) |
| Mod | Please share your views, and preferences, for the 2nd online discussion. |
| Qualcomm | We are fine for either Alt-2.1 or Alt-2.2. For Alt-2.3, layer # may not be determined by CSI-RS for BM to our understanding.  For Alt-2.2, suggest to replace “with” by “for”, since to our understanding, the usage is recommended for future use after the beam report, not used during beam measurement.   * + Alt-2.2: whether beams are received for ~~with~~ spatial multiplexing or diversity |
| Apple | We think proposal 2.5 should be sufficient. |
| OPPO | Do not support that.  It looks like not feasible for the gNB to provide such information to the UE. |
| MediaTek | Alt-2.1: This should be up to UE implementation instead of NW configuration.  Alt-2.2: Similar to Alt-2.1. Whether beam pair can be used for spatial multiplexing or diversity may depend on the pair of beams are associated to same of different Rx filters/panels, which can reported by UE in proposal 2.5.  Alt-2.3: This should be determined by CSI acquisition, not just an indication from NW. |

* 1. L1-SINR and interference measurement (issue 1.7)

Observation:

* Aside from already agreed L1-RSRP, whether L1-SINR should be supported remains open. Company views (including possible interference measurement resources and hypothesis) are summarized in Table I.
* Support (18): ZTE, CATT, Lenovo/MoM, Spreadtrum, Qualcomm, Intel, LGE, Xiaomi, TCL, Nokia/NSB, Sony, ETRI, NTT DOCOMO, Ericsson, Futurewei, AT&T
* Concern (3): Apple, vivo, OPPO

Offline proposal

* Decide whether L1-SINR is supported in RAN1#106-e.
* If supported, down select from the following IMR resource provision methods by RAN1#106b-e
  + Option 1: reuse CMR of other beam in the beam group
  + Option 2: explicit IMR configuration , including ZP and/or NZP IMR

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| Company | Views |
| Qualcomm | Support L1-SINR, which can reflect the cross-beam interference. As clarified in last meeting, the CMR/IMR is measured in TDMed fashion to our understanding, so it is feasible for UE to measure. Suppose UE reports gNB beam 1 and 2 in a group. The CMR and IMR to compute L1-SINR for gNB beam 1 are transmitted by gNB beam 1 and 2, respectively, and are received by UE Rx beam corresponding to gNB beam 1. Similar configuration is applied for computing L1-SINR for gNB beam 2. |
| Apple | We failed to see performance gain for L1-SINR. It would be challenging to measure inter-beam interference. In addition, this seems to be redundant since there are some enhancement in CSI. |
| NTT DOCOMO | Support L1-SINR. |
| Lenovo/MotM | Support L1-SINR report to reflect the cross-TRP interference at least with only two CMR configuration. We can further study whether additional IMR resource can be configured. |
| vivo | We don’t support L1-SINR report with interference calculated between the reported beam pair, where the CMR of one beam in the beam group is regarded directly as interference for the CMR of the other beam in the beam group. |
| LGE | Support L1-SINR for option 2. |
| Sony | Support the offline proposal on making a decision in 106e. Otherwise, there seems no enough TU to complete the work. |
| ZTE | Support L1-SINR. It should be noticed that L1-SINR report has been supported in group based reporting in Rel-16. Whether to support inter-CMR interference calculation for SINR can be treated later. |
| InterDigital | Support FL’s offline proposal. We don’t see an issue with reporting L1-SINR. |
| Huawei, HiSilicon | Support L1-SINR reporting for beam reporting Option 2. |
| Xiaomi | We share same view as ZTE that L1-SINR for Option 2 can be supported first, further discuss on whether to support inter-beam interference within the group. |
| Nokia/NSB | We support the proposal. For interference measurement, IMR should be specified for a CMR regardless of dedicated IMR or another CMR. We are fine to support L1-SINR at least for dedicated IMR. Whether to configure dedicated IMR by RRC or to activate dedicated IMR or CMR pair by MAC-CE can be further discussed. |
| MediaTek | Supprot the FL proposal |
| TCL | Support L1-SINR reporting, as it can reflect the cross-beam interference. For interference measurement, explicit IMR configuration is more preferred. |
| CMCC | Support L1-SINR for option 2. |
| ZTE | The original manner in Rel-16 SINR for group based reporting should be supported as a starting point. Whether to support inter-CMR interference calculation can be discussed as a separate issue. |
| Ericsson | We support L1-SINR for option 2. |
| Futurewei | Support L1-SINR for Option 2. |
| AT&T | Support L1-SINR reporting |
| Samsung | We support the FL’s proposal |
| Qualcomm | Support the offline proposal. One good use case for L1-SINR is for cross-beam interference, which can be predicted. |
| Intel | Support L1-SINR for option 2 |
| Mod | Please share your views, and preferences, for the 2nd online discussion. |
| Qualcomm | Support Option 2. We are not clear how Option 1 works. CMR for gNB beam 2 cannot serve as IMR for gNB beam 1. Because they are supposed to be received with corresponding Rx beams at different time. |
| Apple | We still failed to see performance gain from L1-SINR. |
| OPPO | It seems measuring L1-SNR would cause trouble for the UE to find beam pair. An chicken-egg problem. |

* 1. Other BM options (issue 1.8)

Observation:

* It is open whether the two remaining options (option 1 and 3) for beam measurement/reporting should be supported in Rel.17. It appears that concerns on both options have not been resolved over the meetings, so the FL proposal is to adopt neither.

Offline proposal

* Do not support beam measurement/feedback option 1 and 3 in Rel.17 for M-TRP simultaneous transmission with multiple UE Rx panels.
  + Concerns: ZTE, vivo, Huawei, HiSilicon, Nokia/NSB

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| Company | Views |
| Qualcomm | We slightly prefer no new Option. Option 2 should be enough |
| Apple | OK with the proposal |
| NTT DOCOMO | We support Option 1. We do not support Option 3.  But we can accept no support of both. |
| Vivo | We support Option 3 for non-ideal backhaul MTRP scenarios. |
| LGE | For the sake of progress, we are fine with only supporting option 2. |
| ZTE | We think Option-3 can be precluded firstly. Then, we can further review whether Option-1 is needed or not (it may be also relevant to MPUE discussion in 8.1.1 BM). |
| InterDigital | Support FL’s offline proposal. |
| Huawei, HiSilicon | Support Option 3 for non-ideal backhaul case. |
| Nokia/NSB | We still see the usecase for option 3, but we don’t see need for option 1 because it is alternative for option 2.  Proponent for option 1 shall clarify what new functionality is supported by option 1 over option 2.  At least option 3 has different usecase than option 2, if time is allowed, we can further discuss supporting of option 3 especially for inter-cell M-TRP. |
| Ericsson | We think supporting Option 2 in Rel-17 is enough. No further need for agreeing additional options. |
| AT&T | Ok with the FL proposal |
| Qualcomm | Support the offline proposal. |
| Intel | Its ok to not agree to not support :-) |

1. M-TRP Beam failure recovery

**Action item**: Companies are invited to provide your preferences in **Table II**.

**Table II**: list of issues and company positions

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 2.1 | Q1: Simultaneous configuration of cell-specific and TRP-specific BFR in a cell  Q2: how many BFD-RS sets can be configured per at least SCell   * Alt-1: 3 * Alt-2: 2 | Q1:  Yes (11): CMCC, MediaTek, ITRI, TCL, Nokia/NSB, Sony, ZTE, LGE  No (8): Qualcomm, Intel, DOCOMO, CATT, MediaTek,OPPO, FGI/APT  Q2:  Alt-1 (3): Sony, ZTE, TCL  Alt-2 (16): Qualcomm, DOCOMO, Lenovo/MotM, Spreadtrum, LGE, MediaTek, Huawei, HiSilicon, OPPO, Xiaomi, Convida, Futurewei, FGI/APT, CATT |
| 2.2  BFD-RS | Q1: # of BFD-RS resources per set   * Alt1: max value is 2 * Alt2: max value is a UE capability, including possible candidate value of 1   Q2: # total number of BFD-RS resource across two sets is a UE capability | Q1:   * Alt-1: Convida, * Alt-2: Qualcomm, Apple, LGE, TCL, vivo, ETRI, NTT DOCOMO, Sony, ZTE, Xiaomi   Q2:  Yes: Qualcomm, Sony |
| 2.3  BFD-RS | Explicit vs. Implicit BFD-RS  Q1 : Explicit configuration   * Each BFD-RS set should be configured with a CORESSETPoolIndex   Q2: Implicit configuration of BFD-RS set k (k=0,1) for M-DCI   * Based on X TCI of CORESETs with CORESETPoolIndex = k * FFS: value of X (determined in spec or UE capability), and TCI selection rule when the number of CORESETs with CORESETPoolIndex = k exceeds X (e.g. reuse RLM RS selection rule)   Q3: Implicit configuration BFD-RS set k for S-DCI, e.g.   * Option 1: Based on TCI of CORESETs with CORESETPoolIndex = k; Extend CORESETPoolIndex to S-DCI (for BFD-RS set generation) * Option 2: From TCI states associated with activated TCI codepoint   Q4: Support 1-to-1 association between BFD-RS set with CORESETPoolIndex | Q1: ZTE, Spreadtrum, Samsung, Fujitsu, FGI/APT, Qualcomm, CMCC, MediaTek, LGE, ITRI, Convida, Ericsson, Nokia/NSB, vivo, Sony, ETRI, NEC, Xiaomi  NO: OPPO  Q2: ZTE, Lenovo/MoM, Samsung, Fujitsu, OPPO, FGI/APT, Qualcomm, CMCC, MediaTek, AT&T, LGE, Xiaomi, ITRI, Convida, Ericsson, Nokia/NSB, Nokia/NSB, vivo, ETRI, NEC, NTT DOCOMO,Spreadtrum  Q3: HW/HiSilicon, Lenovo/MoM, Samsung, Fujitsu, MediaTek, CATT, Intel, AT&T, CMCC, LGE, Xiaomi, ITRI, Sony, Nokia/NSB (option 2), QC, NEC, FGI/APT  No: Ericsson, vivo  Q4: MediaTek, CATT (if explicit BFD-RS is adopted), OPPO, Spreadtrum  No: LGE |
| 2.4  BFD-RS | Introduce MAC-CE for updating explicit BFD-RS set | Support: CATT, ZTE |
| 2.5  NBI-RS | Association between BFD-RS set k and NBI-RS set j   * Alt-1: 1-to-1, fixed in spec * Alt-2: 1-to-1, configurable * Alt-3: 1-to-1, leave it to RAN2 | Alt-1: CATT, Intel, Apple, ITRI, ETRI, DOCOMO, Lenovo/MoM, LGE, Spreadtrum, Convida  Alt-2: ZTE, Fujitsu, OPPO (via CORESETPoolindex), Qualcomm, CMCC (via CORESETPoolIndex), Sony (via CORESETPoolindex), MediaTek, Xiaomi  Alt-3: Convida, Nokia/NSB, Lenovo/MoM, LGE, Spreadtrum, FGI/APT |
| 2.6  PUCCH-SR resource | PUCCH-SR resource selection rule for LRR feedback   * Alt 2.5.2 A: * On PUCCH-SR resource selection rule when SR is triggered and 2 PUCCH-SR resources are configured, there is no consensus to adopt alt-1 or alt-2. PUCCH-SR resource selection is up to UE implementation. * Alt 2.5.2 B: * On the PUCCH-SR resource selection rule when SR is triggered and 2 PUCCH-SR resources are configured, and at most one BFD RS set fails per CC, adopt alt 2 (e.g. association to failed BFD-RS set) if all failed BFD RS sets cross CCs are associated with the same PUCCH SR resource, else PUCCH-SR resource selection is up to UE implementation. * Alt 2.5.2 C: * On the PUCCH-SR resource selection rule when SR is triggered and 2 PUCCH-SR resources are configured, and at most one BFD RS set fails per CC, adopt alt 1 (e.g. association to non-failed BFD-RS set) if all failed BFD RS sets cross CCs are associated with the same PUCCH SR resource, else PUCCH-SR resource selection is up to UE implementation. * Alt 2.5.2 D: * Revert the past agreement on supporting configuration of up to 2 PUCCH-SR resources. A UE can be configured up to 1 PUCCH-SR resource in a cell group. | Alt-2.5.2 A: FGI/APT, Apple, LGE, TCL  Alt-2.5.2 B: ZTE (Scell), InterDigital, Spreadtrum, CATT, Fujitsu, Qualcomm, Xiaomi, ETRI  Alt-2.5.2 C: ZTE (SpCell), Samsung, NEC, CMCC, Xiaomi, CATT, Nokia/NSB, NTT DOCOMO, Sony  Alt-2.5.2 D: Convida, Ericsson |
| 2.7  PUCCH-SR resource | Whether PUCCH-SR resource can have 1 or 2 activated spatial filters  Alt-1: Only 1  Alt-2: up to 2; diversity (e.g. AI 8.1.2.1) when 2 spaial filters are activated  Alt-3: up to 2; filter selection when 2 spatial filters are activated  Alt-4: up to 2; transmission method undefined when 2 spatial filters are activated | Alt-1: Spreadtrum,  Alt.2: CATT, NTT DOCOMO, ZTE  Alt-3: Qualcomm, Intel, LGE,  Alt-4: APT/FGI, Apple, Convida, |
| 2.8  MAC-CE | Q: One or two MAC-CE for TRP-specific BFR   * Alt-1: one MAC-CE * Alt-2: two MAC-CE * Alt -3: leave it to RAN2 | Alt-1: HW/HiSilicon, CATT, MediaTek (2-bit bitmap), LGE, TCL, Nokia/NSB, QC, NTT DOCOMO, ASUSTeK,Spreadtrum, Sony,OPPO, Xiaomi, Convida  Alt-2: ZTE  Alt-3: |
| 2.9  MAC-CE | Indication of failed TRP in MAC-CE   * Alt-1: failed BFD-RS set ID * Alt-2: failed CORESETPoolIndex | Alt-1: HW/HiSilicon, LGE, CATT. TCL, Nokia/NSB, vivo, QC, NTT DOCOMO, ASUSTeK,Spreadtrum, Convida (when a single TRP has failed and no candidate beam RS is reported)  Alt-2: ZTE, OPPO, Sony, ETRI, |
| 2.10  MAC-CE | Q1: Whether 1 or 2 TRP receives new beam report for each Scell   * Alt-1: resource index representing identified new beam (if found) for only 1 failed TRP, irrespective of 1 or 2 TRP failure * Alt-2: resource index representing identified new beam (if found) for each failed TRP   Q2: format of new beam   * Alt-1: separate encoding (e.g. log2(N1) bit for TRP1, log2 (N2) bit for TRP2, where N1/N2 are # NBI-RS resources in set 1 and 2) * Alt-2: joint encoding | Q1:   * Alt-1: DOCOMO * Alt-2: HW/HiSilicon, DOCOMO, CATT, QC,Spreadtrum, ZTE, Convida   Q2:   * Alt-1: CATT, QC, ZTE * Alt-2: |
| 2.11  Beam/power update | UE assumption of DL QCL-typeD and UL filter/power control after receiving gNB response  Q1: If a single TRP fails   * Failed TRP update by new beam (if reported)   Q2: If both TRPs fail   * Each failed TRP updated by its corresponding new beam (if reported)   Q3: Support beam update for PDCCH   * Introduce association between BFD-RS set and CORESETs   Q4: Support beam/power update for PUCCH   * Introduce association between PUCCH and TRP, e.g. through BFD-RS set ID, CORESETPoolIndex, etc.   Q5: Support beam/power update for all data/control channels | Q1: Support: CATT, QC, NTT DOCOMO, Spreadtrum, Sony, ZTE, FGI/APT  Q2: Support: CATT, QC, NTT DOCOMO, Spreadtrum, Sony, ZTE  Q3: Support: ZTE, Lenovo/MoM, Spreadtrum, Fujitsu, OPPO, MediaTek, CATT, Sony, ETRI, QC, NTT DOCOMO, Xiaomi, FGI/APT  No:  Q4: Support: ZTE, Lenovo/MoM, Spreadtrum, Fujitsu, APT/FGI, Qualcomm, DOCOMO, Sony, ETRI, Xiaomi  No: OPPO  Q5: Support: Apple , ZTE, FGI/APT  No: |
| 2.12  RACH based fallback | Support CBRA based fallback on SpCell as a result of per-TRP beam failure, conditions FFS. | Support: Hw/HiSilicon, ZTE, CATT, NEC, FGI/APT, Intel, LGE, Asustek, Nokia/NSB, OPPO, Xiaomi, Asustek, QC, NTT DOCOMO, Convida  No: |
| 2.13  RACH based fallback | Support CFRA based fallback | Support: Asustek, Lenovo/MoM, Nokis/NSB (if configured), LGE  No: |

* 1. Simultaneous configuration of cell-specific and TRP-specifc BFR in the same CC (issue 2.1)

Observation:

* It remains open whether cell-specific and TRP-specific BFR can be simultaneously configurd in the same cell. To decide on this issue, a clear definition of “cell-specific” vs. “TRP-specific” BFR is needed.
* It should be clear that TRP-specific BFR requires two BFD-RS sets configured in a CC, to allow per-TRP failure detection.
* Cell-specific BFR has two interpretations.
  + Interpretation 1: refers to RACH-based fall back scheme (e.g. Rel.15/16).
  + Interpratation 2: refers to a case where one BFD-RS is configured in a CC. Simultaneous configuration of “cell-specific” and “TRP-specific” BFR can then be interpretated as 3 BFD-RS in a CC corresponding to two seprate BFR procedures, each associated to 1 and 2 BFD-RS sets.
  + The FL’s understanding is that the intended discussion is to clarify the use case of interpretation 2. Interpration 1 (e.g. interaction with RACH-based fallback) is discussed in a separate sub-agenda.
* Several companies remained concerned with the configuration of 3 BFD-RS sets in a CC/BWP (i.e., one cell-specific BFD-RS set and two TRP-specific BFD-RS sets).

Issue 1: Offline definition (for purpose of facilitating discussion)

* With simultaneous configuration of cell-specific and TRP-specific BFR in the same CC/BWP, 3 BFD-RS sets are configured in the CC/BWP, where cell-specific and TRP-specific BFR are associated to 1 and 2 BFD-RS sets, respectively.
  + Note: The BFD RS should be QCLed with DMRS of PDCCH in the same CC/BWP
  + Note: One BFD RS can be configured within both cell-specific BFD RS set and TRP-specific BFD RS set
  + Note: Other aspects of simultaneous configuration of cell-specific and TRP-specific BFR such as BFRQ configuration (e.g., information delivered by *BeamFailureRecoveryConfig* or *BeamFailureRecoverySCellConfig* in legacy system) are for separate discussion.
* Support: Qualcomm, Apple, DOCOMO, Spreadtrum, Lenovo, Fujitsu, Sony, MediaTek, Convida
* Concern: Huawei, HiSilicon, Futurewei (2 sets are enough),

Through the discussion it appears there may be a majority view on the maximum number of BFD-RS sets that can be configured on a cell/BWP (including for all BFR purposes, e.g. Rel.15 SpCell, Rel.16 SCell, and Rel17 TRP-specific). Companies are invited to share their views below.

Issue 2:

* how many BFD-RS sets can be configured for a UE in a SCell
  + Alt-1: up to 3, i.e., 1 for cell-specific BFR and 2 for TRP-specific BFR
    - Support: Sony, ZTE, TCL
  + Alt-2: up to 2
    - Support: Qualcomm, DOCOMO, Lenovo/MotM, Spreadtrum, LGE, MediaTek, Huawei, HiSilicon, OPPO, Xiaomi, Convida, Futurewei, FGI/APT, CATT, Apple, NEC
* how many BFD-RS sets can be configured for a UE in a SpCell
  + NOTE; resources reserved for RACH-based fallback are not considered
  + Alt-1: up to 3, i.e., 1 for cell-specific BFR and 2 for TRP-specific BFR
    - Support:
  + Alt-2: up to 2
    - Support: CATT, Qualcomm, Apple, NEC, MTK

Offline proposal:

* TBD

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| --- | --- |
| Company | Views |
| Qualcomm | We are fine for the above definition. We don’t support simultaneous configuration. |
| NEC | As BFD RS set(s) are configured/assumed per BWP, so we think it’s better to be discussed on BWP level, and the issues are:   1. Whether simultaneous configuration of cell-specific and TRP-specific BFR supported on different BWPs of a same CC.   It seems this is related to the offline definition (Interpretation 2)? For this issue, we think it should be supported, as there may be a case that in one CC, one BWP configured with only one TRP, and another one BWP configured with two TRPs, so cell-specific BFR and TRP-specific BFR should be supported respectively.   1. Whether simultaneous configuration of cell-specific and TRP-specific BFR supported on a same BWP of a CC   It seems this is related to Interpretation 1 (RACH-based fall back). We think this needs to be supported, when two TRPs failed. |
| Apple | Regarding the definition, we think we need clarification as follows：   * Simultaneous configuration of cell-specific and TRP-specific BFR in the same CC refers to the configuration of 3 BFD-RS sets in a CC, where cell-specific and TRP-specific BFR are associated to 1 and 2 BFD-RS sets, respectively.   + Note: The BFD RS should be QCLed with DMRS of PDCCH in the same CC   + Note: One BFD RS can be configured within both cell-specific BFD RS set and TRP-specific BFD RS set |
| NTT DOCOMO | It is good to clarify the definition of simultaneous configuration f cell-specific and TRP-specific BFR. And we don’t support simultaneous configuration. |
| Lenovo/MotM | We are fine for the definition of simultaneous configuration of cell-specific and TRP-specific BFR in the same CC. Then we don’t support simultaneous configuration according to the definition. |
| Spreadtrum | Fine with FL’s definition clarification, also fine with update from Apple. We also don’t support simultaneous configuration. |
| Vivo | Before discussion of the simultaneous configuration, the remaining issues of the simplest TRP-specific BFR procedure should be determined firstly, where only one TRP fails in non-CA case, such as the configuration of BFD-RS, BFR MAC CE and beam reset.  As for the simplest TRP-specific BFR procedure, it needs to be discussed separately in mDCI and sDCI cases.   * For mDCI case, due to RSs and channels associated with CORESETPoolindex, the configuration of BFD-RS and reset beam of CORESETs seem natural. Therefore, the whole procedure of BFR should be discussed. * For sDCI, it is ambiguous to configure BFD-RS, transmit SR and reset beam. And due to sDCI with low priority, we think simplify the procedure of TRP-specific BFR in sDCI case is feasible.   + Support indication of failure event in BFR MAC CE based on the explicitly configured BFD-RS   + No further enhancement on the configuration of TRP-specific NBI-RS and beam resetting |
| LGE | There are two aspects of BFR configuration. One is BFD (configured by *RadioLinkMonitoringConfig* and/or CORESET TCI configuration) as captured by FL.The other is BFRQ related parameters configured in *BeamFailureRecoveryConfig* or *BeamFailureRecoverySCellConfig*, which includes BFRQ-RACH configuration, RSRP threashold, candidate beam RS set configuration, etc.  From BFD perspective, as guided by FL, we think 2 BFD RS sets are sufficient to support both cell-speific and TRP-specific BFR. If both TRPs are in beam failure, it can be considered as cell-specific BF.  From BFRQ perspective for SpCell, however, we think two separate BFRQ configuration for single TRP failure and for cell-specific BF(or both TRP BF) are needed. When a single TRP is in failure, UE can use SR PUCCH for BFRQ. But when both TRPs are in failure, SR PUCCH would not work so that fallback to Rel-15 BFRQ, i.e. CFRA/CBRA based mechanism should be used.  In summary, from BFD perspective (as FL suggested), simultanoues configuration of cell-specific and TRP-specific BFR in the same CC is not needed. But from BFRQ perspective, simultanoues configuration of cell-specific and TRP-specific BFR in the same CC is needed for SpCell. |
| Fujitsu | Support to the offline definition. |
| Sony | Interpretation 2 on cell-specific BFR looks good to us. We are fine with the possibility that simultaneous configuration of cell-specific and TRP-specific BFR. |
| MediaTek | Okay to the offline definition, and we don’t support simultaneous configuration according to the definition. |
| ZTE | We support simultaneous configuration, especically for supporting CFRA-BFR procedure as fall back mode in Pcell. |
| InterDigital | Support the offline definition, however need further discussion on support of simultaneous configuration. |
| Mod | The offline definition (to facilitate discussion) seems agreeable. Revised the offline definition per Apple/LGE/NEC.  @LGE: added a 3rd note to clarify that this definition only involves BFD-RS configuration. Please check if this is fine.  @NEC: clarified that this discussion is for each BWP/CC.  However these seem to be different views whether simultaneous configurations should be supported. |
| Huawei, HiSilicon | We are open to consider simultaneous operation of cell-specific BFR and TRP-specific BFR for one CC. However, we don’t think it is necessary to configure three BFD-RS sets, in terms of UE complexity and system overhead. Instead, we think two BFD-RS sets should suffice. To be specific, when one BFD-RS set is detected with beam failure, TRP-specific BFR is triggered; when both BFD-RS sets are detected with beam failure, cell-specific BFR is triggered. |
| OPPO | We do not support simultaneous configuration. When per-TRP BFR is configured, instead of configuring cell-specific, a CBRA-based fall back is more preferred.  The issue for configuring cell-specific and per-TRP at the same time is: the cell-specific TRP is detected only based on two BFD-RS. The following strange scenario could happen: cell-speific beam failiure is declared while per-TRP BF is not claimed. |
| Xiaomi | It is good to clarify the definition of simultaneous configuration of cell-specific and TRP-specific BFR in the same CC/BWP. According to the offline definition, we prefer not to support configuration of cell-specific and TRP-specific BFR in the same CC/BWP. But we support configuration of both PUCCH-SR and RACH-based BFRQ. |
| Nokia/NSB | Fine with the offline definition |
| Lenovo/MotM | We support the simultaneous configuration of cell-specific and TRP-specific BFR, however, we think it is not necessary to configure 3 BFD-RS sets. Two BFD-RS sets are enough for the case that cell-specific and TRP-specific BFR are simultaneously configured. When both BFD-RS sets are failed, the cell-specific BFR is triggered. |
| TCL | We support simultaneous configuration of cell-specific and TRP-specific BFR at least in SpCell. |
| Convida Wireless | Support the offline definition.  We don’t see the need for simultaneous configuration. In our understanding, CBRA fallback on SpCell is already supported if SR isn’t configured or if SR\_COUNTER reaches its max value. |
| CMCC | We support simultaneous configuration. Fine with the offline definition. |
| LGE | To avoid confusion, we would like to suggest making the note to be more precise, as revised below:   * + Note: Other aspects of simultaneous configuration of cell-specific and TRP-specific BFR such as BFRQ configuration (e.g., information delivered by *BeamFailureRecoveryConfig* or *BeamFailureRecoverySCellConfig* in legacy system) are for separate discussion. |
| Ericsson | We are OK with the definition. Just for clarification: the cell-specific BFR is the legacy BFR procedures? SpCell in R15 and Scell in R16?  [mod]: My understanding is that people may have different views. |
| Futurewei | We shared the same view as several other companies that two BFD-RS sets are enough for the case that cell-specific and TRP-specific BFR are simultaneously configured. Fine to consider simultaneous configuration. |
| AT&T | We are ok with the offline definition |
| FGI/APT | We support to clarify the definition of “simultaneous configuration of cell-specific and TRP-specific BFR” here. Referring to the offline definition, we do not support the kind of simultaneous configuration. Three BFD-RS set configuration imposes much burden on UE side. Same as LG, we think BFRQ discussion is needed. |
| Samsung | We are OK with the definition. |
| Qualcomm | Fine with the latest offline definition. Not support simultaneous configuration to avoid unnecessary complication. TRP-specific BFR can achieve cell level BFR as well. |
| Mod | Please see issue 2 and provide your views. |
| Qualcomm | Support Alt-2 for both issues. TRP-specific BFR can achieve cell specific BFR functions. Configuring both will unnecessarily complicate the logic/complexity. |
| NEC | Similar view with QC.  Support Alt-2 for both Scell and Spcell in issue 2. |

* 1. BFD-RS resource set size (issue 2.2)

Observation:

* Toward the end of last meeting, the majority of companies were willing to support a UE capability on the maximum number of BFD-RS resources per set. The FL recommends to agree on this.

Offline proposal

* The maximum number of BFD-RS resources per set is a UE capability, including a possible candidate value of 1 in Rel.17.

|  |  |
| --- | --- |
| Company | Views |
| Qualcomm | Support the proposal. |
| NEC | Support the proposal. |
| Apple | Support the proposal |
| NTT DOCOMO | Support the proposal |
| Lenovo/MotM | Support the proposal. |
| Spreadtrum | Support the proposal |
| vivo | We would like to remove the FFS from the offline proposal, since it had been agreed in 104bis-e meeting.  Agreement  On BFD-RS of TRP-specific BFR   * BFD-RS resource number:   + The total number of RSs in two BFD-RS sets per DL BWP is a UE capability   + On the maximum number of RS per BFD-RS set, down-select from the following two alternatives in RAN1#105-e     - Alt1: max value is 2     - Alt2: max value is a UE capability, including possible candidate value of 1 |
| LGE | Support the proposal. But I also think FFS point was already agreed in 104bis-e. |
| Fujitsu | Support the proposal. |
| Sony | Support the FL proposal. And we are also fine to remove the FFS in the sub-bullet. |
| MediaTek | Support the proposal without the FFS. As indicated by vivo, the UE capability was agreed in previous meeting. |
| ZTE | Support the FL proposal. |
| InterDigital | Support the FL proposal. |
| Samsung | Fine with the FL proposal |
| Huawei, HiSilicon | Support latest offline proposal |
| OPPO | Support the proposal |
| Xiaomi | Support the FL proposal. |
| Nokia/NSB | Fine with the proposal. |
| TCL | Support the FL proposal. |
| Convida Wireless | Given that we already have a UE capability on the maximum number of BFD-RS across the two sets, we don’t think it’s motivated to also add the per set capability. However, we can accept the majority view for progress. |
| CMCC | Support the proposal. |
| Ericsson | Support the proposal |
| Futurewei | Support the FL proposal. |
| AT&T | Support the proposal |
| FGI/APT | Supportive of FL proposal |
| Samsung | We support the FL’s proposal |
| Intel | Same view as Convida |
| Mod | This seems stable |

* 1. BFD-RS set determination (issue 2.3)

Observation:

* Explicit configuration:
  + the majority of companies support this operation, except one company. Given that QCL-typeD of TCI states may correspond to aperiodic RS, and that beam failure detection should be based on periodic/semi-persistent RS, it appears that explicition configuration is required in Rel.17.
  + Concern: OPPO
* Implicit configuration for M-DCI:
  + Majority of companies support this operation, with no concern raised, where BFD-RS set k (k = 1, 2) is based on CORESETs with CORESETPoolIndex = k.
  + Concern: None
* Implicit configuration for S-DCI:
  + A large number of companies (including operators) support this operation, with a small number of companies with lingering question on its need, which was clarified by supporting companies in the past.
  + Given the majority view, the FL wishes to check if the concerned companies would oppose this functionality.
  + Concern: vivo, OPPO

Offline proposal:

Support the following BFD-RS configurations in Rel.17 for UEs with one activated TCI state per CORESET:

* Explicit configuration:
  + Down-select from the following options in RAN1#106-e
  + Option 1 : RRC configuration BFD-RS resources in BFD-RS set k, k = 0, 1,
    - Supported by : ZTE, Spreadtrum, Samsung, Fujitsu, FGI/APT, Qualcomm, CMCC, MediaTek, LGE, ITRI, Convida, Ericsson, Nokia/NSB, vivo, Sony, ETRI, NEC, Xiaomi
    - Concern : OPPO, Apple (This needs RRC reconfiguration to change BFD-RS)
  + Option 2 :
    - In each TCI state, gNB can optionally configure the BFD RS index
    - If the BFD-RS is not provided, the RS for QCL indication in the TCI state is used for BFD
    - Supporte: Apple
    - Concern: Xiaomi
* Implicit configuration:
  + M-DCI:
    - BFD-RS set k (k = 0, 1) is derived based on X TCI of CORESETs with CORESETPoolIndex = k
    - FFS: value of X (determined in spec or UE capability), and TCI selection rule when the number of CORESETs with CORESETPoolIndex = k exceeds X (e.g. reuse RLM RS selection rule)
    - Supported: ZTE, Lenovo/MoM, Samsung, Fujitsu, OPPO, FGI/APT, Qualcomm, CMCC, MediaTek, AT&T, LGE, Xiaomi, ITRI, Convida, Ericsson, Nokia/NSB, Nokia/NSB, vivo, ETRI, NEC, NTT DOCOMO,Spreadtrum
    - Concern:
  + S-DCI:
    - Down-select from the following options in RAN1#106-e
    - Option 1: BFD-RS set k (k = 0, 1) is derived based on based on TCI of CORESETs with CORESETPoolIndex = k; Extend CORESETPoolIndex to S-DCI (for BFD-RS set generation)
    - Option 2: From TCI states associated with activated TCI codepoint
    - Supported (19): HW/HiSilicon, Lenovo/MoM, Samsung, Fujitsu, MediaTek, CATT, Intel, AT&T, CMCC, LGE, Xiaomi, ITRI, Sony, Nokia/NSB (option 2), QC, NEC
    - Concern (3): vivo, OPPO, Ericsson, Apple

FFS: CORESETs with more than 1 activated TCI states.

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| Company | Views |
| Qualcomm | We support implicit config for s-DCI. Similar to m-DCI, s-DCI can also send PDCCH from both TRPs for diversity. So the use case is as important as m-DCI. Introducing a new TRP ID should be a simple way to our understanding. |
| NEC | We support all the configurations, with more input in above table. |
| Apple | We support to reuse the approach as PL-RS configuration to configure BFD RS as follows：   * Two candidate BFD RS sets can be configured by RRC * In each TCI state, gNB can optionally configure the BFD RS index   + If the BFD RS is not provided, the RS for QCL indication in the TCI state is used for BFD |
| NTT DOCOMO | We support explicit configuration for both m-DCI and s-DCI.  For implicit configuration, we support m-DCI. And we donot think implicit configuration is needed for s-DCI.  But we can be flexible if there is a majority support. |
| Lenovo/MotM | We support explicit and implicit configuration for both S-DCI and M-DCI based M-TRP. |
| Spreadtrum | We support explicit configuration for both m-DCI and s-DCI, implicit configuration for M-DCI. Although we don’t think it is necessary to support implicit configuration for S-DCI, but we can be flexible for the majority. If implicit configuration for S-DCI is supported, we prefer option 2. |
| Vivo | We support explicit BFD-RS configuration for mDCI and sDCI, and implicit BFD-RS configuration for mDCI. |
| LGE | Support both explicit and implicit configuration of BFD-RS, for both M-DCI and S-DCI. |
| Fujitsu | We are fine with all above configurations provided by FL. |
| MediaTek | We support explicit and implicit configuration for both S-DCI and M-DCI |
| ZTE | We can support first two configuration provided by FL. If support sDCI, we think that one ‘TRP-ID’ is needed for ssociating CORESETs and TRPs, like CORSETPoolID in mDCI-mTRP. |
| InterDigital | We support explicit and implicit configuration for M-DCI and S-DCI. |
| Samsung | We support the three configurations above |
| Huawei, HiSilicon | Support the offline proposal in principle, and prefer Option 1 for both explicit and implicit configuration. |
| OPPO | For explicit configuration: we have concern on the misalignment between TCI state switch and BFD RS. In rel16, the TCI state for PDCCH is updated by MAC CE. In rel17, the TCI state for PDCCH is switched by the DCI. The question is how RRC-based BFD-RS configuration can follow the PDCCH TCI state switch.  For implicit configuration, it looks like either Option 1 and Option 2 for S-DCI do not work. In option 1: S-DCI does not have CORESETPoolIndexvalue. Actually, in S-DCI system, we do not differentiate TRP in PDCCH transmission. Option 2: does the activated TCI point means the TCI states for PDSCH? BFR is about the PDCCH, not PDSCH. We can not use the TCI state for PDSCH to detect beam failure on PDCCH. |
| Xiaomi | We support both explicit and implicit configuration for both M-DCI and S-DCI.  As for the FL’s offline proposal, for explicit configuration, we are confusing about Option 2, we want to know what TCI state in Option 2 refer to ?  For implicit configuration for M-DCI, we are fine with the offline proposal.  For implicit configuration for S-DCI, we prefer Option 1. |
| Nokia/NSB | Fine with the offline proposal. For explicit configuration, support option 1. For S-DCI implicit configuration, we support option 2. Option 1 is too restrictive limiting the number of the CORESET per TRP due to fixed configuration. |
| MediaTek | Support the FL proposal and prefer Option 1 for both configurations. |
| Lenovo/MotM | For explicit configuration, we only support Option 1 since it’s a straightforward option by extending the existing solution of explicit configuration of BFD-RS set.  For implicit configuration in M-DCI, support the proposal.  For implicit configuration in S-DCI, support Option 1. |
| TCL | Support the offline proposal. Regarding the explicit configuration and implicit configuration, we prefer Option1. |
| Convida Wireless | We support explicit configuration (option 1). We also support implicit configuration for M-DCI.  For implicit configuration for S-DCI, we could come back to this in Rel-18, after completion of multi-TRP PDCCH repetition and SFN enhancements. |
| CMCC | For explicit configuration, support Option1.  For implicit configuration of S-DCI, we support Option1. |
| ZTE | For explicit configuration, the following case should be additionally provided:   * + Option 3 : MAC-CE activation for BFD-RS resources in BFD-RS set k, k = 0, 1,   For mDCI-mTRP, we can support it.  For sDCI-mTRP, we perfer Option-1.  [Moderator] : Although I personally support the proposal, this should be discussed in section 2.4. |
| NTT DOCOMO | For explicit configuration, support Option1.  For implicit configuration of S-DCI, even though we think it has lower priority, we can be flexible. |
| Ericsson | For explicit configuration, we support option 1, to align with legacy BFR  For implicit configuration, we support mDCI operation  We do not support implicit configuration for sDCI operation: we are very reluctant to introduce CORESETPoolIdx for sDCI operation, and we do not understand option 2: wouldn’t that mean up to 8 BFD-RSs? |
| Futurewei | Support the offline proposal and we prefer Option 1 for both configurations. |
| AT&T | We support implicit configuration for both mDCI and sDCI |
| Mod | Noted Ericsson’s concern to implicit sDCI. This can be discussed online. |
| FGI/APT | We support explicit and implicit configuration for both M-DCI and S-DCI based M-TRP. For Explicit configuration, we prefer Option 1. For Implicit configuration, we prefer Option 1 as well. |
| Samsung | Support the offline proposal by the FL. |
| Qualcomm | Support the offline proposal. For s-DCI, we think Option 1 can be a more flexible solution but open to discuss. |
| Intel | Agree with QC, we also think technically there is no difference in motivation to support both sDCI and mDCI cases for implicit configuration |

* 1. BFD-RS set update by MAC-CE (issue 2.4)

Observation:

* Two companies support update of BFD-RS sets by MAC-CE, which is currently only possible by RRC. Among these two companies, one company supports this functionality only if implicit BFD-RS is not supported (for at least S-DCI).

Offline Conclusion

* There is no concensus to support BFD-RS set update by MAC-CE.

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| Company | Views |
| Qualcomm | We believe implicit BFD RS is needed and can solve this issue. Even for explicit BFD RS, our understanding based on the spec is that UE will select the BFD RS with same QCL as the new CORESET TCI from the RRC configured candidate BFD RSs. |
| Apple | With our proposal in 3.3, this issue would not exist. |
| NTT DOCOMO | We think it is beneficial to support the update of BFD-RS sets by MAC-CE, since the TCI state of CORESET can be updated by MAC CE. |
| Spreadtrum | Not needed if supporting implicit BFD-RS configuration in issue 3.3. |
| LGE | Not needed. Implicit configuration has similar functionality already. |
| Sony | It seems that whether such MAC CE is needed or not depends on whether implicit BFD-RS set determination can be supported. |
| ZTE | If considering sDCI based enhancement and R17 unified TCI architecture, we identify the necessity of explicit configuration for BFD-RS.  But, BFD RS is still reconfigured through RRC signaling. Such different latency of dynamic signaling and RRC signaling would cause misalignment and ambiguity to BFD. Specifically, when the beam of PDCCH is updated by DCI, the current q\_0 may not be suitable for BFD anymore. Therefore, updating BFD RS based on a dynamic signaling should be supported. As a starting point, updating BFD RS through MAC-CE signaling can be considered. |
| InterDigital | We don’t think this is needed. |
| Huawei, HiSilicon | Seems not really needed - Implicit derivation of BFD-RS in Section 3.3 should suffice. |
| Xiaomi | This issue will be not exist with implicit configuration of BFD-RS set. |
| Nokia/NSB | Not needed. This is already supported by updating TCI for CORESET. |
| Lenovo/MotM | Support the conclusion. |
| Convida Wireless | Agree that the enhancement could be beneficial, but we can discuss again in a later release. |
| ZTE | It is up to final decision in Section 3.3. |
| Ericsson | Not needed. Similar view as Nokia/NSB. |
| Futurewei | Support the offline conclusion. It is not needed with the support of implicit configuration. |
| Qualcomm | Support the offline conclusion, but also fine to discuss later. |
| Intel | No need to conclude this, lets check outcome of 3.3 |

* 1. NBI-RS set association to BFD-RS set (issue 2.5)

Observation:

* It has been agreed there is a 1-to-1 association between BFD-RS set and NBI-RS set. Three options on BFD-RS/NBI-RS set association are pending a down-selection.

Offline proposal

* Detail of 1-to-1 association between BFD-RS set and NBI-RS set is left to RAN2.

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| Company | Views |
| Qualcomm | Support Alt2. Both BFD-RS set and NBI-RS set are linked to the TRP ID. |
| Apple | Support Alt1. One question to Alt2, is it configured by RRC or MAC CE? If it is configured by RRC, there seems to be no difference compared to Alt1. |
| NTT DOCOMO | We think Alt1 is sufficient. |
| Lenovo/MotM | Support Alt 1 or 3. |
| Spreadtrum | Support Alt1, also fine with Alt3 |
| vivo | As for NBI-RS, we think it can be configured optionally. If not configured, an aperiodic beam report can be triggered and achieve the functionality of finding new beam(s) after NW receiving the BFR MAC CE not carrying new beam(s). And compared with periodic measurement of NBI-RS resources, aperiodic beam measurement consumes less resource, which is beneficial for the network to schedule various services of users within the limited UE capability flexibly.  If NBI-RS set are configured, we prefer Alt-1 that the association between BFD-RS set k and NBI-RS set j is 1-to-1 and fixed in spec, which has less signal overhead and specification impact. |
| LGE | Either alt1 or alt3 is fine. |
| Fujitsu | Support Alt2. |
| Sony | Support Alt-2 which links to actual ‘TRP ID’ i.e. CORESETPoolIndex defined in Rel.16. |
| MediaTek | Support Alt2. CORESET pool index can be used to provide the association. |
| InterDigital | Support Alt2. |
| Mod | @all: Please comment if it is OK to leave it to RAN2. I think it accommodates all possibilities.  In my view this is not the most urgent issue in RAN1 and we should move on. |
| Huawei, HiSilicon | Support the latest offline proposal |
| OPPO | Support the updated proposal |
| Xiaomi | Slightly prefer Alt 2 by configuration with CORESETPoolIndex. |
| Nokia/NSB | Support offline proposal. |
| Lenovo/MotM | Support FL proposal. |
| Convida Wireless | Support the proposal.  Support both Alt 1 and Alt 3, i.e. it is fixed in the spec, but the details can be left in RAN2.  It is not clear what the benefit is of a configurable association between BFD RS set and NBI RS set, given that the set/list of NBI RS is configurable. If the gNB want to “flip” the association, it can just reconfigure/flip the NBI RSs? |
| CMCC | Support Alt 2. |
| ZTE | It is not our preference, but we can live with it. |
| NTT DOCOMO | Support FL proposal. |
| Ericsson | Support FL proposal |
| Futurewei | Support the offline proposal. |
| FGI/APT | Support FL proposal (i.e., left to RAN2) |
| Qualcomm | Support the offline proposal. |
| Intel | Agree this is not an urgent issue but not sure we need to agree to leave it to RAN2 – we can still give it a shot later ? |

* 1. PUCCH-SR resource selection (issue 2.6)

Observation:

* In case of one TRP failure (one SCell and/or SpCell), whether/how to perform PUCCH-SR resource selection for LRR has been debated in several meetings. Four candidate options were captured in Chairman’s notes for down-selection in RAN1#106-e.
* An offline email discussion was conducted between RAN1#105-e, where another two alternatives were discussed.

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| *Offline Proposal1 in email*   * *For PUCCH-SR resource selection for TRP-specific BFR,* * *Support to configure an association between a TRP (e.g., BFD-RS set) on SpCell and a PUCCH-SR resource on SpCell.*   *Offiline Proposal2 in email*   * *When 2 PUCCH-SR resources are configured on SpCell, if SR for BFR is triggered (e.g., by any TRP/cell failure in the cell group), the two PUCCH-SR resources are transmitted.* |

* The FL does not intend to spend online time on this, unless consensus can be reached offline. Note that if consensus is not possible, option A is the default assumption.

Offline proposal (offline proposal 1 in email discussion)

* For PUCCH-SR resource selection for TRP-specific BFR,
  + Support to configure an association between a TRP (e.g., BFD-RS set) on SpCell and SCell(s) (FFS) and a PUCCH-SR resource on SpCell.
* Concern: Apple, Convida, Ericsson

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| --- | --- |
| Company | Views |
| Qualcomm | Support offline proposal 1. Suppose UE sends two PUCCH-SRs, gNB may need to determine which one is stronger to send back response. This may require ideal BH and additional coordination between 2 TRPs. If gNB simply sends responses from both TRPs after receiving the 2 PUCCH-SRs, this unnecessarily wastes UL resource and we need to further clarify beam resetting time is based on which response. If gNB sends response only from one randomly selected TRP, the response may not be reliable if the selected TRP is the failed one. So UE only sending PUCCH-SR to the working TRP should be the most efficient way to avoid unnecessary transmissions. |
| NEC | In our understanding, PUCCH-SR resource selection is actually related to BFR on SpCell.  If two TRPs configured for SpCell, and one TRP failed, either Alt 1 or Alt 2 can be applied for PUCCH-SR resource selection, and if no TRP failed on SpCell, any one of the two PUCCH-SR resource can be selected. |
| Apple | We think up to UE implementation could be the best way, which is like RACH resource selection for CBRA. |
| NTT DOCOMO | Support offline proposal 1. At least on SpCell, such association is beneficial. |
| Lenovo/MotM | Support offline proposal 1. And if only one TRP is failed on SpCell, then a PUCCH-SR resource transmitting for the other TRP should be selected; otherwise, it’s up to UE implementation to select one PUCCH-SR resource of two PUCCH-SR resources. |
| Vivo | Both Alt 2.5.2 B and Alt 2.5.2 C are OK to us. |
| LGE | Not fine with current Alt 2.5.2 B or Alt 2.5.2 C. As it covers only a partial case (i.e., at most one BFD-RS set fails per CC) and gNB don’t know which case will happen to UE. Either completely defining selection rule or not defining any selection rule is fine to us. In this regard, we can compromise to accept the offline proposal 1 if it is modified as follows:  *Offline Proposal1 in email*   * *For PUCCH-SR resource selection for TRP-specific BFR,* * *Support to configure an association between a TRP (e.g., BFD-RS set) on SpCell/SCell(s) and a PUCCH-SR resource on SpCell.*   Offline proposal 2 seems conflicting with proposal 1 since proposal 1 is for PUCCH resource selection while proposal 2 is for transmitting both PUCCH resources when two PUCCH resources are configured in SpCell. |
| Fujitsu | Support offline proposal 1 at least for M-DCI. |
| Sony | Slightly prefer offline Proposal 1. |
| MediaTek | Support offline proposal 1 |
| ZTE | Support offline proposal 1. |
| InterDigital | Support offline proposal 1 and Alt. 2.5.2B/Alt2. |
| Samsung | Support offline proposal 1. The association is necessary at least for SpCell. Support sending PUCCH-SR to working TRP. |
| Mod | @all: please see if offline proposal 1 (in email discussion) is agreeable. |
| Huawei, HiSilicon | Support the latest offline proposal |
| OPPO | The association between BFR and PUCCH is built through SR configuration, which is specified in RAN2. So, suggest to change the wording of the proposal:  Support to configure an association between a BFR of a TRP with a SR configuraiton. |
| Xiaomi | Support FL’s offline proposal 1, and either Alt 2.5.2 B or Alt 2.5.2 C is fine to us. |
| Nokia/NSB | Support offline proposal. |
| MediaTek | Support the proposal |
| Lenovo/MotM | The PUCCH-SR resources can only be configured in SpCell, there is an association between TRPs in SpCell and PUCCH-SR resources is sufficient. It is hard to built the association between TRPs in a SCell and PUCCH-SR resources considering that the TPRs in different SCell may be different with the TRPs in SpCell. Therefore, we propose the modified proposal as shown:   * For PUCCH-SR resource selection for TRP-specific BFR,   + Support to configure an association between a TRP (e.g., BFD-RS set) on SpCell~~/SCell(s)~~ and a PUCCH-SR resource on SpCell. |
| TCL | Support Alt 2.5.2 A. We share the same view as LGE |
| Convida Wireless | We prefer to revert the agreement on 2 PUCCH-SR resources since it has become increasingly clear to us that it doesn’t provide any significant benefit beyond what the multi-TRP PUCCH enhancement in agenda 8.1.2.1 offers. Furthermore, the introduction of 2 PUCCH resources per SR configuration violates the current RAN2 framework and therefore adds more unnecessary work to RAN2. |
| CMCC | Support offline proposal 1. |
| ZTE | Support the proposal. |
| NTT DOCOMO | Fine with either keeping or deleting ‘SCell(s)’ in the proposal. |
| Mod | Put SCells with FFS, per request from Lenovo. |
| Ericsson | We think the agreement on 2 PUCCH-SR resources should be reverted. If the PUCCH-SR resource selection is up to the UE, the feature is anyway useless. |
| Futurewei | Support the latest offline proposal 1. |
| FGI/APT | For PUCCH-SR resource selection for TRP-specific BFR, we support UE implementation. We don’t think specifying an association just tailored for SpCell is useful, since TRP-BFR should be configured for other SCells as well. |
| Qualcomm | Support the offline proposal. |
| Intel | Support latest offline proposal 1 |
| Apple | We still have concern for this proposal. Some questions to the proposal:  Q1: Does it mean when 2 PUCCH resources are configured, mDCI based mTRP should be enabled for PCell?  Q2: Does it mean the mTRP operations from PCell and SCell should be from the same 2 TRPs? |

* 1. PUCCH-SR spatial filter (issue 2.7)

Observation:

* In Rel.16, a PUCCH resource can have 1 activated UL spatial relation info at any time. With Rel.17 PUCCH enhancement for M-TRP, it is possible that a PUCCH resource can have more than 1 activated UL spatial filters. Several companies discussed whether Rel.17 PUCCH-SR for M-TRP BFR should be allowed to have more than 1 activated UL spatial relation info, and if so, transmission scheme.
* The FL believes this is not the most essential issue for Rel.17 completion. Unless consensus can be reached, the FL proposes to postpone this issue to later stage.

Offline proposal

* Postpone to future meetings.

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| --- | --- |
| Company | Views |
| NTT DOCOMO | Support FL offline proposal. |
| Lenovo/MotM | Support the proposal |
| LGE | Support 2 activated UL spatial relation info for a PUCCH-SR resource. |
| MediaTek | Okay to postpone |
| ZTE | We are fine to postpone this discussion. |
| InterDigital | Support FL’s offline proposal. |
| Xiaomi | OK to postpone. |
| Nokia/NSB | OK to postpone. We think PUCCH spatial relation is upto NW configuration. UE use spatial relation as configured by NW. No further specification work is required. |
| Convida Wireless | OK to postpone. |
| Ericsson | Support FL proposal |
| FGI/APT | Fine with the proposal |
| Intel | Agree with proposal |
| NEC | Support the offline proposal. |

* 1. BFRQ MAC-CE content (issue 2.8, 2.9, 2.10)

void

* 1. QCL/Spatial filter and power update after gNB response (issue 2.11)

Observation:

* A large number of companies support QCL assumption update for CORESETs that have been identified as failed and for which a new beam has been reported. For implicit BFD-RS determination, applicable CORESETs can be derived from the assoction of CORESETs to BFD-RS and NBI-RS sets. For explicit BFD-RS determination, association of BFD-RS sets to applicable CORESETs have been proposed, e.g. via CORESETPoolIndex.
* A few company support spatial filter and power control parameter update for PUCCH. Association between applicable PUCCH resources and new beam is needed in this case, e.g. via association between PUCCH resources and CORESETPoolIndex. Several companies expressed concerns (e.g. MediaTek, vivo, Convida, Ericsson).
* One company supports QCL/spatial filter and power control parameter update for all DL/UL data/control channels, across CCs in a band.
* Offline proposal: after receiving BFR responseFor each failed TRP link, the DL QCL-typeD assumption of all CORESETs with 1 activated TCI state associated with that TRP is updated by the resource associated with the latest reported new candidate beam (if found)
  + FFS: How to associate CORESET(s) with TRP link
  + FFS: timeline for the new beam updte after receiving BFR response
* FFS: Update of QCL-type D assumption UL spatial filter/power control assumption for PUCCH, and other channels/RSs
* The above applies at least to SCell; FFS SpCell

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| Company | Views |
| Qualcomm | Our views are added to the list. |
| NEC | We are fine with the discussion when one TRP failed, and in case of two TRPs failed, we think it should depend on the output of 3.1 and 3.10 |
| Apple | Currently the number of active TCI/QCL is limited from commercial UE, if we only recover the control channel beam, one possible outcome is that gNB has to use fallback mode, e.g. default PDSCH beam and DCI format 0\_0 to schedule data channel. |
| NTT DOCOMO | We support the new beam and/or power update for both DL and UL. |
| Lenovo/MotM | Support the beam updating of CORESETs.  Support the beam updating and power control parameter updating for PUCCH. And support to specify an association between applicable PUCCH resources and BFD-RS sets. |
| Vivo | We support updating QCL assumption for CORESETs that associate with the same CORESETPoolindex as the failed BFD-RS set in mDCI case. But for the spatial relation of PUCCH, due to no relationship between PUCCH resource and CORESETPoolindex currently, we think the spatial relation of PUCCH can be updated by MAC CE, rather than the new beam directly, which has no specification impact. |
| LGE | This issue has dependency on the detailed design of BFR MAC-CE (e.g. whether to report new beam per TRP or for one TRP). It would be good to discuss this after stabilizing the MAC-CE design. Our preference is to align design principle of Rel-15/16 BFR as much as possible. |
| Fujitsu | We are fine to discuss the QCL/spatial assumption update of CORESET(s) and PUCCH(s). |
| MediaTek | Support the beam updating only for CORESET(s) after gNB response |
| ZTE | We think that this issue is very essential, and should be discussed with high priority. |
| Xiaomi | We support beam updating for CORESETs and PUCCHs. |
| Convida Wireless | Share the view of Vivo. |
| Ericsson | We support update of QCL assumptions for CORESETs. Association via CORESETPoolindx needs further discussion. |
| FGI/APT | We agree with Apple’s views that it’s useful to update all DL/UL data/control channels at least within one CC. We are fine to extend it to apply across CCs in a band. |
| Mod | Please share your views on the offline proposal. |
| Qualcomm | Support the offline proposal. |
| Apple | Suggest some revision as follows. We do not know why SpCell is FFS. At least if Pcell and SCell are in the same band, it seems there is no reason to preclude PCell.   * Offline proposal: after X symbols after receiving BFR response, the QCL assumption of all CORESETs with 1 activated TCI state associated with failed BFD RS set reported in the MAC CE for TRP-specific BFR is updated by the resource associated with the latest reported new candidate beam (if found)   + FFS: How to associate CORESET(s) with the failed BFD RS set   + FFS: details of X * FFS: Update of QCL assumption for other downlink channels/RSs, e.g. PDSCH, and UL spatial filter/power control assumption for PUCCH, and other UL channels/RSs * The above applies at least to SCell; FFS SpCell |
| NEC | Support the offline proposal. |
| OPPO | Why does the proposal have “with 1 activated TCI state”? We do not have activated TCI state for PDCCH. Each CORESET in mDCI mTRP system is indicated with one TCI state. |
| MediaTek | We are okay to Apple’s revision with one change if I don't misunderstand the intension of “1 acitvated TCI state” in this proposal:  Offline proposal: After X symbols after receiving BFR response, the QCL assumption of all CORESETs with 1 activated TCI state per CORESET associated with failed BFD RS set reported in the MAC CE for TRP-specific BFR is updated by the RS resource associated with the latest reported new candidate beam (if found)   * + FFS: How to associate CORESET(s) with the failed BFD RS set   + FFS: details of X * FFS: Update of QCL assumption for other downlink channels/RSs, e.g. PDSCH, and UL spatial filter/power control assumption for PUCCH, and other UL channels/RSs * The above applies at least to SCell; FFS SpCell   And we have the same question raised by Apple, any particular reason why this proposal cannot apply to SpCell? |

* 1. RACH-based fallback (issue 2.12, 2.13)

Observation:

* Issue 2.12 (CBRA): A large number of companies support CBRA-based fallback on SpCell *as a result of* per-TRP beam failure detection. Several triggering conditions are proposed.
* Issue 2.13 (CFRA): Lenovo/Asustek/Nokia/NSB/LGE/ ZTE support CFRA-based fallback.

Offline proposal

* CBRA-based transmission can be triggered on SpCell as a result of beam failure detection for per-TRP BFR
* *FFS: applicable scnearios, e.g.* 
  + *Scenario 1: When beam failure is detected on all BFD-RS sets on the SpCell*
  + *Scenario 2: at least one TRP fails on SpCell*
  + *Scenario 3: at least one pre-defined TRP fails on SpCell*
  + *Scenario 4: at least one TRP fails and no PUCCH-SR is configured, and no UL grant is available*
  + *Scenario 5: If MAC-CE based reporting does not work (details FFS)*
  + *Scenario 6: When no PUCCH-SR is configured*
* FFS: CFRA based transmission on SpCell

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| Company | Views |
| Qualcomm | Support the offline proposal. CBRA can be triggered if both TRPs fail on SpCell. |
| NEC | Support the proposal. |
| Apple | Support the proposal. At least when no PUCCH-SR configured, CBRA should be the fallback mode. |
| NTT DOCOMO | Support the FL offline proposal. |
| Lenovo/MotM | We support both CBRA-based and CFRA-based(if CF-RA for BFR is configured) fallback. |
| ASUSTeK | Support the proposal, and support configurable CFRA based transmission (similar to legacy SpCell BFR) for fallback RACH on SpCell. |
| LGE | The proposal looks ambiguous since triggering condition is not captured. We would like to clarify whether this is for SpCell per-TRP BFR or SCell per-TRP BFR. If this is for SpCell per-TRP BFR, and if both TRPs are in failure, it will be good to reuse Rel-15 BFR mechanism as fallback(i.e. based on CFRA/CBRA) as commented earlier. If this is for SCell per-TRP BFR, and if both TRPs are in failure, it will be good to reuse Rel-16 BFR mechanism as fallback(i.e. based on SR PUCCH/CBRA). |
| MediaTek | Support both CBRA and CFRA |
| ZTE | Firstly of all, we can NOT live with CBRA-only.  By default, if two TRPs fail in SpCell, CFRA-BFR as specified in Rel-15 should be supported. Then, we share the same views with LGE that the condition should be discussed firstly, and current FL proposal looks ambiguous. |
| InterDigital | Support FL’s offline proposal. |
| Huawei, HiSilicon | Support triggering RACH-based BFR when both BFD-RS sets are detected with beam failure. |
| Xiaomi | Support FL’s offline proposal |
| Nokia/NSB | Support both CBRA and CFRA. At least, UE can trigger CBRA without restriction. |
| TCL | Support the offline proposal. CBRA can be a fallback mode when two TRPs fail in SpCell. |
| Convida Wireless | Support the proposal. It seems “CBRA fallback” is already supported if SR isn’t configured or if the max number of SR transmissions is reached. |
| CMCC | Support the FL proposal. |
| Ericsson | This is unclear. For SpCell, legacy BFR will under som circumstances trgger CBRA.What would the triggering criterion be in this case?  [mod]: I think this could be further clarified under the first sub-bullet (condition for CBRA). For instance it remains open |
| Futurewei | Support the offline proposal. |
| FGI/APT | Support in general, but we suggest clarifying the triggering contitions first as other companies mentioned. |
| Intel | Support the FL proposal |
| Mod | Added a list of possible scenarios. Please share your views. |
| Qualcomm | Support both Scenario 1 and 4. |
| Apple | Support scenario 6 |
| NEC | Support the updated proposal, and at least for Scenario 1 and 4. |
| OPPO | Support scenario 5. When the MAC CE BFRQ can not go through, the UE can trigger CBRA |
| MediaTek | Support Scenario 1 and 4. |

1. Simultaneous reception of signals with different QCL-typeD assumption

**Table III**: list of issues and company positions

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| --- | --- | --- |
| **#** | **Issue and proposals** | **Companies’ views** |
| 3.1 | Alt1: **To enhance priority rule to facilitate UE  to receive downlink  signals with two different QCL -TypeD properties, e.g. PDCCH QCL prioritization rule enhancement**  Alt2: **To release some scheduling restrictions which mandate gNB to schedule downlink  signals with the same QCL -TypeD property or prohibit to schedule some downlink  signals overlapped in time domain, e.g. PDSCH + SSB** | Alt1:  Support: Apple, QC, MTK , Ericsson  Concern:  Alt2:  Support: Apple  Concern; |
| 3.2 | Type of combinations to be enhanced:  Case 1: PDCCH+PDCCH  Case 2: PDCCH+PDSCH  Case 3: CSI-RS + CSI-RS | Case 1:  Support: Lenovo, MediaTek, Ericsson  Concern:  Case 2:  Support: MediaTek  Concern:  Case 3:  Support: Lenovo, Ericsson  Concern: |
| 3.3 | Study both S-DCI and M-DCI | Support: DOCOMO, Ericsson  Concern: |

Observation:

Offline proposal:

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| Company | Views |
| Qualcomm | Our preference is added to the list |
| NTT DOCOMO | We support to identify the combination type first, and then discuss each case one by one for S-DCI based and M-DCI based scenarios, respectively. |
| Huawei, HiSilicon | Suggest not opening such discussion at late stage of R17. |
| Nokia/NSB | Simultaneous PDCCH reception shall be discussed under AI8.1.2.1.  Reeiving two CSI-RSs shall be clarified the usecase, and this impacts to RAN4 requirement. We prefer to discuss this aspect in the later release. |
| Ericsson | Our preferences are updated in the table. |

1. Previous agreements
   1. RAN1#102-e

**Agreement**

For L1-RSRP, consider measurement / reporting enhancement to facilitate inter-TRP beam pairing

* Option-1: Group-based reporting,
  + e.g., beam restriction to facilitate inter-TRP pairing.
* Option-2: Non-group-based reporting

**Agreement**

Evaluate and study at least but not limited to the following issues for multi-beam enhancement

* Issue 1: Consideration of inter-beam interference
* Issue 2: For group-based reporting, increased number of groups and/or beams per group
* Issue 3: UE Rx panel related beam measurement/report
  + NOTE: “UE panel” is used for discussion purpose only

**Agreement**

* Evaluate enhancement to enable per-TRP based beam failure recovery starting with Rel-15/16 BFR as the baseline.
* Consider following potential enhancement aspects to enable per-TRP based beam failure recovery
  + Issue 1: TRP-specific BFD
  + Issue 2: TRP-specific new candidate beam identification
  + Issue 3: TRP-specific BFRQ
  + Issue 4: gNB response enhancement
  + Issue 5: UE behavior on QCL/spatial relation assumption/UL power control for DL and UL channels/RSs after receiving gNB response

**Agreement**

Study Rel.17 enhancements on beam management for multi-TRPs with following priority

* High priority:
  + Beam measurement/reporting enhancement
  + Beam failure recovery for multi-TRP
* Low priority
  + Simultaneous reception of same type of channel/RS with different QCL-TypeD
  + Simultaneous reception of different type of channel/RS with different QCL-TypeD
  1. RAN1#103-e

Agreement

Down-select at least one of the following options for beam measurement/reporting enhancement to facilitate inter-TRP beam pairing in RAN1 #104-e

* Option 1: In a CSI-report, UE can report N>1 pair/groups and M>=1 beams per pair/group
  + Different beams in different pairs/groups can be received simultaneously
  + FFS: whether M is equal or can be different across different pair/group
* Option 2: In a CSI-report, UE can report N(N>=1) pairs/groups and M (M>1) beams per pair/group
  + Different beams within a pair/group can be received simultaneously
* Option 3: UE report M(M>=1) beams in N (N>1) CSI-reports corresponding to N report setting
  + Different beams in different CSI-reports can be received simultaneously
  + FFS: whether/how to introduce an association between different CSI-reports
  + FFS: whether/how to differentiate reported measurements for beams that are received simultaneously vs. beams that are not received simultaneously
    - whether/how to introduce an indication along with the CSI-reports to indicate whether the beams in different CSI-reports can be received simultaneously
* FFS: value of N and M in each option
* FFS: Association between different beams in above options and different TRP/UE panels
* FFS: Identify new use cases per option compared with R16 (including backhaul)
* FFS: whether different beams in different pairs/groups/reports can be received by same spatial filter per option

**Agreement**

* For M-TRP beam failure detection, support independent BFD-RS configuration per-TRP, where each TRP is associated with a BFD-RS set.
  + FFS: The number of BFD RSs per BFD-RS set, the number of BFD-RS sets, and number of BFD RSs across all BFD-RS sets per DL BWP
  + Support at least one of explicit and implicit BFD-RS configuration
    - With explicit BFD-RS configuration, each BFD-RS set is explicitly configured
      * FFS: Further study QCL relationship between BFD-RS and CORESET
    - FFS: How to determine implicit BFD-RS configuration, if supported
* For M-TRP new beam identification
  + Support independent configurat**i**on of new beam identification RS (NBI-RS) set per TRP if NBI-RS set per TRP is configured
    - FFS: detail on association of BFD-RS and NBI-RS
    - Support the same new beam identification and configuration criteria as Rel.16, including  L1-RSRP, threshold

Agreement

* Support TRP-specific BFD counter and timer in the MAC procedure
  + The term TRP is used only for the purposes of discussions in RAN1 and whether/how to capture this is FFS

Agreement

* Support a BFRQ framework based on Rel.16 SCell BFR BFRQ
  + In RAN1#104-e, select one from the following options
    - Option 1: Up to one dedicated PUCCH-SR resource in a cell group
      * A cell group refers to either MCG, SCG, or PUCCH cell group
      * FFS: number of spatial filters associated with the PUCCH-SR resources
      * FFS: How the SR configuration is done
    - Option 2: Up to two (or more) dedicated PUCCH-SR resources in a cell group
      * A cell group refers to either MCG, SCG, or PUCCH cell group
      * FFS: whether each PUCCH-SR resource is restricted to be associated to one spatial filter
      * FFS: How the SR configuration is done
  + FFS: Whether no dedicated PUCCH-SR resource can be supported in addition to Option 1 or Option 2
* Study whether and how to provide the following information in BFRQ MAC-CE
  + Index information of failed TRP(s)
  + CC index (if applicable)
  + New candidate beam index (if found)
  + Indication whether new beam(s) is found
  + FFS: whether/how to incorporate multi-TRP failure
  1. RAN1#104-e

**Agreement**

For beam measurement in support of M-TRP simultaneous transmission

* Support a single CSI-report consisting of N beams pairs/groups and M (M>1) beams per pair/group, and different beams within a pair/group can be received simultaneously
  + Support M = 2
  + Support extending the maximum value of N > 1, exact value FFS
  + N=1 and N=2
    - FFS: Other values larger than 2
    - FFS: Whether the UE could report beams are received with different RX beams
* Further study the support of option 1 and option 3
* The above applies at least for L1-RSRP
  + FFS: L1-SINR

**Agreement**

* For M-TRP BFR Support 1-to-1 association between each BFD-RS set and an NBI-RS set
  + FFS: Association details

**Agreement**

For M-TRP BFR

* Support 2 BFD-RS sets per BWP, and up to N resources per BFD-RS set
  + FFS: value of N (e.g. fixed in specification, or UE capability)
* FFS: number of BFD RSs across all BFD-RS sets per DL BWP (e.g. fixed maximum value or UE capability)

**Agreement**

For BFRQ of M-TRP BFR

* Option 3: Up to two dedicated PUCCH-SR resources in a cell group
* FFS: Whether PUCCH-SR for SCell can be reused for M-TRP
* Support BFRQ MAC-CE that can convey information of failed CC indices, one new candidate beam for the failed TRP/CC (if found), and whether new candidate beam is found
  + Support at least indication of a single TRP failure
    - FFS: whether/what information of failed TRP(s) is conveyed in the MAC-CE
    - FFS: whether/how to support indication of more than one TRP failure, corresponding BFR procedure, and applicable cell type (SCell vs. SpCell)
* FFS: UE behavior when TRP failure status is different across cells
* FFS: Whether PUCCH SR resource can be configured with 2 spatial relations
  1. RAN1#104b-e

**Agreement**

For beam reporting option 2

* On the maximum number of beam pairs/groups (N) that can be reported in a single CSI-report, discuss and down-select from the following two alternatives in RAN1#105-e:
  + Alt1: Support maximum value N = {1, 2}
  + Alt2: Support maximum value N = {1, 2, 3, 4}
* FFS: Introduce a UE capability Ncap on the maximum value of N in Rel.17
* On the number of beam pairs/groups (N) reported in a single CSI-report, discuss and down select between the following two alternatives in RAN1#105-e
  + Alt1: The value of N is fixed by RRC configuration
  + Alt2: The value of N is upper bounded by a maximum value Nmax configured by RRC, and dynamically selected/indicated by UE

**Agreement**

On CMR resource configuration for beam reporting option 2, adopt the following alternative:

* Two CMR resource sets or subsets, per periodic/semi-persistent CMR resource setting
  + FFS: extension to aperiodic CMR resource setting
* Each reported beam pair in a single CSI-report consists of M = 2 SSBRI / CRI values, where each SSB-RI / CRI points to a CMR resource in a different CMR resource set or subset.
* Decide in RAN1#104b-e whether to adopt “set” or “subset” in the above.

**Agreement**

* Support simultaneous configuration of cell-specific BFR and TRP-specific BFR in different CCs.
* FFS: whether cell-specific and TRP-specific BFR can be configured in the same CC.

**Agreement**

* Support S-DCI and M-DCI in TRP-specific BFR in Rel.17
  + S-DCI is low priority, M-DCI is high priority
  + Unified design for S-DCI and M-DCI should not be precluded due to the prioritization

**Agreement**

On BFD-RS of TRP-specific BFR

* BFD-RS resource number:
  + The total number of RSs in two BFR-RS sets per DL BWP is a UE capability
  + On the maximum number of RS per BFD-RS set, down-select from the following two alternatives in RAN1#105-e
    - Alt1: max value is 2
    - Alt2: max value is a UE capability, including possible candidate value of 1

**Agreement**

Adopt the following beam failure detection criteria for each BFD-RS set

* The physical layer in the UE assesses the radio link quality per BFD-RS set and indicates the BFD-RS set index to higher layers every X ms, if the hypothetical PDCCH BLER of all BFD-RS in the corresponding set of BFD-RS is higher than a threshold
  + X is max{minimal periodicity of BFD RS in the set, 2ms}

**Agreement**

A UE configured with TRP-specific BFR can be configured with 1 PUCCH-SR resource in a cell group

* NOTE: it has been agreed in RAN1#104-e that a UE can be configured with up to 2 PUCCH-SR resources in a cell group

**Agreement**

For the TRP specific BFR, for a UE configured with two PUCCH-SR resources in a cell group when beam failure is detected in a one or more CCs in one or more of BFD-RS sets configured in one or more of CCs,

* Down select one of the following PUCCH-SR resource selection rules when SR is triggered (or their combinations) for the study, without precluding other alternatives, in RAN1#105-e
  + Alt-1: PUCCH-SR resource associated with other/non-failed BFD-RS set, association details FFS
  + Alt-2: PUCCH-SR resource associated with failed BFD-RS set, association details FFS
  + Alt-3: Leave it up to UE implementation
* Note: PUCCH-SR resource is PUCCH resource carrying SR
* FFS: Whether two PUCCH-SR resources are under the same or different SR resource configuration or SR configuration (eventual decision may or may not happen in RAN1)

**Agreement**

On CMR resource configuration for beam reporting option 2, decide in RAN1#105-e whether to adopt “set” or “subset”:

* NOTE: the following has been agreed
  + Two CMR resource sets or subsets, per periodic/semi-persistent CMR resource setting
    - FFS : extension to aperiodic CMR resource setting if two CMR resource sets are supported
  + Each reported beam pair in a single CSI -report consists of M = 2 SSBRI/CRI values, where each SSBRI /CRI points to a CMR resource in a different CMR resource set or subset.
* FFS : bitwidth of each SSBRI/CRI determined based on the number of SSB/CSI-RS resources from the associated set/subset, or across two sets/subsets
  1. RAN1#105-e

**Agreement**

For CMR configuration for option 2, adopt

* Alt-1: “set”

**Agreement**

The bitwidth of each SSBRI/CRI is determined based on the number of SSB/CSI-RS resources in the associated CMR resource set

* FFS: specify the association between SSBRIs/CRIs in a reported group and CMR resource sets

**Agreement**

* For beam measurement/reporting option 2, the maximum number of beam groups in a single CSI-report is a UE capability and may take value from Nmax = {1,2,3,4} in Rel.17.
  + FFS: If UCI payload reduction for Nmax>=2 is needed and if so, how
* The number of beam groups (N) reported in a single CSI-report
  + Alt1: The value of N is configured by RRC signalling

**Agreement**

Select one of the following alternatives with possible modification in RAN1#106-e

* Alt 2.5.2 A:
  + On PUCCH-SR resource selection rule when SR is triggered and 2 PUCCH-SR resources are configured, there is no consensus to adopt alt-1 or alt-2. PUCCH-SR resource selection is up to UE implementation.
* Alt 2.5.2 B:
  + On the PUCCH-SR resource selection rule when SR is triggered and 2 PUCCH-SR resources are configured, and at most one BFD RS set fails per CC, adopt alt 2 if all failed BFD RS sets cross CCs are associated with the same PUCCH SR resource, else PUCCH-SR resource selection is up to UE implementation.
* Alt 2.5.2 C:
  + On the PUCCH-SR resource selection rule when SR is triggered and 2 PUCCH-SR resources are configured, and at most one BFD RS set fails per CC, adopt alt 1 if all failed BFD RS sets cross CCs are associated with the same PUCCH SR resource, else PUCCH-SR resource selection is up to UE implementation.
* Alt 2.5.2 D:
  + Revert the past agreement on supporting configuration of up to 2 PUCCH-SR resources. A UE can be configured up to 1 PUCCH-SR resource in a cell group.
  1. RAN1#106-e

**Agreement**

For aperiodic report of beam reporting option 2,

* When associated with aperiodic resource setting, extend the existing RRC parameter *CSI-AssociatedReportConfigInfo* to be configured with two CMR resource sets where each may be configured with their corresponding QCL information.
  + FFS: Detailed association scheme
* When associated with periodic/semi-persist resource setting, the resource setting comprises two CMR resource sets.

**Conclusion**

There is no consensus to support M>2 beams per group for beam reporting option 2 in Rel.17.

**Agreement**

Support differential L1 RSRP reporting as a UCI reduction scheme for beam measurement/reporting option 2.

**Agreement**

Differential reporting across all beam groups in a CSI-report

* Including 1-bit indicator of the CMR set associated with the largest RSRP value in all groups
  + NOTE: best beam is assumed in the 1st group
  + 1-bit indicating CMR set with higher RSRP value (e.g. 0 indicating 1st SSBRI/CRI from 1st CMR set, 1 indicating 1st SSBRI/CRI from 2nd CMR set); UCI payload partitioning = 7/4 bits for 1st/2nd SSBRI/CRI in first beam group; 4 bits for all beams in other groups;

**Agreement**

For multi-TRP BFR, a single MAC-CE is used at least for BFRQ for all TRPs in all CCs in a cell group, which includes

* Indices of failed BFD-RS set (as an indication of failed TRP link)
* Indices of CC containing the failed TRP link
* An indicator whether a new candidate beam is identified in the NBI-RS set associated with the failed BFD-RS set, and an resource indicator representing the new candidate beam (if identified) based on the number of NBI-RS resources in the corresponding NBI-RS set.
* FFS: Content of MAC-CE related to SpCell when transmitted on msg3, msgA
* Note: MAC-CE signaling design details are up to RAN2
* The term “failed TRP link” is used here for discussion purposes only

1. Reference

|  |  |  |
| --- | --- | --- |
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| [R1-2106938](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106938.zip) | Enhancements on beam reporting and beam failure recovery for multi-TRP | CATT |
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