**3GPP TSG RAN WG1 #106-e R1-210nnnn**

**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 contribution 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

|  |  |  |
| --- | --- | --- |
| **#** | **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 DOCOMONo: Option 2: Lenovo/MoM, NTT DOCOMONo: 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 DOCOMOAlt-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-1: mediaTek, NECAlt-2: MediaTek, CATT, Intel, DOCOMO, QC, NEC, SonyAlt-3: MediaTek  |
| 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 UCI payload partitioning (e.g. 7/4 bits or 4/7 bits) between 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 * Alt-1.1: MediaTek
* Alt-1.2: NEC

Alt-2: ZTEAlt-3: CATT, QCAlt-4: Sony |
| 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)
	+ **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: LGE, DOCOMO (BM option 1)Alt-2: ZTE, Samsung, Qualcomm, CMCC, MediaTek, Apple, LGE, Xiaomi, Ericsson, CATTAlt-3: Nokia/NSB, SonyAlt-4:  |
| 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, QCNo:  |
| 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: ZTE, CATT, Lenovo/MoM, Spreadtrum, Qualcomm, Intel, LGE, Xiaomi, TCL, Nokia/NSB, Sony, ETRI, NTT DOCOMO
* No: 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
* Option 3: CATT, Nokia/NSB, vivo
* No: CMCC, Apple, Ericsson, Qualcomm, NTT DOCOMO
 |

* 1. Increasing M beyond 2 (issue 1.1)

Observation**:**

* On whether the number of reported beams in a group (M) should be increased beyond 2, at least one company is OK with supporting M > 2 for option 2. For option 1 (which has not been agreed yet), one company proposes to adopt M = 1/2/3/4.

Offline proposal

|  |  |
| --- | --- |
| Company | views |
| Qualcomm | We are fine to support M>2 with UE capability for Option 2. Option 2 itself may be enough to our understanding. |
| NEC | We do not support M > 2 for option 2. 2 CMR sets configuration is agreed for option 2, and M=2 could be enough. To support M>2 with 2 CMR sets we need to address many new issues, e.g., how to determine the number of beams per set, how to report. |
| Apple | We failed to see the use case of M>2. Currently, mTRP only supports 2 TRPs. |
| NTT DOCOMO | Support M>2 with UE capability for Option 2. Also support Option 1 with UE capability. |
| Lenovo/MotM | We are fine support M>2 and the value of M is configured by RRC singaling according to UE capability. Option 1 with M>2 are useful for mDCI mTRP scheduling, where dynamic beam pairing is required. |
| Spreadtrum | Not support M>2 for option 2. Only up to 2 TRPs is supported for M-TRP. We have not seen the use case and necessarity. |
| vivo | We don’t support M>2 for Option 2. if M is larger than 2, the pair relationship between CMRs within the group would be confusing. |
| LGE | For option 2, support only M=2. |
| Sony | With up to 2 TRPs, we think it’s not necessary to support M>2 beams per group.  |

* 1. Aperiodic CMR configuration (issue 1.2)

Observation:

* It was agreed in the last meeting that CMR resource associated with each TRP is represented by a CMR resource set. For periodic/semi-persistent CMR, this should be straightforward as one CMR resource setting comprises two CMR resource sets (each associated with a TRP). For aperioic CMR configuration, one company (MediaTek) proposes two alternatives. In one alternative, one CMR resource setting consists of a list of CMR sets, where an aperiodic triggering state can be associated with two CMR sets in the resource setting. In the other alternative, two CMR set lists are included in the resource setting, and a triggering state is associated with two CMR sets (in two CMR set lists respectively).

Offline proposal

|  |  |
| --- | --- |
| Company | views |
| Qualcomm | Our understanding is that current trigger state can already link to multiple CMR sets. The only missing thing is to clarify each trigger state can trigger two sets simultaneously, which is not allowed today. A new CMR list may not be needed to our understanding. CSI-AssociatedReportConfigInfo ::= SEQUENCE { reportConfigId CSI-ReportConfigId, resourcesForChannel CHOICE { nzp-CSI-RS SEQUENCE { resourceSet INTEGER (1..maxNrofNZP-CSI-RS-ResourceSetsPerConfig), qcl-info SEQUENCE (SIZE(1..maxNrofAP-CSI-RS-ResourcesPerSet)) OF TCI-StateId OPTIONAL -- Cond Aperiodic }, csi-SSB-ResourceSet INTEGER (1..maxNrofCSI-SSB-ResourceSetsPerConfig) }, csi-IM-ResourcesForInterference INTEGER(1..maxNrofCSI-IM-ResourceSetsPerConfig) OPTIONAL, -- Cond CSI-IM-ForInterference nzp-CSI-RS-ResourcesForInterference INTEGER (1..maxNrofNZP-CSI-RS-ResourceSetsPerConfig) OPTIONAL, -- Cond NZP-CSI-RS-ForInterference ...} |
| Apple | We are open to study the issue, but we would like to understand it more. It seems currently one trigger state can be linked to multiple CMR sets, what would be the problem for legacy way？ |
| NTT DOCOMO | Similar view with QC.In Rel-16, if a Resource Setting linked to a CSI-ReportConfig has multiple aperiodic resource sets, only one of the aperiodic CSI-RS resource sets from the Resource Setting is associated with the trigger state. In Rel-17 MTRP beam measurement/reporting, for aperiodic CSI Resource Settings, up to two of the aperiodic CSI-RS resource sets from the Resource Setting can be associated with a trigger state. And if two of the aperiodic CSI-RS resource sets are configured, it should be used for group-based beam reporting only. |
| Spreadtrum | Share the same view with Qualcomm/Docomo. We just need to remove the restriction in the legay way. |
| vivo | We share similar view with QC/DOCOMO/SPRD. In addition to the configuration of the CMR set, we think the TCI state list corresponding to the CMR set also needs to be enhanced when the CSI resource setting the sets belongs to is aperiodic. |
| LGE | We also share the similar view with Qaulcomm. Anyway, it should be enhanced to associate two CMR resource sets for a single *CSI-AssociatedReportConfigInfo* IE. In order to reuse legacy RRC structure, two CMR set can be included in a single *CSI-AssociatedReportConfigInfo* IE, or it can be interpreted two CMR set is included in a single *CSI-AssociatedReportConfigInfo* IE when one of the linked two CMR sets is included in the IE. |

* 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.

Offline proposal

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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.  |

* 1. UCI reduction scheme (issue 1.4)

Observation:

* Differential reporting has been supported in group-based reporting in earlier NR releases. One open issue from the last meeting is how/whether to support UCI reduction toward M-TRP. Several proposals are captured in Table I.

Offline proposal

* Support differential reporting as a UCI reduction scheme for beam measurement/reporting option 2.
* Details FFS.

|  |  |
| --- | --- |
| Company | Views |
| Qualcomm | Support Alt3. We don’t think new bits should be introduced to reduce the payload.  |
| NEC | Firstly, we support the proposal to have differential reporting in general.Secondly, we support Alt-1 in Table 1 #1.4 to have global differential reporting since clearly it has a lower UCI size.Thirdly, we support Alt-1.2 to reflect which set has the highest RSRP reported. To make it clear, we suggest the following changes in red for **Table 1, #1.4, Alt-1.2*** + **Alt-1.2**: 1-bit indicating the mapping position of 7-bit highest RSRP value, e.g., UCI payload partitioning ~~(e.g.~~ 7/4 bits or 4/7 bits~~) between~~ for reporting RSRP values corresponding to 1st/2nd SSBRI/CRI in first beam group; 4 bits in all other groups;

We also notice the relationship between issue 1.3 and 1.4. Naturally, if a pre-defined/fixed mapping order of SSBRI/CRI (e.g., Alt1 or Alt2 of Table 1, #1.3) is supported, Alt-1.2 would be the reasonable solution. |
| Apple | Support the proposal |
| NTT DOCOMO | Support FL’s offline proposal.For issue 1.4, support Alt.1 in the table. |
| Lenovo/MotM | We think issue 1.4 should be discussed together with issue 1.3. Generally, we support to adopt differential reporting for overhead reduction. We slightly prefer Alt-1.1 since only 1 additional bit is introduced when two CMR resource sets are configured. |
| Spreadtrum | Support FL’s offline proposal, also support Alt-1 |
| vivo | We prefer Alt-1. In addition to differential reporting, to further reduce UCI payload size, we think the reported beam information could be divided into two parts, like CSI, with part 1 only reporting a subset of the reported beam information and indicating whether there is the second subset of beam information that needs to report in part 2. |
| LGE | I think one alternative is missed in Table 1, that 7 bit RSRP for the each CMR in first(best) group and 4 bit differential RSRP value for the rest of CMRs. Each differential value of CMR within a CMR resource set can be calculated from the best CMR within the CMR resource set(=differential value of CMR of a TRP can be derivated from best CMR of that TRP). This method has several benefits, 1) the additional indication for the position of best CMR is not needed, 2) differential value can be expressed by 4 bit bitwidth with sufficient value range, since differential value is calculated within a TRP. Meanwhile, in case of Alt 1-1, 4 bit bitwidth for differential value would not be enough for express RSRP of worst CMR in worst TRP. This is because, for some cases including single/multiple Rx panel reception, RSRP difference between two TRP can be extremely large. Based on the SLS simulation in our companion contribution(R1-2107821), RSRP difference between 2 TRP on a multi-Rx panel UE can be more than 30 dB in worst case, which cannot be exprressed by 4 bit differential RSRP value with 2 dB step size. This can be a critical problem when multiple beam groups are reported in option 2. |
| Sony | As for Alt-1, it seems the global differential reporting across all beam group could save the most UL payload with lowest indication cost, i.e. 1 bit to locate the largest RSRP. But our concern is the quantization loss. Taking SS-RSRP quantization as example, the strongest value is quantized ranging from -156dBm to -31dBm, and the differential value is only up to -30dB. So if the gap between the strongest RSRP from TRP1 and the strongest RSRP from TRP0 is larger than -30dB, then there would be large quantization loss for the CMRs from the 2nd TRP. Therefore, we think differential reporting with each CMR set (added as Alt-4) can be considered as well.  |

* 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. One company proposed to delay this discussion until panel-ID related issue in AI 8.1.1. is more stabilized.

Offline proposal

|  |  |
| --- | --- |
| 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.  |

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

Observation:

* Related to UE indication of panel related information, it is possible that gNB provides indication/configuration of such panel-related hypotheis in CSI-report configuration.

Offline proposal

|  |  |
| --- | --- |
| 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. |

* 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.

Offline proposal

* NOTE: The FL recommends to make a decision whether it is supported in RAN1#106-e.

|  |  |
| --- | --- |
| 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. |

* 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.

|  |  |
| --- | --- |
| 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. |

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 | Simultaneous configuration of cell-specific and TRP-specific BFR in a cell   | Yes: APT/FGI, CMCC, MediaTek, ITRI, TCL, Nokia/NSB, Sony,No : Qualcomm, Intel, DOCOMO, CATT |
| 2.2BFD-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: FGI/APT, Convida,
* Alt-2: Qualcomm, Apple, LGE, TCL, vivo, ETRI, NTT DOCOMO, Sony

Q2: Yes: Qualcomm, Sony |
| 2.3BFD-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, NECNO: 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,SpreadtrumQ3: HW/HiSilicon, Lenovo/MoM, Samsung, Fujitsu, MediaTek, CATT, Intel, AT&T, CMCC, LGE, Xiaomi, ITRI, Sony, Nokia/NSB (option 2), QC, NECNo: EricssonQ4: MediaTek, CATT (if explicit BFD-RS is adopted), OPPO, SpreadtrumNo: LGE  |
| 2.4BFD-RS | Introduce MAC-CE for updating explicit BFD-RS set | Support: CATT, ZTE |
| 2.5NBI-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,Alt-2: ZTE, Fujitsu, OPPO (via CORESETPoolindex), Qualcomm, CMCC (via CORESETPoolIndex), Sony (via CORESETPoolindex)Alt-3: Convida, Nokia/NSB,  |
| 2.6PUCCH-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, TCLAlt-2.5.2 B: ZTE (SCell), InterDigital, Spreadtrum, CATT, Fujitsu, Qualcomm, Xiaomi, ETRIAlt-2.5.2 C: ZTE (SpCell), Samsung, NEC, CMCC, Xiaomi, CATT, Nokia/NSB, NTT DOCOMO, SonyAlt-2.5.2 D: Convida, Ericsson |
| 2.7PUCCH-SR resource | Whether PUCCH-SR resource can have 1 or 2 activated spatial filtersAlt-1: Only 1 Alt-2: up to 2; diversity (e.g. AI 8.1.2.1) when 2 spaial filters are activatedAlt-3: up to 2; filter selection when 2 spatial filters are activatedAlt-4: up to 2; transmission method undefined when 2 spatial filters are activated | Alt-1: Spreadtrum, Alt.2: CATT, NTT DOCOMOAlt-3: Qualcomm, Intel, Alt-4: APT/FGI, Apple, Convida, |
| 2.8MAC-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, SonyAlt-2: ZTE(?)Alt-3:  |
| 2.9MAC-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,SpreadtrumAlt-2: ZTE, OPPO, Sony, ETRI, |
| 2.10MAC-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

Q2: * Alt-1: CATT, QC
* Alt-2: Convida
 |
| 2.11Beam/power update | UE assumption of DL QCL-typeD and UL filter/power control after receiving gNB responseQ1: 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, SonyQ2: Support: CATT, QC, NTT DOCOMO, Spreadtrum, SonyQ3: Support: ZTE, Lenovo/MoM, Spreadtrum, Fujitsu, OPPO, MediaTek, CATT, Sony, ETRI, QC, NTT DOCOMONo: Q4: Support: ZTE, Lenovo/MoM, Spreadtrum, Fujitsu, APT/FGI, Qualcomm, DOCOMO, Sony, ETRINo: OPPOQ5: Support: Apple No:  |
| 2.12RACH 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 DOCOMONo:  |
| 2.13RACH based fallback | Support CFRA based fallback  | Support: AsustekNo:  |

* 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.

Offline definition (for purpose of facilitating discussion)

* 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.

Action item:

* Please comment if the offline definition above is agreeable.
* Please share your views on issue 2.1 in Table II.

Offline proposal:

|  |  |
| --- | --- |
| 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. |

* 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.
	+ FFS: whether the maximum total number of BFD-RS resources across two BFD-RS sets is a UE capability.

|  |  |
| --- | --- |
| 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. AgreementOn 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. |

* 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 aperidic RS, and that beam failure detection should be based on periodic/semi-persistent RS, it appears that explicition configuration is required in Rel.17.
* 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.
* 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.

Offline proposal

*

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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. |

* 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 proposal

|  |  |
| --- | --- |
| 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.  |

* 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

|  |  |
| --- | --- |
| 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. |

* 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.

|  |
| --- |
| *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 onsensus can be reached offline. Note that if onsensus is not possible, option A is the default assumption.

Offline proposal

|  |  |
| --- | --- |
| 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.  |

* 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.

|  |  |
| --- | --- |
| 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. |

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

Observation: There are three main issues on MAC-CE design

* Whether one or two MAC-CEs are used for BFRQ report.
* What information is conveyed in the MAC-CE
* Format of information in the MAC-CE

Offline proposal

|  |  |
| --- | --- |
| Company | Views |
| Qualcomm | One MAC-CE is enough. Failed BFD-RS set ID should be included. CORESETPoolIndex only works for m-DCI. Support Alt2, the same MAC-CE can also indicate new beam per TRP when both TRPs fail |
| Apple | We support one MAC CE.We think the failed BFD RS set ID should be reported.Detail MAC CE format can be handled by RAN2, and we can decide what information is needed. |
| NTT DOCOMO | One MAC-CE is enough.For a SCell, the MAC CE can indicate new beam per TRP, if found, when two TRPs fail.For SpCell, the MAC CE indicates one new beam for the failed TRP, if found, when one TRP fails. If both TRPs fail, since RACH will be performed, we need to discuss whether an enhancement BFR MAC CE can be transmitted in Msg.3. |
| Lenovo/MotM | One MAC CE is enough. Failded TRP index(ex), CC index(ex), and new beam index if new beam can be found. |
| Spreadtrum | One MAC CE is enough.Failed BFD-RS set index and new beam index if found should be reported.Regarding the format of information in the MAC-CE, it can be up to RAN2. |
| Vivo | For issue 1, we prefer one MAC CE to be used for BFRQ report.For issue 2 and issue 3, we think when one TRP fails, the corresponding BFR MAC CE would contain the following contents:* Indication of failed TRP
	+ Prefer BFD-RS set index with consideration that CORESETPoolindex only exists in mDCI case
* Indication of the cell containing the failed TRP
* Indication whether new beam(s) is found if NBI-RS(s) is configured for the failed TRP
* New beam index if NBI-RS(s) is configured for the failed TRP and new beam is found
	+ Reuse legacy format to indicate new beam
	+ Legacy format: new beam index is determined based on the number of the NBI-RS resources in the corresponding NBI-RS set
 |
| LGE | One MAC-CE is enough. Failed BFD-RS set ID is fine for TRP ID. |

* 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.
* 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

|  |  |
| --- | --- |
| 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). |

* 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): One company proposes 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: exact triggering condition
* FFS: CFRA based transmission on SpCell

|  |  |
| --- | --- |
| 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). |

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

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

|  |  |  |
| --- | --- | --- |
| **#** | **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 Concern: Alt2: Support: AppleConcern;  |
| 3.2 | Type of combinations to be enhanced: Case 1: PDCCH+PDCCHCase 2: PDCCH+PDSCHCase 3: CSI-RS + CSI-RS | Case 1: Support: Lenovo, MediaTekConcern: Case 2: Support: MediaTekConcern: Case 3: Support: LenovoConcern:  |
| 3.3 | Study both S-DCI and M-DCI | Support: DOCOMOConcern:  |

Observation:

Offline proposal:

|  |  |
| --- | --- |
| 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. |

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. Reference

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| --- | --- | --- |
| [R1-2106791](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106791.zip) | Enhancements on beam management for multi-TRP | Sony |
| [R1-2106868](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106868.zip) | Enhancements on beam management for multi-TRP | Samsung |
| [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 |
| [R1-2107031](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107031.zip) | Enhancements on beam management for multi-TRP | Fujitsu |
| [R1-2107081](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107081.zip) | Beam management for simultaneous multi-TRP transmission with multi-panel reception | FUTUREWEI |
| [R1-2107145](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107145.zip) | Discussion on beam management for multi-TRP | NEC |
| [R1-2107206](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107206.zip) | Enhancements on beam management for multi-TRP | OPPO |
| [R1-2107298](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107298.zip) | Discussion of enhancements on beam management for multi-TRP | FGI, Asia Pacific Telecom |
| [R1-2107326](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107326.zip) | Enhancements on beam management for multi-TRP | Qualcomm Incorporated |
| [R1-2107393](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107393.zip) | Enhancements on beam management for multi-TRP | CMCC |
| [R1-2107470](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107470.zip) | Enhancements on beam management for multi-TRP | ETRI |
| [R1-2107487](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107487.zip) | Enhancement on beam management for multi-TRP | MediaTek Inc. |
| [R1-2107573](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107573.zip) | Multi-TRP enhancements for beam management | Intel Corporation |
| [R1-2107690](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107690.zip) | Beam Management Enhancements for multi-TRP | AT&T |
| [R1-2107721](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107721.zip) | Views on Rel-17 multi-TRP BM enhancement | Apple |
| [R1-2107817](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107817.zip) | Enhancements on beam management for multi-TRP | LG Electronics |
| [R1-2107841](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107841.zip) | Discussion on beam management for MTRP | NTT DOCOMO, INC. |
| [R1-2107896](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2107896.zip) | Enhancement on beam management for Multi-TRP | Xiaomi |
| [R1-2108009](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2108009.zip) | Discussion on beam management for multi-TRP | ITRI |
| [R1-2108021](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2108021.zip) | On Multi-TRP BFR | Convida Wireless |
| [R1-2108030](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2108030.zip) | Discussion on beam management for multi-TRP | ASUSTEK COMPUTER (SHANGHAI) |
| [R1-2108044](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2108044.zip) | Enhancements on beam management for multi-TRP | TCL Communication Ltd. |
| [R1-2108045](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2108045.zip) | On beam management enhancements for multi-TRP | Ericsson |
| [R1-2108055](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2108055.zip) | Enhancements on Beam Management for Multi-TRP/Panel Transmission | Nokia, Nokia Shanghai Bell |