**3GPP TSG RAN WG1 #104b-e R1-210nnnn**

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

Source: Moderator (CATT)

Title: Moderator summary #3 on M-TRP simultaneous transmission with multiple Rx panels

Agenda Item: 8.1.2.3

Document for: Discussion and Decision

1. Background

This is FL summary #3 of Rel.17 MIMO AI 8.1.2.3.

Company inputs in the previous two rounds of discussion are documented in [1] and [2].

# Discussion

* 1. Beam measurement/reporting
     1. Issue 1: CMR configuration

**Proposal:** On CMR resource configuration for beam reporting option 2 , decide in RAN1#104b-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
  + 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 CRI determined based on the number of SSB/CSI-RS resources from the associated set/subset, or across two sets/subsets

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| Company | Views |
| Moderator  Summary | **Observation from last round**:   * Support “set” (9): Qualcomm, ZTE, Apple, Lenovo/MoM, CMCC, Huawei, HiSilicon, Futurewei, * Support “subset” (7): vivo, DOCOMO, LGE, CATT, TCL, Nokia/NSB |

* + 1. Issue 2: UE panel/antenna related feedback

**Proposal**: For potential UE panel related information feedback for beam reporting option 2, further study the following alternatives:

* 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
* Other alternatives are not precluded

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| Company | Technical views |
| Moderator  Summary | **Observation from last round**. There is no consensus.  Alt-1:   * Support: vivo, Lenovo/MotM, AT&T, Huawei, HiSilicon, Futurewei * Concern: OPPO, DOCOMO, MediaTek, Xiaomi, Nokia/NSB, Qualcomm   Alt-2:   * Support: CMCC, vivo, ZTE, MediaTek, Lenovo/MotM, Xiaomi, Apple; Samsung, AT&T, Huawei, HiSilicon, Futurewei, Qualcomm * Concern: OPPO, Nokia/NSB |

* + 1. Issue 3: L1-SINR and interference measurement

**Proposal 2.4**: For beam reporting option 2, evaluate the performance, specification, and implementation aspects of L1-SINR based beam measurement/feedback, including at least the following aspects

* Physical resource for interference measurement, e.g.
  + CMR of the other reported beam within the beam pair, and/or
  + CMR of the reported beam, and/or
  + Dedicated IMR resource
* UE behavior of interference measurement
* Note: L1-RSRP report has been agreed for option 2

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| Company | Technical views |
| Moderator | **Observation from last round**: There is no consensus.   * Support: DOCOMO, ZTE, Lenovo&MotM, LGE, CMCC, ETRI, AT&T, Huawei, HiSilicon, Futurewei, Qualcomm * Concern: vivo, Apple, OPPO, Nokia/NSB (except implicit IMR) |

* + 1. Issue 4: Value of N

The following has been agreed and a down-selection is due in RAN1#105-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*

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| Company | Technical views |
| Moderator  Summary | **Observation from last round**: There is no consensus at the moment.  Moderator recommends to follow the RAN1#104b-e agreement and down select in RAN1#105-e.  Q1:   * Alt-1: OPPO, Xiaomi, Apple, OPPO, * Alt-2: DOCOMO, CATT, ZTE, MediaTek, CMCC, TCL, Nokia/NSB, Samsung, Huawei, HiSilicon, Futurewei, Qualcomm   Q2:   * Alt-1: CATT, DOCOMO, OPPO, MediaTek, Xiaomi, Apple (with a researched SSBRI/CRI value to indicate no beam identified), LGE, CMCC, Huawei, HiSilicon, Futurewei, Qualcomm * Alt-2: CATT, ZTE, MediaTek, OPPO, TCL, Nokia/NSB, Samsung |

* 1. M-TRP Beam failure recovery
     1. Issue 0: Simultaneous configuration of cell-specific and TRP-specifc BFR on the same cell

**Proposal**:

* FFS: whether cell-specific and TRP-specific BFR can be configured in the same CC.

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| Company | Technical views |
| Moderator summary | **Observation from last round**:   * There is no consensus. * Some companies (e.g. DOCOMO, Xiaomi, Lenovo/MotM, NEC, LGE, APT/FGI, Apple, Samsung, AT&T, Ericsson) think this is possible, while some (OPPO, Convida, MediaTek, Huawei, HiSilicon, Futurewei, Qualcomm) disagree. * Some companies suggested that SpCell and SCell may be discussed separately. |
| Qualcomm | We support not to simultaneously configure both on same CC to simplify the design/complexity. Otherwise, UE may have to monitor BFD RS for both, and new rules are needed for the interaction between the two, e.g. if both per-TRP and cell level BFR are triggred, do we need to report both or report only one? We are also open to discuss the design for simultaneous configuration of both before certain deadline. If no consensus, then we should agree no simultaneous configuration. |

* + 1. Issue 1: S-DCI vs. M-DCI

**Proposal**:

* Support S-DCI and M-DCI in TRP-specific BFR in Rel.17

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| Company | Technical views |
| Moderator summary | **Observation**: There is no consensus. Individual company view appears stable.   * Support (23): Huawei, HiSilicon, CATT, vivo, CMCC, Intel, Samsung, Nokia/NSB, AT&T, Ericsson, Spreadtrum, Qualcomm, Futurewei, APT/FGI, Convida, Xiaomi, NEC, Sony, DOCOMO, TCL, ETRI * Concern on S-DCI (6): ZTE, OPPO, MediaTek, Lenovo/MM, Apple |
| Qualcomm | We support both sDCI and mDCI. They are identical in terms of use case. Yes, we agree a TRP ID may be needed for sDCI to work. Perhaps we can prioritize mDCI first, then sDCI if time allows? |

* + 1. Issue 3: 1-to-1 association between BFD-RS and NBI-RS set

Proposal:

* On the 1-to-1 association between BFD-RS setsand NBI-RS sets when two NBI-RS sets are configured, down-selecte from the following two alternatives in RAN1#105-e
  + Alt-1: First BFD-RS set associated with first NBI-RS set, and second to the second(NOTE: how to capture this can be up to RAN2)
  + Alt-2: RRC configurable association between BFD-RS se *k* (*k*=0, 1) and NBI-RS set *j* (*j*=0, 1). (NOTE: how to capture this can be up to RAN2)

Revised Proposal:

* On the 1-to-1 association between BFD-RS setsand NBI-RS sets, support the following association
  + Alt-1: First BFD-RS set associated with first NBI-RS set, and second to the second (NOTE: how to capture this can be up to RAN2)

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| Company | Technical views |
| Moderator summary | **Observation from last round**:   * Alt1 (16): CATT, DOCOMO, Convida, MediaTek, Lenovo&MotM, Xiaomi, Apple, NEC, APT/FGI, TCL, Ericsson, Futurewei, Huawei, HiSilicon (both acceptable) * Alt2 (3): ZTE, Huawei, HiSilicon (both acceptable) * Can be left to RAN2 (4): OPPO, Nokia/NSB, AT&T, Qualcomm   A revised proposal is provided based on majority view. |
| Qualcomm | Suggest to add the following text to clarify how those sets are finally linked to CORESETPoolIndex for both sides to be in sync on the failed TRP. Otherwise, we are also fine to leave the signaling to RAN2   * On the 1-to-1 association between BFD-RS sets and NBI-RS sets, support the following association   + Alt-1: First BFD-RS set associated with first NBI-RS set, and second to the second (NOTE: how to capture this can be up to RAN2)     - For mDCI, both first sets map to CORESETPoolIndex 0, and both second sets map to CORESETPoolIndex 1     - FFS: sDCI |

* + 1. Issue 4: Explicit/implicit BFD-RS set

**Version 1**

Proposal 3.3.c: BFD-RS set configuration

* Support both explicit and implicit BFD-RS set configuration in Rel.17 with 1 activated TCI state for each CORESET
* For implicit BFD-RS configuration, down select from the following two alternatives
  + Alt-1: support implicit BFD-RS configuration for M-DCI, where BFD-RS set *k* is derived from TCI states of CORESETs with the same *CORESETPoolIndex*
  + Alt-2: Support implicit BFD-RS configuration, where BFD-RS set *k* is derived from TCI states of CORESET with the same *CORESETGroupIndex*

**Revised version 2**: BFD-RS set configuration

* Support both explicit and implicit BFD-RS set configuration in Rel.17 with 1 activated TCI state for each CORESET.
* For implicit BFD-RS configuration, down select from the following two alternatives
  + Alt-1: support implicit BFD-RS configuration for M-DCI, where BFD-RS set *k* is derived from TCI states of CORESETs with the same *CORESETPoolIndex*
  + Alt-2: Support implicit BFD-RS configuration, where BFD-RS set *k* is derived from TCI states of CORESET with the same *CORESETPoolIndex.* Extend configuration of *CORESETPoolIndex* to S-DCI in Rel.17 when TRP-specific BFR is configured.

**Revised version 3**: BFD-RS set configuration

* Support both explicit and implicit BFD-RS set configuration in Rel.17 with 1 activated TCI state for each CORESET.

**Revised version 4**: BFD-RS set configuration

* Support both explicit and implicit BFD-RS set configuration in Rel.17 with 1 activated TCI state for each CORESET.
* For implicit BFD-RS configuration for M-DCI and S-DCI M-TRP
  + For M-DCI, BFD-RS set *k* is derived from TCI states of CORESETs with the same *CORESETPoolIndex*
  + FFS: details for S-DCI

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| Company | Technical views |
| Moderator summary | **Summary from last round**:   * 4 companies support implicit only. * 28 companies support both implicit and explicit. Some companies think explicit is not strictly necessary but are are OK to accept both (e.g. Intel, CATT).   A revised proposal (version 4) is provided based on Nokia/NSB’s suggestion. |
| Qualcomm | Suggest the following wording change, since 2-TCI CORESET is still pending  **Revised version 4**: BFD-RS set configuration   * Support both explicit and implicit BFD-RS set configuration in Rel.17 ~~with~~ at least in case of 1 activated TCI state for each CORESET. * For implicit BFD-RS configuration for M-DCI and S-DCI M-TRP   + For M-DCI, BFD-RS set *k* is derived from TCI states of CORESETs with the same *CORESETPoolIndex*   + FFS: details for S-DCI |
| Convida Wireless | Support the proposal, but a suggested rewording for clarity, similar to Qualcomms suggestion above:   * For M-DCI, the first BFD-RS set is derived from TCI states of CORESETs with *CORESETPoolIndex* = 0 and the second BFD-RS set is derived from TCI states of CORESETs with *CORESETPoolIndex* = 1. |

* + 1. Issue 5: Implicit configuration for BFD-RS set with more than 1 activated TCI

**Proposal:**

* For a CORESET associated with more than 1 activated TCI states
  + BFD-RS set associated with this CORESET is based on QCL-typeD source RS of all activated TCI states
  + FFS: BLER determination based on two TCI states, e.g. whether separate BLER are independently derived from each TCI state, or a common BLER is derived from all TCI states, or leave to RAN4

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| Company | Technical views |
| Moderator summary | **Observation from last round**:   * There is no consensus. * Some companies think the case with two activated TCI states relates to AI 8.1.2.1/8.1.2.4 and should be postponed until the other two AIs are sufficiently clear. |
| Qualcomm | We are fine for the Proposal. |

* + 1. Issue 7: Whether two NBI-RS sets can overlap

Proposal:

* When two NBI-RS sets are configured , set k and j are disjoint (k, j = 0, 1)
  + This applies to at least SCell. FFS for SpCell (e.g. whether NBI-RS set associated with TRP associated with CORESET #0 may include NBI-RS associated with the other TRP)

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| Company | Technical views |
| Moderator summary | **Observation from last round**:   * There is no consensus. |
| Qualcomm | We are fine for the proposal |

* + 1. Issue 8: RACH-based fallback

Proposal: CBRA-based transmission can be triggered on a SpCell for per-TRP BFR as least in the following scenarios

* Scenario 1: When beam failure is detected on all BFD-RS sets on the SpCell
* FFS: other scenarios
  + 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
* NOTE: It is RAN1’s understanding that RAN1 decision does not preclude RAN2 from studying other scenarios.

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| Company | Technical views |
| Moderator summary | **Observation from last round**:   * Support proposal and scenario 1: DOCOMO, Convida, Lenovo, ZTE, Xiaomi, NEC, LGE, APT/FGI, TCL, ETRI, Samsung, Huawei/HiSilicon, Futurewei, Ericsson. Qualcomm, CATT * Focus on single-TRP failure first: CMCC, vivo * When PUCCH-SR is not configured (added Scenario 6): Apple * No restriction (by UE implementation): OPPO, Nokia / NSB   Moderator feels this is not the most urgent issue, so discussion may be postponed. |
| Qualcomm | Our preference is Scenario 1 |

* + 1. Issue 9: PUCCH-SR

**Proposal:**

* 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
* FFS: if a PUCCH-SR resource can be associated with 2 UL spatial filters, and if so, transmission schemes (e.g. multi-TRP PUCCH scheme agreed in AI 8.1.2.1, or selection of UL spatial filter)
* For a UE configured with two PUCCH-SR resources in a cell group
  + When beam failure is detected in one BFD-RS set in a CC, one PUCCH-SR resource is selected for failure event indication. Down select from the following PUCCH-SR resource selection rule in RAN1#104b-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 to UE implementation
  + FFS: When beam failure is detected in two BFD-RS sets in a CC

**Revised proposal (version 2):**

For a UE configured with ~~“~~*~~n”~~*two PUCCH -SR resources in a cell group~~, (~~*~~n~~*~~=1,2), For~~ when beam failure is detected in a single/multiple CCs in one or more of BFD-RS sets configured in one or more of CCs ,

* ~~Study the “~~*~~n”~~* ~~number of PUCCH -SR resources (“~~*~~n”~~*~~) selected for beam failure event indication, and selection rule (if needed),  (~~*~~n~~*~~=1,2)~~
* Down select one of the following PUCCH -SR resource selection rules (and 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

Proposed conclusion

* For TRP-specific BFR, UE can be configured with one BFD-RS set in one CC and two BFD-RS sets in another CC in the same cell group.

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| Company | Technical views |
| Moderator summary | **Observation from last round:**  There is an ongoing email discussion. Company positions (for single-TRP failure with 2 configured PUCCH-SR resources) are summarized below.   * Alt-1: Huawei, HiSilicon, Qualcomm, Futurewei, ZTE, NEC, Sony, ETRI * Alt-2: CMCC, CATT, Spreadtrum, Qualcomm, IDCC, vivo, Xiaomi, Fujitsu, Nokia/NSB, DOCOMO * Alt-3: Intel, CATT, Apple, Convida, LGE, Spreadtrum, MediaTek, APT/FGI, TCL   A revised proposal (version 2) is provided for further discussion. |
| Qualcomm | We are fine for the revised proposal. For the conclusion, what is the use case for 1 BFD RS set for per-TRP BFR? Good to clarify |

* + 1. Issue 10: BFRA MAC-CE content

**Proposal**:

* A single MAC-CE is used for BFRQ report for all TRPs in all CCs in a cell group
* The MAC-CE carries information of failed TRP identifiers, e.g.
  + Alt-1: indices of BFD-RS set where beam failure is detected,
  + Alt-2: implicitly through resource indicator that corresponds to the identified new beam
  + other alternatives are not precluded
* For each failed TRP for a CC, BFRQ carries information whether a new candidate beam is found, and new beam index (if found).

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| Company | Technical views |
| Moderator | **Observation from last round:** Majority companies are OK with the proposal, except the first bullet on 1. vs 2 MAC-CE. Majority companies prefer a single MAC-CE.   * 1 MAC-CE (21): Apple, vivo, Spreadtrum, MediaTek, Huawei, HiSilicon, Qualcomm, Futurewei, APT/FGI, Convida, Xiaomi, Sony, DOCOMO, Fujitsu, LGE, TCL, ETRI, CATT * 2 MAC-CE (2): ZTE, NEC * Delete the 1st bullet: OPPO * Nokia/NSB (details up to RAN2) |
| Qualcomm | We prefer 1 MAC-CE. The MAC-CE ID is also limited resource |
| Convida Wireless | Support the proposal, but suggested editorial update:   * The MAC-CE carries information of failed TRP identities~~fiers~~, e.g.   In the 3rd bullet, the terminology used is “new beam index”. I suggest to use the same term in Alt-2, i.e.:  Alt-2: implicitly through ~~resource indicator that corresponds to the identified~~ new beam index |

* + 1. Issue 11: UE assumption after BFR response

Proposal 3.8 : After receiving BFR response

* For each failed TRP, the DL QCL-typeD assumption of all CORESETs associated with that TRP with 1 activated TCI state is updated by the RS associated with the latest reported new candidate beam (if found when NBI-RS set is configured).
  + FFS: How to associate CORESET(s) with each TRP
* 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
* For each failed TRP, the DL QCL-typeD source RS of all CORESETs associated with the TRP is updated by the associated latest reported new candidate beam (if found).

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| Company | Technical views |
| Moderator | The proposal is updated based on inputs from MediaTek, vivo, Huawei, HiSilicon. |
| Qualcomm | Do we need the last bullet, given the 1st bullet? |

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 SSBRI/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**

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

1. Reference
2. R1-2103858, “Moderator summary #1 on beam management enhancement for M-TRP with multiple Rx panels”, Moderator (CATT)
3. R1-2103906, “Moderator summary #2 on beam management enhancement for M-TRP with multiple Rx panels”, Moderator (CATT)