**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. |

* + 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 |

* + 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   A revised proposal is provided based on majority view. |

* + 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. |

* + 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. |

* + 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. |

* + 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. |

* + 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. |

* + 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) |

* + 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. |

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)