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~~

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~~

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~~

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~~

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 N~~~~max~~~~>=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.~~

RAN1#106-e

**Agreement**

For aperiodic report of beam reporting option 2,

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

**Conclusion**

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

**Agreement**

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

**Agreement**

Differential reporting across all beam groups in a CSI-report

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

**Agreement**

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

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

**Agreement**

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

**Agreement**

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

* Implicit configuration:
  + M-DCI:
    - BFD-RS set k (k = 0, 1) is derived based on X TCI of CORESETs with CORESETPoolIndex = k
    - ~~FFS: value of X (determined in spec or UE capability), and TCI selection rule when the number of CORESETs with CORESETPoolIndex = k exceeds X (e.g. reuse RLM RS selection rule)~~
* ~~FFS: CORESETs with more than 1 activated TCI states~~

**Conclusion**

BFD-RS configurations in Rel.17 for UEs with one activated TCI state per CORESET via implicit configuration for S-DCI mTRP is not supported in Rel-17.

**Agreement**

For extension of the existing RRC parameter *CSI-AssociatedReportConfigInfo* for the purpose of M-TRP beam reporting option 2,

* Introduce a second ‘*resourcesForChannel’* in *CSI-AssociatedReportConfigInfo*

**Agreement**

For option 2 with differential reporting

* For each reported beam group other than the 1st beam group, the same SSBRI/CRI ordering as the 1st beam group is assumed.

**Agreement**

* ~~For the case of all CORESETs with 1 activated TCI state per CORESET, after 28 symbols from receiving the BFR response, the QCL assumption of all CORESETs associated with the failed BFD-RS set reported in the MAC-CE for TRP-specific BFR is updated by the RS resource associated with the latest reported new candidate beam (if found) associated with the failed BFD-RS set~~
  + ~~FFS: How to associate CORESET(s) with failed BFD-RS set~~
  + ~~FFS: SCS configuration of 28 symbols~~
* ~~FFS: Update of QCL assumption for other DL channels/RSs, UL spatial filter/power control assumption for PUCCH, and other UL channels/RSs~~
* ~~FFS: the case of CORESETs with 2 activated TCI states per CORESET.~~
* ~~The above applies to SCell and SpCell~~
* ~~The above applies at least for the multi-DCI case~~

**Agreement**

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

* Explicit configuration of BFD-RS resources in BFD-RS set k, k = 0, 1
* ~~FFS: CORESETs with more than 1 activated TCI state.~~

RAN1#106b-e

**Agreement**

Support to configure an association between a BFD-RS set on SpCell and a PUCCH-SR resource / SR configuration for per TRP BFR.

* ~~FFS: Configure an association between a BFD-RS set on SCell and a PUCCH-SR resource / SR configuration for per TRP BFR~~

A UE capability signaling is introduced for indicating the support of this association. Above applies only for multi-DCI case.

**Agreement**

RACH-based transmission can be triggered on a SpCell at 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~~

**Agreement**

To associate BFD-RS set k and NBI-RS set j

* Alt-1: 1-to-1, fixed in spec
* Whether NBI-RS configuration is mandatory is separate discussion

**Conclusion**

Design of MAC-CE related to SpCell when transmitted on msg3, msgA is up to RAN2.

**Agreement**

For the case of all CORESETs with 1 activated TCI state per CORESET , after 28 symbols from receiving the BFR response, the QCL assumption of all CORESETs  associated with CORESETPoolIndex  k (k=0,1) is updated by the RS resource associated with the latest reported new candidate beam (if found) associated with the failed BFD -RS set k (k=0,1) in the MAC-CE for TRP -specific BFR

* The above applies to Scell and SpCell
* The above applies for the multi-DCI case

**Agreement**

SCS of the 28 symbols is the smallest SCS of the active DL BWP for the response reception CC and of the active DL BWP (s) of the CC(s) with the failed TRP link(s) reported in BFR MAC CE.

**Agreement**

For RACH-based transmission, at least when all BFD-RS sets fail in SPCell, CBRA is supported

RAN1#107-e

**Conclusion**

For per-TRP BFR, no further restriction will be introduced on the spatial relation configuration of a PUCCH-SR resource.

**Agreement**

For implicit BFD RS configuration, if number of TCI states for CORESETs associated with a *CORESETPoolIndex* exceeds the UE capability on maximum number of BFD-RS resources per set, re-use the RLM-RS selection rule.

**Agreement**

On the PUCCH-SR resource/SR configurations selection rule when SR is triggered and 2 PUCCH-SR resource/SR configurations are configured, the UE triggers the PUCCH-SR resource/SR configuration that is associated with failed BFD-RS set.

**~~Agreement~~**

~~Regarding whether the two dedicated PUCCH-SR resources are corresponding to one~~ *~~schedulingRequestId~~* ~~or two~~ *~~schedulingRequestId~~*

* ~~Alt3: Leave it to RAN2~~

**Agreement**

Regarding how to differentiate Rel-15/16 and Rel-17 group-based beam reporting procedure,

* Alt-1 (explicit): to introduce a RRC parameter groupBasedBeamReportingR17, e.g. groupBasedBeamReportingR17

**~~Agreement~~**

~~On RACH -based transmission on a SpCell , the support of additional scenarios triggering RACH -based transmission on SpCell, if any, is up to RAN2.~~

**Conclusion**

For beam reporting option 2, there is no consensus on supporting the following alternatives in Rel-17:

* Alt-1: gNB configures UE whether to report beams associated with same or different RX spatial filters.
* Alt-2: UE informs to NW whether the reported beams in a beam group are associated with same or different RX spatial filters.
* Alt-3: UE informs to NW whether the reported beams in a beam group are associated with same or different RX spatial filters.
  + Maximum number of supported layers per RX spatial filter is signaled to gNB by UE capability signaling.

**Conclusion**

TRP -specific BFR for the case of CORESET with 2 TCI states is not supported in Rel-17.