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

**E-meeting, January 25th – February 5th, 2021**

Source: Moderator (CATT)

Title: Moderator summary on M-TRP simultaneous transmission with multiple Rx panels (round 1)

Agenda Item: 8.1.2.3

Document for: Discussion and Decision

1. Background

This is a summary of round 1 email discussion on AI 8.1.2.3.

# Discussion

* 1. Issue 1: Beam measurement/reporting for inter-TRP simultaneous transmission

Companies are further invited to provide their views on the following draft proposals in the table below. In addition, as two companies specifically requested to have more focused study on inter-TRP interference measurement in the 1st GTW meeting, companies are encouraged to share their thoughts on this particular topic.

Draft Proposal 1.1: For beam measurement in support of M-TRP simultaneous transmission with multiple Rx panels

* Support at least option 2, where a single CSI-report consists 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 at least M = 2 and N=1 (NOTE: this is the Rel.16 configuration for group-based reporting)
  + Support extending the maximum value of N > 1, exact value FFS
* Further study the support of option 1 and option 3

Draft Proposal 1.2:

* Down-select from the following alternatives in RAN1#104b-e
  + Alt-1: For option 2, support configuration of S=2 CMR resource sets corresponding to a periodic/semi-persistent CMR resource setting or an aperiodic trigger state
    - UE reports M beams (e.g. CMR resource indices) from S=2 different CMR resource sets which can be received simultaneously
    - NOTE: UE may assume that different CMR resources in different CMR sets can be received simultaneously, and CMR resources in the same CMR set cannot be received simultaneously
    - FFS: whether S = M
  + Alt-2: For option 2, support configuration of two CMR resource subsets in a CMR resource set corresponding to a CMR resource setting
    - UE reports M beams (e.g. CMR resource indices) from different CMR resource subsets, which can be received simultaneously
    - NOTE: UE may assume that different CMR resources in different CMR subsets can be received simultaneously, and CMR resources in the same CMR subset cannot be received simultaneously
    - FFS: a specific ID can be used to differentiate CMR resource subsets in a CMR resource set.
  + Alt-3: For option 2, support indication of S=2 SSB sets, where CMRs are implicitly mapped to a

a CMR set where a CMR in the set is QCLed (Type D) with a SSB in the same SSB set

* + - UE reports M=2 beams (e.g. CMR resource indices) from S=2 CMR sets
    - NOTE: UE may assume that different CMR resources in different CMR sets can be received simultaneously, and CMR resources in the same CMR set cannot be received simultaneously

Draft Proposal 1.3:

* Study beam measurement/reporting with consideration of inter-TRP interference

Table 1: Company views

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Regarding Proposal-1.1 from FL, we would like to further understand the motivation to only focus on Option2. Hope to hear more views on this issue.  In our understanding, Option2 does not provide any additional benefit compared to Option1 or Option3 with the following two aspects.   * Overhead of Option2 is obviously larger than Option1/3.  1. UCI payload size(bits/report)  |  |  |  |  |  | | --- | --- | --- | --- | --- | | Number of beam pairs | Option 1（N=2） | Option 2（M=2） | Option 3  （N=2） | | | 2 | 33 | 43 | report 1: 13 | report 2: 23 | | 4 | 43 | 83 | report 1: 23 | report 2: 23 | | 8 | 63 | 163 | report 1: 23 | report 2: 43 | | 16 | 83 | 323 | report 1: 43 | report 2: 43 |  * Companies claim additional benefit of Option2 is to measure interference, but according to our initial evaluation, the interference measurement does not provide any performance gains as shown in the following. L1-SINR criterion for selecting beams is illustrated below: regarding the CMR resources from another TRP as interference and then selecting one beam pair with highest capacity calculated on L1-SINR. The process of calculating capacity is as followings:  |  | | --- | | * Determine the signal panel pairs based on L1-RSRP，such as TRP 1 panel and UE panel 1, TRP 2 panel and UE panel 2 . * Calculate the value of L1-RSRP on each beam pair of each panel pair, including signal panel pairs (TRP 1 panel, UE panel 1), (TRP 2 panel, UE panel 2), and interference panel pair (TRP 1 panel, UE panel 2), (TRP 2 panel and UE panel 1). And then for each beam pair combination, which consists of (TRP 1 panel, UE panel 1) and (TRP 2 panel, UE panel 2), calculate the capacity as follows:   + Calculate the value of L1-SINR per UE panel according to the following formula. is signal power measured in UE panel 1 from TRP 1 and is signal power measured in UE panel 2 from TRP 2. is interference power measured in UE panel 2 from TRP1 and is interference power measured in UE panel 1 from TRP2. and are interference power from other TRPs, other than TRP1 and TRP2.   + Calculate capacity based on the value of L1-SINR per UE panel |  1. UPT with different measurement and report metrics in MTRP, FR2 InH  |  |  |  |  |  | | --- | --- | --- | --- | --- | | RU | Report metric | Mean | 5% | 50% | | 4% | L1-RSRP | 0.00% | 0.00% | 0.00% | | L1-SINR | -10.99% | -24.24% | -11.58% | | 16% | L1-RSRP | 0.00% | 0.00% | 0.00% | | L1-SINR | -24.42% | -53.42% | -29.24% | | 61% | L1-RSRP | 0.00% | 0.00% | 0.00% | | L1-SINR | -36.00% | -54.26% | -44.20% | |
| Huawei, HiSilicon | **For Proposal 1.1**, we support the proposal. Furthermore, we additionally support Option-3 for non-grouping cases, but it can be decided later. In our understanding on the proposal 1.1 is not for only Option-2, but agree on Option-2 first.  For the benefits of Option-2 compared with Option-1, firstly Option-2 can provide much more flexibility of beam pair reporting than Option-1 as shown in Figure-1of R1-2100211. Secondly, the interference between reported beam pairs (for simultaneous reception) can be measured and reported with L1-SINR. But for Option-1, since beams in each group is not for simultaneous reception, so UE cannot measure the inter-beam interference for beam pairs for simultaneously.  **For Proposal 1.2**, we prefer Alt-1.  **For Proposal 1.3**, ok at this stage. |
| MediaTek | In order to avoid sticking without progress, we suggest at least we can reach consensus at least on a **general** version of Proposal 1.2 first. We believe resource configuration enhancement is needed for all of these options. Based on the Draft Proposal 1.2, an example is provided as follows:  Draft Proposal 1.2:   * At least for Option 1 and/or Option2, if supported, down-select from the following alternatives in RAN1#104b-e   + Alt-1: Support configuration of two CMR resource sets corresponding to a periodic/semi-persistent CMR resource setting or an aperiodic trigger state     - UE reports two beams (e.g. CMR resource indices) that can be received simultaneously from different CMR resource sets     - NOTE: UE may assume that different CMR resources in different CMR sets can be received simultaneously, and CMR resources in the same CMR set cannot be received simultaneously   + Alt-2: Support configuration of two CMR resource subsets in a CMR resource set corresponding to a CMR resource setting     - UE reports two beams (e.g. CMR resource indices) that can be received simultaneously from different CMR resource subsets     - NOTE: UE may assume that different CMR resources in different CMR subsets can be received simultaneously, and CMR resources in the same CMR subset cannot be received simultaneously     - FFS: a specific ID can be used to differentiate CMR resource subsets in a CMR resource set.   + Alt-3: Support indication of two SSB sets, where CMRs are implicitly mapped to a   a CMR set where a CMR in the set is QCLed (Type D) with a SSB in the same SSB set   * + - UE reports two beams (e.g. CMR resource indices) that can be received simultaneously from different CMR sets     - NOTE: UE may assume that different CMR resources in different CMR sets can be received simultaneously, and CMR resources in the same CMR set cannot be received simultaneously |
| APT | **Draft Proposal 1.2**: Regarding revision of MTK, we sympathize the intention to make the proposal general and we are also a fan of Option 1. However, in this way, the description of these three alternatives is needed to be changed as well, since they seem now tailored for Option 2. |
| Lenovo&MotM | For Proposal 1.1, support.  For Proposal 1.2, we prefer Alt-1.  For Proposal 1.3, support. |
| Apple | We have the following questions for option 2.  Q1: If UE reports 4 beams (2 from TRP 1 and 2 from TRP 2), which are received from different UE panels, to let gNB know whether each two can be received simultaneously, in option 1, UE reports 2 groups {1, 2}, {3, 4}, in option 2, UE reports 4 groups {1, 3}, {1, 4}, {2, 3}, {2, 4}. So, the overhead for option 2 could be larger than option 1 in this case. Is it correct understanding?  Q2: Our understanding is that it is hard to measure inter-beam interference. The key problem is UE Rx beam selection. Let’s assume there are 3 NW beams from two TRPs as shown in the figure below, {1}, {2, 3}. UE uses beam {1, 2, 3} to receive corresponding NW beams. Then to measure inter-beam interference, UE needs to use UE beam {1, 2} to receive NW beam {1, 2}, and UE beam {1, 3} to receive NW beam {1, 3}. But it is impossible for UE to scan all combinations when receiving corresponding DL RS, e.g. SSB 1 based one NW beam 1 as shown in the figure. So, is it correct understanding that none of the options can be used for inter-beam interference measurement? If not, how can UE apply the Rx beam for different NW beams?    Q3: According to the following agreements in Rel-15, do you agree that both option 1 and option 2 have been supported in Rel-15?  Agreements:         Support the following for group based beam reporting, if group based beam reporting is configured:  o   In a beam reporting instance, a UE can be configured to report N different Tx beams that can be received simultaneously    Note: UE may report N or fewer beams in a given reporting instance    N is configured by the gNB where N<= Nmax         Nmax depends on UE capability  o   FFS:  how to define the UE capability  o   N =2 is supported. Further study {4,8}         Notes: Information indicating group is not required to be reported in Rel-15  o   Note:    From the perspective of Alt-1, the UE reports one group with N Tx beams.    From the perspective of Alt-2, the UE reports N group with one Tx beam per each group.  o   Note: Mechanisms to reduce UE complexity for beam pair search should be further studied |
| Intel | To Apple:  Q1: **Overhead**: Yes, but option 2 also provides more information than option 1, so we are comparing apples to oranges.  Q2: **Impossible:** we don’t understand why it is “impossible” to measure pair-wise interference. This is up to UE implementation on how to reduce the search space (perhaps using RSRP information to prune some beam-pairs or hierarchical search etc.)  Q3: **Already agreed**: probably not a critical/relevant issue at this point.  To Vivo:  **Performance**: Firstly, L1-RSRP information is also available from option-2. we want to utilize L1-SINR information to differentiate between the case that 2 beams (in a reported beam-pair) that are received by 2 UE panels vs 2 beams (in a reported beam-pair) that are received by the same panel. Secondly, in the simulation results it appears that the best beam pair according to L1-SINR metric is worse than L1-RSRP metric – this probably depends on how UE is measuring interference (the beam used to measure interference perhaps) but only you can provide the answer. But this aspect we assume will be left for UE implementation such that the used interference reflects well the interference due to multi-TRP reception using the reported beam-pair. |
| Apple2 | To Intel:  Q1: could you clarify what “more information” is?  Q2: To clarify a little bit. The problem is about the UE Rx beam selection to measure inter-beam interference. If there are 64 SSBs in each TRP. How can UE select the Rx beam to receive each SSB for mutual interference measurement? We should note that UE would not optimize Rx beam for a particular CSI-reportConfig, since UE may be configured with multiple CSI-reportConfig for different functionalities, e.g. P1/P2/P3, group based, non-group based and so on. The SSB may also be configured for other functionalities, e.g. CBD/BFD/RLM.  The situation for beam reporting for aperiodic CSI-RS could be even worse.  Q3: To clarify more, during GTW, there is a comment that only option 2 is agreed in current spec. We would like to say that is not true, and check companies understanding about it. |
| Vivo2 | @Intel  Computation of L1-SINR is well documented in 38.215 between channel part and interference part. Some other more advanced measurement behavior should first be discussed and evaluated before we directly go to the “support” of a new report based on non-justified assumptions. For example, if we would like to use CSI-like calculation to evaluate beam pair performance, the related behavior and the relationship with CSI report would need further discussion. Based on these understanding, inter-beam interference should not used to justify support of Option2.  For your comment on overhead part, we would like to understand which additional information you are referring to. |
| Xiaomi | For proposal 1.1, support  For proposal 1.2, take Alt-1 as an example, since UE assumes CMR resource in the same CMR resource set cannot be received simultaneously, how can UE reports more than 2 beams which can be received simultaneously? For example, M=3, beam#1 from CMR resource set#1, beam#2 and beam#3 from CMR resource set#2, but in the assumption, beam#2 and beam#3 cannot received simultaneously. There must be a contradiction. So in our understanding, M cannot larger than 2.  For proposal 1.3, support. |
| LGE | For Proposal 1.1: Support. We sympathize with HW’s comment. We are also supporting option 3, but there is clear majority view on option 2 so prefer to support option 2 first. We are not objecting option 1 and option 3 and we can further discuss.  For Proposal 1.2: Ok, and we prefer Alt-1.  For Proposal 1.3: support.  Regarding Apple’s questions:  Q1) If UE has to report all of beam pairs which can be received simultaneously for option 2, the overhead for option 2 can be larger than that of option 1. But, UE don’t need to report all of combinations and also gNB don’t need to push UE to report all of combinations. As Intel commented, option 2 provides more information than option 1 when N, M of option 1 and 2 are same, e.g., UE reports best pair(s) within all of pairs from UE Rx circumstance perspective.  Q2) Agree with Intel. Or with further enhancement (group/pair candidates for option 2 can be configured for CMR resource configuration in advance to reporting), UE can explicitly measure L1-SINR of TRP1 and L1-SINR of TRP 2 simultaneously using multi Rx panel from the group/pair candidates configuration.  Q3) Agree. But share the same view with Intel |
| NTT DOCOMO | For Proposal 1.1, we can somehow understand Apple’s concern on Option2, e.g., UE may not be able to measure inter-beam interference for all the combinations of beam pairs from two CMR groups. However, on the other hand, it also depends on how the CMRs are configured, and how UE assumes the CMR pairing. We need to carefully consider the CMR configuration and pairing in Option2 to make sure UE can measure the inter-beam interference of assumed CMR pairs (instead of measuring all of the pairs from two CMR groups). Anyway, with proper CMR pairing configuration/assumption, UE can measure inter-beam interference for certain beam pairs, which can provide more information than other options. And we also support Option1 when such inter-beam interference does not need to be considered.  Hence, we support Proposal 1.1 and we also support Option1. |
| ZTE | For proposal 1.1, our views are still kept unchanged. We can support FL proposal. But, we preference is to support both of Option 1 and Option 2, but it indeed has some drawback if only option 2 is supported.  Regarding Apple’s comment, please check my following reply:  Q1: More information corresponds to optimize a better beam pair with low mutual interference;  Q2: In order to measure inter-beam interference, we need to have some prior information, e.g., which candidate Tx beam combinations can be received by UE side (in other words, the two Tx beams can be received by a respective UE beam of each panel). The desirable design is to have Option-1 (UE panel based) reporting firstly, the output of which can be considered as inputs for determining the candidate pairs. One example can be found in the following figure. In other words, if enabling this function of Option-2, we need Option-1 for guarantee the information that the candidate combination can be received by a UE.    Q3: Agree. As a big compromise for Rel-15 group based reporting, we was NOT to down-select each of alternatives as Apple mentioned.  For proposal 2.1: Not support. Our concerns about the note has not been handled. Please check our following update for Alt-1. If we really do NOT want to modify Alt-1, let’s have another candidate directly.   * + Alt-1: For option 2, support configuration of S=2 CMR resource sets corresponding to a periodic/semi-persistent CMR resource setting or an aperiodic trigger state     - In one of N groups, UE reports M=2 beams (e.g. CMR resource indices) from S=2 different CMR resource sets which can be received simultaneously     - FFS: whether S = M   For proposal 1.3: Support. |
| Ericsson | After some offline discussion, we understand that there can be an overhead difference between Option 1 and Option 2. In the 4 beam example by Apple above, the UE would report 2 groups {1,2}, {3, 4} for Option 1 and 4 groups {1, 3}, {1, 4}, {2, 3}, {2, 4} for Option 2. This would result in a larger overhead for Option 2.  However, for the case of M=2 and N=1 which is the main use case captured in Proposal 1.1, Option 1 and Option 2 are equivalent and the overheads would be the same. Hence, we suggest to focus on this main use case. In fact, if we limit proposal 1.1 to M=2 and N=1, then there is no need to mention option 1 or 2. Please see a suggested revision below:  Revised Draft Proposal 1.1: For beam measurement in support of M-TRP simultaneous transmission with multiple Rx panels   * 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 and N=1 (NOTE: this is the Rel.16 configuration for group-based reporting) * Further study the support of option 3   For Proposal 1.2, we are fine with either Alt-1 or Alt-2. |
| Sony | Thanks to Yushu for the re-illustrated example which we may not pay a good attention. Please see our thoughts below  Q1: in your example, it seems that the reporting overhead of Option 2 (DL beam combinations done at UE side) is heavier than that Option 1 (DL beam combinations to be done at NW side). And we failed to see more information Option 2 provides than Option 1 does. But as mentioned by Ericsson and legacy Rel.15/16 that when M = 2 and N = 1, both Option 1 and Option 2 can be interpreted with same overhead.  Q2: The problem for inter-beam interference measurement in your example is that the UE could only measure SSB1 once, so either UE beam 2 or UE beam 3 is not good choice. But what if the UE could measure SSB1 twice when proper resource setting is configured? In the 1st instance, the UE applies UE Rx beam 2 and in the 2nd instance, it uses Rx beam 3. But anyway, the pre-condition is that the UE has such chance to measure SSB1 twice.  Q3: we share the same understanding that both the group-based beam reporting in Rel.15.16 can be interpreted as either Option 1 or Option 2.  From vivo’s simulation results, we also observed that L1-RSRP based group beam selection significantly outperforms that based on the metric of L1-SINR. Moreover, by far, we only agreed L1-RSRP as beam selection metric and now the inter-beam interference issues seem blockage for us to move forward. So one question popped up in our mind, should we support L1-SINR as group-based beam selection metric? If not (only supporting L1-RSRP), then I guess we can easily move ahead. |
| CATT | Please find our views below.  Q1: We don’t agree with the assessment on the overhead. It is important to note the proposal is on the grouping of ***reported beams***, not on the grouping of ***CMR resources***. We should focus on the grouping of ***reported beam***.  First of all, feedback overhead and beam pairing search space size are two different things. Feedback overhead (value of N and M) is controlled by NW; once N/M is set, the overhead remains the same.  Secondly, the search space size depends on the # of TRP and # beams per-TRP, and changes by cases. In Apple’s particular example (2 TRP and 2 beams per-TRP), a normal UE would still compare all beam pairs {(1,3), (1,4), (2,3), (2,4)}. The search size remains the same, regardless option 1 or 2.  In terms of **reporting**, the difference of option 1 and option 2 are a matter of formulation of the reported beam pair, e.g. whether a reported pair (1,3) is formulated as one group [(1,3)], or two groups ([1], [3]). There is no CSI overhead difference.  Q2: See Q1. We don’t see any functional difference in terms of interference measurement between option 1 and option 2. Either they both support, or they both don’t. |
| MediaTek | We think the suggestion (either they both support, or they both don’t) provided by CATT is good. If nothing is supported, Rel-17 still can introduce enhancement on Rel-16 group-based reporting. |
| Nokia/NSB | **For proposal 1-1,**  If you see the description of option1 and option 2, nothing is related to the CMR configuration, and the same CMR configuration can be supported for option 1 and option 2. What is different is only the report format.   * 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   Regarding to UL overhead, option 1 could have slightly lower overhead when number of pairs increases. But, when 4 beams are reported, the overhead is already very high. Also, if AP-CSI report is used, UL feedback via PUSCH is not so sensitive to overhead.  Regarding to flexibility, option 1 has limitation of what exact pair can be supported. For example, as in the above (1,2), (3,4) beams from two TRPs, if 1+3, 2+3, 2+4 can be received simultaneously. Option 1, should report 2, (3,4), because 1+4 cannot be supported. On the other hand, option 2 can support reporting all three combinations.  Regarding to interference measurement, though we thank to vivo’s intensive evaluation, it is not related to this discussion. The evaluation is related to proposal 1-3 whether to support L1-SINR report. Until now, we just agreed on L1-RSRP report. For L1-RSRP report, we don’t configure IMR. IMR is only supported for L1-SINR report.  Also, both for option 1 and option 2, only part of cross-beam interference can be measured by implementation. There is no difference because only CMRs are configured. Assume CMRs are TDMed and in general CMR from the same TRP are transmitted successively, UE first measure CMRs from a TRP1 by a panel, and when UE receive the other CMRs from the TRP2 with another panel, UE can receive the CMR with proper Rx beam, while the other panel is also receiving the CMR with the Rx beam used for the TRP1 CMR. This is one possible implementation.  In option 2, based on this measurement, if best beam pair can be identified, or some high interference pair can be omitted by UE implementation.  Option 3 has similar pros and cons with Option 1. But, it is intended for non-ideal backhaul where NW only provide limited functionality. But, option 1 and option 2 are alternative each other for ideal backhaul scenario.  **For proposal 1-2,**  In fact, all the alternatives are providing the same functionality of CRM to TRP association, and only difference is RRC message structure.  In order to make alignment with M-TRP CSI decision, we are preferring single CSI-Resource Set which is used in Alt2 and Alt 3. Alt 2 is explicit indication while alt 3 is implicit indication of CMR association to TRP.  Alt 1, if two or more CMR resource sets are configured, we have to make clarification of CRI indexing.  Alt 3 has advantage of wider applicability. Once SSB group is identified per cell, this can be used in BFR, PUCCH grouping, CSI-report without changing existing message structure.  Also, inter-cell M-TRP or inter-cell mobility, the SSB is already distinguished by PCI, no additional signaling is required. So, we supporting alt 3. And alt 2 is our second preference.  **For proposal 1-3,**  In order to discuss the interference modeling, we have to first agree on enhancement for L1-SINR reporting. |
| Samsung | From the beam measurement perspective, we see the point that measuring all possible beam pairs could be difficult and under certain settings, some beam pair combinations cannot be measured (example from Apple) without additional design/consideration. From our understanding, proposal 1-1 is more about reporting format; as long as some beam measurements (if not all) can be obtained by the UE, the UE can report them. We are fine with the revised proposal 1-1 from the FL, which is generic.  We also think narrowing down potential beam pairs to measure is beneficial to facilitate the process, which is suggested by ZTE. But it is unclear to us how option 1 can help reduce the search space because option 1 and option 2 are only different in terms of reporting format. Maybe we are missing something. |

* 1. Issue 2: M-TRP Beam failure recovery

Draft Proposal 2.1: 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)

Draft Proposal 2.2: For M-TRP BFR, BFD-RS configuration

* Support explicit RRC/MAC-CE configuration of BFD-RS set, for both S-DCI and M-DCI
* Support implicit configuration of BFD-RS set
  + If all CORESETs in a BWP are configured/activated with one TCI
    - For M-DCI, BFD-RS set k (k = 0, 1…) is based on TCI state of CORESETs with *CORESETPoolIndex = k*
  + FFS: decided in RAN1#104-e whether/how to support implicit configuration for S-DCI, e.g. BFD-RS set k (k = 0, 1 …) is based on TCI state of CORESETs in CORESET subset k (k = 0, 1...)FFS: if at least one CORESET is activated with multiple TCI states, if supported.

Draft Proposal 2.3: For M-TRP BFR

* Support 1-to-1 association between BFD-RS set k (k=0, 1…) and NBI-RS set j (j = 0, 1…),
  + FFS: k = j.

Draft Proposal 2.4: For BFRQ of M-TRP BFR

* In RAN1#104-e, down-select from the following options :
  + Option 1: Up to one dedicated PUCCH-SR resource in a cell group, and if applicable, with one UL Tx spatial filter activated for each PUCCH-SR resource
  + Option 2: Up to one dedicated PUCCH-SR resources in a cell group, and if applicable, with two UL Tx spatial filters activated for each PUCCH-SR resource
  + Option 3: Up to two dedicated PUCCH-SR resources in a cell group, and if applicable, with one UL Tx spatial filter activated for each PUCCH-SR resource
    - For option 2 and 3, study the selection of PUCCH-SR resource(s) and/or the UL Tx spatial filter
* Support BFRQ MAC-CE that can convey information of failed CC indices, one new candidate beam per 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, and applicable cell type (SCell vs. SpCell)

Draft Proposal 2.5: BFRQ response

* Support the same gNB response as in Rel.16 SCell BFR (i.e. DCI with toggled NDI scheduling a same HARQ process ID as the PUSCH carrying BFRQ MAC-CE)

Draft Proposal 2.6: UE QCL/spatial relation assumption /UL power control upon gNB response

* Support PDCCH QCL assumption update with the latest reported new candidate beam, per associated failed TRP.

Table 2: Company inputs

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| --- | --- |
| **Company** | **Comments** |
| vivo | For proposal 2.5, support the following update.  Draft Proposal 2.5: BFRQ response   * Support the same gNB response as in Rel.16 SCell BFR (i.e. DCI with toggled NDI scheduling a same HARQ process ID as the PUSCH carrying BFRQ MAC-CE)   FFS considering as response the MAC CE activation command to update the TCI states for the CORESET(s) related to the TRP/BFD-RS set in beam failure; |
| OPPO | Proposal 2.2: Do not support the proposal.  Do not support explicit configuration. The TCI-state for PDCCH can be even indicated by DCI. How can we use high layer signaling to configure BFD RS. Furthermore, we do not support to enhance BFR for S-DCI. There is no use case to support per-TRP BFR for S-DCI system because there is no explicit TRP in S-DCI system. Furthermore, we are designing repetition of PDCCH from two TRPs,  We suggest to update the 2.2 as follows:  Draft Proposal 2.2: For M-TRP BFR, BFD-RS configuration   * ~~Support explicit RRC/MAC-CE configuration of BFD-RS set, for both S-DCI and M-DCI~~ * Support implicit configuration of BFD-RS set   + If all CORESETs in a BWP are configured/activated with one TCI     - For M-DCI, BFD-RS set k (k = 0, 1…) is based on TCI state of CORESETs with *CORESETPoolIndex = k*   + ~~FFS: decided in RAN1#104-e whether/how to support implicit configuration for S-DCI, e.g. BFD-RS set k (k = 0, 1 …) is based on TCI state of CORESETs in CORESET subset k (k = 0, 1...)FFS: if at least one CORESET is activated with multiple TCI states, if supported.~~   Proposal 2.6: we do not support including PUCCH here because there is no association between the PUCCH resource and TRP/CORESETPoolIndex. That at least needs FFS.  Furthermore, Rel.16 mechanism can not be used because Rel.16 is not per-TRP.  We suggest to update 2.6 as follows:  Draft Proposal 2.6: UE QCL/spatial relation assumption /UL power control upon gNB response   * Support PDCCH/~~PUCCH QCL/spatial relation assumption / UL power control update~~ with the latest reported new candidate beam, per associated failed TRP~~, based on Rel.16 mechanism~~. |
| Huawei, HiSilicon | General fine for the proposals.  For Proposal 2.4, Option-3 is preferred. |
| APT | **Draft Proposal 2.5/2.6**: Since we have mentioned “M-TRP BFR” in main bullets of proposals 2.1 to 2.4, we should also make similar changes for proposal 2.5/2.6 to make them aligned and clear. |
| Lenovo&MotM | **For Proposal 2.1, support.**  **For Proposal 2.2, we only support implicit configuration.**  **For Proposal 2.3, support.**  **For Proposal 2.4, we suggest to discuss this issue for SpCell and SCell separately since the priority of SpCell and SCell is different. For SpCell, we support Option 3, while for SCell, we support Option 1.**  **For Proposal 2.5, support.**  **For Proposal 2.6, we don’t support to reuse the scheme of R16 for UL power control update. Because there is a discussion about TPC commands enhancement for PUCCH in multiple TRPs, two closed loop indexes may be configured for PUCCH to different TRPs. Therefore, whether the closed loop index of all PUCCH resources can be 0 should be further discussed.** |
| Apple | As we commented, for proposal 2.4, we suggest we remove all “UL Tx spatial filter” related part. |
| MediaTek | On draft Proposal 2.4, we believe the discussion point of PUCCH-SR resource is when TRP-specific beam failure happens on a PUCCH cell, how to avoid SR transmission on the link of the failed TRP. Then, these options should be limited for the case if a PUCCH cell is configured in FR2 since we don't have to handle beam failure in FR1. Thus, we prefer the following update, and this may address Apple’s concern.  Draft Proposal 2.4: For BFRQ of M-TRP BFR   * In RAN1#104-e, down-select from the following options if a PUCCH cell of a cell group is configured in FR2 :   + Option 1: Up to one dedicated PUCCH-SR resource in the cell group, with one UL Tx spatial filter for each PUCCH-SR resource   + Option 2: Up to one dedicated PUCCH-SR resources in the cell group, with two UL Tx spatial filters for each PUCCH-SR resource   + Option 3: Up to two dedicated PUCCH-SR resources in the cell group, with one UL Tx spatial filter for each PUCCH-SR resource     - For option 2 and 3, study the selection of PUCCH-SR resource(s) and/or the UL Tx spatial filter   On draft Proposal 2.6, share same view with OPPO. |
| Xiaomi | Support all proposals and prefer Option 2 in proposal 2.4 |
| LGE | Generally fine with the above draft proposals. As we commented on email, for proposal 2.2, explicit BFD-RS can be supported regardless of whether S-DCI or M-DCI based M-TRP transmission is configured. We prefer to remove “for both S-DCI and M-DCI” in the first bullet.  Regarding the issue of supporting explicit BFD as well as implicit BFD, explicit BFD was introduced for UE-specifically beamformed CSI-RS and implicit BFD was mainly for TRP-specific CSI-RS in Rel-15/16. Since both types of CSI-RS are possible depending on different NW deployment, RAN1 have been agreed to support both options for BFR in Rel-15/16. We are not sure why Rel-17 BFR should be different from Rel-15/16 and limits the use of BFR in one of the NW implementation options. |
| NTT DOCOMO | Too early to decide Proposal 2.6, which should be discussed after MAC CE and per-TRP BFR is settled. |
| ZTE | Proposal 2.1: Support  Proposal 2.2: If supporting explicit configuration, MAC-CE method should be considered. As we mentioned before, BFR of ‘s-DCI’ discussion should be postponed.  Proposal 2.3: Support  Proposal 2.4: To solve concerns from other companies, we may need to add ‘if the PUCCH-SR resource is configured in FR2’ in main bullet.  Proposal 2.5: Support  Proposal 2.6, we can live with OPPO’s suggestion, but we need to add one bullet of “FFS: whether a CORESETPoolID can be introduced for PUCCH” |
| Ericsson | Fine with all FL’s proposals. |
| Convida Wireless | Proposal 2.1: Support  Proposal 2.2: We don’t support the addition of MAC CE activation to the explicitly configured BFD RS. For that kind of dynamic update, the implicit method could be used. However, we are open to discussing common beam update of the explicitly configured BFD RS.  Proposal 2.3: Support, but suggest to remove the indices that don’t seem to add anything:   * Support 1-to-1 association between each BFD-RS set ~~k (k=0, 1…)~~ and an NBI-RS set ~~j (j = 0, 1…),~~   + ~~FFS: k = j.~~   [Mod]: Given this is a very small issue, my preference is to list the candidates to make a decision later. If Convida wishes to add another candidate (e.g. left to RAN2), this can be considered below.  [CW2]: Your suggestion is fine.  Draft Proposal 2.3: For M-TRP BFR   * Support 1-to-1 association between BFD-RS set k (k=0, 1…) and NBI-RS set j (j = 0, 1…),   + FFS: k = j or left to RAN2.   Proposal 2.4: Support but suggest to use the wording in Option 1-3:  “… with up to one/two UL Tx spatial filters ~~for~~associated with each PUCCH-SR resource”.  We don’t think we need to spend effort on multi-beam PUCCH-SR design since it is configured in FR1 in almost all cases in practice. If we anyway want to introduce multi-TRP PUCCH-SR, why not use a solution from agenda item 8.1.2.1?  [Mod]: From individual company perspective, my understanding is that feature in 8.1.2.1. and 8.1.2.3 cannot be always dependent, e.g. a UE supporting MTRP BFR doesn’t necessarily support 8.1.2.1. So a solution without 8.1.2.1. should at least be available.  [CW2]: The multi-TRP PUCCH schemes in 8.1.2.1 are based on TDM repetition of PUCCH, so I think all FR2 UEs that support multi-TRP BFR should support a TDM-based multi-TRP PUCCH agreed in 8.1.2.1. It would be inefficient to duplicate the discussions on multi-TRP PUCCH in this agenda item, incl. multi-TRP PUCCH power control, etc. Therefore, I suggest adding Option 4:   * Option 4: support a multi-TRP PUCCH repetition scheme agreed in 8.1.2.1 for a PUCCH-SR resource.   Proposal 2.5: Support  Proposal 2.6: Support |
| CATT | Regarding proposal 2.2:   * Neither S-DCI nor M-DCI has been agreed. Both need to be discussed. * Functional wise, S-DCI is an integral part of M-TRP and we don’t agree to depriorize. Secondly, as a NW vendor, which TRP/CORESET to send the PDCCH (carrying S-DCI) is NW implementation. The diversity gain of PDCCH doesn’t hinge on the DCI bit values. Knowing each TRP quality helps in the diversity management   Explicit vs. implicit:  o   Control channel enhancement seems never-ending (e.g. MTRP PDCCH enhancement). Given its unforeseen variation in Release.1X, explicit configuration is much simpler and futureproof:  all that needs to be done is to configure/activate a set of RS, and that’s all. Implicit is on the other hand much more time-consuming and requires new design whenever PDCCH beam management is changed.  Proposal 2;4: Regarding Apple’s comment on spatial filter, one proposed change is below.   * In RAN1#104-e, down-select from the following options :   + Option 1: Up to one dedicated PUCCH-SR resource in a cell group, and if applicable, with one UL Tx spatial filter activated for each PUCCH-SR resource   + Option 2: Up to one dedicated PUCCH-SR resources in a cell group, and if applicable, with two UL Tx spatial filters activated for each PUCCH-SR resource   + Option 3: Up to two dedicated PUCCH-SR resources in a cell group, anf if applicable, with one UL Tx spatial filter activated for each PUCCH-SR resource |
| MediaTek | Proposal 2.4: We don't support current proposal. If PUCCH cell is configured in FR1 (i.e., no UL Tx spatial filter is activated for PUCCH-SR resource), all of the three options are not needed. In the other words, we don't have to discuss this issue when PUCCH-SR resource is not provided with UL Tx spatial filter. For example, if Option 3 is adopted but UL Tx spatial filter is not applicable to PUCCH-SR resource, why do we need two dedicated PUCCH-SR resources?  Proposal 2.5: Suggest to remove PUCCH for further study. |
| Nokia/NSB | **Proposal 2-1**. Support FL’s proposal.  **Proposal 2-2**. For explicit configuration, we don’t support MAC-CE based update. Implicit method can be used instead.  **Proposal 2-3**. Support FL’s proposal.  **Proposal 2-4**. Support Option 3. Other options are special case of Option 3.   * Option 1: configuring the same PUCCH-SR for two TRPs. * Option 2: configuring two PUCCH-SRs with the same time-frequency resource but different spatial relation RS.   **Proposal 2-5**. Generally fine, but good to discuss later  **Proposal 2-6**. Need further discussion. |
| Mod | Proposal 2.1: seems stable.  Proposal 2.2: requires more discussion.  Proposal 2.3: revised from FFS: k = j to FFS: k = j or up to RAN2. @Convida: please check if this addresses your view.  Proposal 2:4: Pending check by @MediaTek.  Proposal 2.5: seems OK.  Proposal 2.6: removed PUCCH. |
| Convida Wireless 2 | I added response to the Moderator comments in our previous comment as [CW2]. |
| Qualcomm | For Proposal 2.4,  Some minor wording suggestion   * + Option 1: Up to one dedicated PUCCH-SR resource in a cell group, and if applicable, with one UL Tx spatial filter activated for the ~~each~~ PUCCH-SR resource   + Option 2: Up to one dedicated PUCCH-SR resources in a cell group, and if applicable, with two UL Tx spatial filters activated for the ~~each~~ PUCCH-SR resource   Also one more aspect in the FFS   * + - FFS: whether/how to support indication of more than one TRP failure, corresponding BFR procedure, and applicable cell type (SCell vs. SpCell)   For Proposal 2.6,  Suggest to at least include deleted part in FFS. For example, if PUCCH is only sent to TRP1 but TRP1 failed, should we reset PUCCH beam or not.  Draft Proposal 2.6: UE QCL/spatial relation assumption /UL power control upon gNB response   * Support PDCCH QCL assumption update with the latest reported new candidate beam, per associated failed TRP.   + FFS: PUCCH QCL/spatial relation assumption / UL power control update with the latest reported new candidate beam, per associated failed TRP |
| Samsung | We support the FL’s proposals. For proposal 2.2, we support both S-DCI and M-DCI. |

* 1. Issue 3: Simultaneous reception of signals with different QCL-TypeD

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Issue** | **Companies’ views** | **notes** |
| 3.1 | Introduce at least one of the following methods should be considered when beam collision between different DL channel(s) and RS(s) occurs.   * Alt 1: UE can prioritize the reception of a DL channel or RS with higher priority. * Alt 2: UE can use a predefined beam to receive the conflicting DL channels or RSs. * Alt 3: UE can use the indicated beam and corresponding panel to receive the DL channel or RS with higher priority, and meanwhile UE can use the other active panel and a predefined beam to receive the other DL channel or RS with lower priority. | Support: ZTE, InterDigital |  |
| 3.2 | * Support to enhance on DL SPS PDSCH reception for multi-DCI based multi-TRP case. * In overlapping PDSCH without corresponding PDCCH transmissions receiving occasions from multiple TRP, one PDSCH with lowest configured sps-ConfigIndex for each TRP could be received. * PDSCH without corresponding PDCCH transmission associates with the same value of CORESETPoolIndex as CORESET where PDCCH activating the PDSCH lies in. | Support: Spreadtrum |  |
| 3.3 | In multi-DCI based mTRP, the existing QCL prioritization rule for overlapped CORESETs should be applied within CORESETs with same CORESETPoolIndex. | Support: Qualcomm |  |
| 3.4 | Release some constraints due to QCL-TypeD collision for UEs that can receive two beams simultaneously, where the starting point is to release the constraints for SSB/CSI-RS for RLM/BFD/CBD. | Support: Apple |  |
| 3.5 | * + Support a higher layer signaling to indicate whether to enable simultaneous reception of multiple channels/RSs with different QCL-TypeD at UE.   + Discuss UE behavior for S-DCI and M-DCI separately | Support: DOCOMO: |  |

Table 3: Additional company inputs: issue 3

|  |  |
| --- | --- |
| **Company** | **Input** |
| Lenovo&MotM | We have the same view with Apple on “Release some constraints due to QCL-TypeD collision for UEs that can receive two beams simultaneously”. In addition to mentioned SSB/CSI-RS for RLM/BFD/CBD, simultaneous transmission on PDCCH and simultaneous transmission on CSI-RS for beam management can be also discussed. |
| Huawei, HiSilicon | These issues are low priority for discussion. |
| Apple | The objective is to handle simultaneous reception related BM enhancement, we suggest we list potential study points for next steps. |
| Spreadtrum | Support to discuss the above issues |
| ZTE | This issue is essential and should be discussed with priority. From our perspective, the following aspects have been identified for DL simultaneous reception: PDCCH+PDSCH, PDSCH+PDSCH, PDSCH+CSI-RS, CSI-RS+CSI-RS. |
| InterDigital | We agree with ZTE that the issues proposed by ZTE are essential and should be discussed. |

# 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

# Reference

1. R1-2101862, “Moderator summary on M-TRP simultaneous transmission with multiple Rx panels (round 0)”, Moderator (CATT)