**3GPP TSG-RAN WG4 Meeting #104-eR4-221xxxx**

Electronic Meeting, August 15 – 26, 2022

**Title:** **WF on FeMIMO RRM requirements for inter-cell beam management and TRP-specific link recovery**

**Source:** **Huawei, HiSilicon**

**Agenda item: 9.17.2**

**Document for: Approval**

# Introduction

This contribution is to capture the agreements for the email discussion for Rel-17 FeMIMO RRM in RAN4 #104-e meeting.

# Way-forward

## Inter-cell beam measurement

**Issue 2-1-1: Whether to consider additional known cell condition**

* Agreements
	+ Don’t need to add an additional known cell condition with L1 measurement only

**Issue 2-1-2 Whether Inter-cell L1-RSRP requirements are applicable for inter cell mTRP**

* Option 1:
	+ No clarification is needed. The existing inter cell L1-RSRP measurement defined in TS 38.133 is applicable for both inter-cell beam management and inter-cell mTRP scenarios.
* Option 2:
	+ For FR1, the existing inter cell L1-RSRP measurement defined in TS 38.133 is applicable for both inter-cell beam management and inter-cell mTRP scenarios.
	+ For FR2, the existing inter-cell L1-RSRP measurement requirements can be applied for TDM based inter-cell mTRP and inter-cell BM.

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| Apple | Option 1. The measurement and scheduling restrictions already cover the cases where simultaneous measurements/ reception is not possible in FR2. Hence, no additional clarification is needed. |
| Intel | both Option 1 and option 2 are fine.  |
| Samsung | Option 1. L1-RSRP measurement on cell with different PCI already includes both scenarios that SSB is from NSC and SSB is from different (non-collocated) TRP. |
| vivo | Option 1. Option 2 is common understanding, since even for intra-cell mTRP, TDM based reception is assumed.  |
| MediaTek | Both option 1 and option 2 are fine to us. |

**Issue 2-2-1: UE reporting behaviour**

* Agreements
	+ No clarification is needed on whether UE shall send L1 measurement report if the known condition is not met.

**Issue 2-3-1 General assumption for sharing factors**

* Agreements
	+ RAN4 do not specify RRM requirements for the following cases:
		- SSBs of CDP are not overlapped with SMTC.
		- SSBs of CDP are fully overlapped with GAP

**Issue 2-3-2 Overlapping SSB definition**

* Option 1:
	+ Based on SSB periodicity and offset alone with overlapping SSB window
* Option 2:
	+ Have the same SSB index in addition to overlapping SSB window.

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| Apple | Option 2 would be more appropriate as UE cannot receive 2 SSBs if overlapping at symbol level. Fine to go with option 1 if that’s majority view.We propose to capture the definition in spec to avoid any misunderstanding, since so far we only have SSB overlapping with SMTC or MG, but first time to define UE behaviour and requirements when we have SSB of serving cell overlapping with SSB from CDP.  |
| Intel | Fine with option 2. If SSB index is the same, the symbol will overlap. |
| Samsung | Option 1. When talking about overlapping SSB in context of UE measurement, we consider periodicity and offset. Same SSB index or not do not have impact on performing measurement. |
| vivo | OK to option 2. However, the issue mentioned by Huawei in 1st round also make sense. For the definition of overlapping, we are OK to option 2. |
| MediaTek | Fine with option 2. |

**Issue 2-3-3 Applicability of Sharing factors**

* Option 1:
	+ Sharing factors are applicable when SSB from serving cell and cell with different PCI are overlapping with same SSB index, or are adjacent SSB index with no symbol gap.
* Option 2:
	+ No matter whether SSB indexes are same between SSB of the serving cell SSB and SSB of the cell with different PCI, UE cannot perform L1 measurement for serving cell and the cell with different PCI at the same time.

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| Apple | Option 1, if Option 2 is agreed on Issue 2-3-2.  |
| Intel | Fine with option 1. |
| Samsung | Option 2. We are not sure how SSB index have impact on measurement. |
| vivo | OK to option 1. In our understanding this is to define the SSB overlapping, i.e. the applicability rule to the P factor between SC and CDP. If not overlapping, sharing between SC and CDP can be ignored. |
| MediaTek | Fine with option 1. |

**Issue 2-3-4 Sharing factors design**

* Principles of Design:
	+ The sharing factors PSC and PCDP for inter-cell BM are introduced without impacting the definition of existing sharing factor P, where P is defined for the sharing factor between L1-RSRP measurements and L3 measurements.
		- No impacts on the existing L3 measurements.
* Based on the remaining L1-RSRP measurement opportunities after punctured by L3 measurements, further study the sharing factor between SSB of SC and SSB of CDP.
	+ Option 1:

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| # | Scenario | PSC | PCDP |
| 1 | T’SSB,SC = T’SSB,CDP  | 2 | 2 |
| 2 | T’SSB,SC < T’SSB,CDP  |  | 1 |
| 3 | T’SSB,CDP < T’SSB,SC  | 1 |  |

* + Option 2:

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| **#** | **Scenario** | **PSC** | **PCDP** |
| A | SC SSB occasions outside MG are fully overlapping with CDP SSB occasions outside MG | 2 | 2 |
| B | SC SSB occasions outside MG are partially overlapping with CDP SSB occasions outside MG | 2 | 1 |
| C | Scenario C: CDP SSB occasions outside MG are partially overlapping with SC SSB occasions outside MG. | 1 | 2 |

* + Other options are not precluded.

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| Apple | We don’t agree that we need to define PSC and PCDP and keep the existing ‘P’. We need to come up with overall sharing factors by accounting for the available measurement occasions after factoring out the overlapping measurement occasions with SMTC and/or MG. We propose the following as proposed in round 1:

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| **#** | **Scenario** | **P for Serving cell** | **P for cell with different PCI** |
| 1 | TSSB,SC = TSSB,CDP < TSMTC or MGRP |  |   |
| 2 | TSSB,SC < TSSB,CDP < TSMTC or MGRPAll occasions of SSB of SC collide with CDP, MG and/or SMTC |  |   |
| 3 | TSSB,CDP < TSSB,SC ≤ TSMTC or MGRPAll occasions of SSB of SC collide with CDP, MG and/or SMTC |  |   |
| 4 | TSSB,SC < TSSB,CDP < TSMTC or MGRPNot all occasions of SSB of SC collide with CDP, MG and/or SMTC |  |  |
| 5 | TSSB,CDP < TSSB,SC ≤ TSMTC or MGRPNot all occasions of SSB of CDP collide with SC, MG and/or SMTC |  |  |
| SSBSC1 is the number of SSB occasions of serving cell which are colliding with CDP but not colliding with MG or SMTC within time max(MGRP, SMTC)SSBCDP1 is number of SSB occasions of CDP which are colliding with SC but not colliding with MG or SMTC within max(MGRP,SMTC)SSBSC2 is the number of SSB occasions of serving cell which are not colliding with CDP, MG or SMTC within time max(MGRP, SMTC)SSBCDP2 is number of SSB occasions of CDP which are not colliding with SC, MG or SMTC within max(MGRP,SMTC) |
|  |

In case SSB of serving cell and cell with diff PCI don’t overlap, then legacy sharing factors are applicable.  |
| Intel | In general, we support the design principle that sharing factors PSC and PCDP for inter-cell BM are introduced without impacting the definition of existing sharing factor P. The reason is that it’s possible that there is only L1 and L3 measurement for one cell, then legacy sharing factor P can be re-used. When there are measurements from two cells, scaling factor can be further scaled due to collision between the two cells.Therefore, we think it’s better to consider two step scaling method. In the first step, only consider the Collison between L1 and L3 for each cell respectively, which is defined in legacy. In the second step, further solve the collision between two cells. The final scaling factor will be the multiply of the two step scaling factors.Option 1 and option 2 are similar. For the scenario description, option 1 using equation and option 2 using wording. Option 1 list the calculation equation for PSC and PCDP. Option 2 calculate the result of PSC and PCDP and find it converge to 2. We are fine to further discuss. The main principle is to design a method which is relatively simple and have limited impact to legacy requirement. |
| Samsung | We see the issue now becomes too complicated and the spec is almost unreadable. We suggest to agree on a basic principle first.We agree on basic principle that L3 measurement is not impacted and sharing between the remaining L1-RSRP measurement opportunities after punctured by L3 measurements. |
| vivo | Firstly, for the first bullet,* We agree with Apple that it is not feasible to define PSC and PCDP without impacting P factor. The key issue is that the relation between PSC and existing P factor is not simple multiplying, but the value would be dependent based on different conditions.
	+ For example, for option 2, we have provided our comments in the 1st round that, the SMTC should also be considered. For example, if all SSB from SC fall in SMTC, Psharing\_factor should be considered and there is no need to scale PCDP = 2. Checking Huawei’s draft CR, it seems all the cases that Psharing factor is considered, scaling factor PSC = 2 is multiplied. This is of course unnecessary. Therefore, we disagree with option 2 in its current form.
* However, if the P factor in the general sentence means Psharing factor for SC, then we are OK with it.
* Therefore, we propose the following revision to the 1st bullet.
* Principles of Design:
	+ The sharing factors PSC and PCDP for inter-cell BM are introduced without impacting the definition of existing sharing factor Psharing factor, where Psharing factor is defined for the sharing factor between serving cell L1-RSRP measurements and L3 measurements.
		- No impacts on the existing L3 measurements.

Secondly, for the second bullet,* When puncturing, not only SMTCs that used for L3 measurements, but also measurement gaps, need to be considered. I think this worth clarification
* We agree with Apple that the in general, when puncturing, the max periodicity between SMTC and measurement gap should be considered.
* After puncturing, if no SSB left in either SC or CDP, then there is no need for any sharing. We think this point should be clear. For the case of SC, the SSB should be measured within SMTC, and Psharing factor should be considered. For the case of CDP, there is no requirements. Therefore, we think whether PSC or PCDP is needed, should also be determined by the SSB configuration of the other cell. As stated in our CR, a sentence like following is needed.
	+ For SC: “If SSB resource from the cell with different PCI is configured for L1-RSRP measurement, and P2 is valid accoding to 9.13.4.1…”
	+ For CDP: “If SSB resource from serving cell is configured for L1-RSRP measurements, and P1 is valid accoding to 9.5.4.1…”
* For the case when both SSB of SC and SSB of CDP are left after puncturing, the number of remaining SSB occasions within the period max(MGRP, SMTC) should be existing 1/P factor multiplying max(MGRP, SMTC)/TSSB. Note that 1/P should be the ratio of left occasions in total occasions, and max(MGRP, SMTC)/TSSB should be the total number of SSB occasions within the max(MGRP, SMTC). Then, the one with less samples would have higher priority, and the one with more samples should be punctured by them. By equation, it is written as:
	+ For SC,

- P = , if P1\*TSSB < P2\*TSSB\_CDP. (i.e. 1/PSC \* max(MGRP, SMTC)/TSSB\_SC > 1/PCDP \* max(MGRP, SMTC)/TSSB\_CDP, more samples are left after puncturing for SC)- P = 1, if P1\*TSSB > P2\*TSSB\_CDP.- P = 2, if P1\*TSSB = P2\*TSSB\_CDP.* + For CDP,

- P = , if P2\*TSSB\_CDP < P1\*TSSB\_SC.- P = 1, if P2\*TSSB\_CDP> P1\*TSSB\_SC.- P = 2, if P1\*TSSB\_SC = P2\*TSSB\_CDP.Therefore, we propose the following wording for the second bullet* + The sharing factors PSC or PCDP is determined in the same way as R15, i.e. by puncturing both SMTC and measurement gaps. PSC or PCDP is valid if there are remaining SSB occasions after this puncturing in the corresponding cell.
		- When puncturing, the max periodicity between SMTC and measurement gap, i.e. max(MGRP, SMTC), should be considered
	+ 1/P should be the ratio of remaining SSB occasions in total SSB occasions after puncturing. P here can be either PSC or PCDP, which is derived based on R15 mechanism.
	+ max(MGRP, SMTC)/TSSB is the total number of SSB occasions within the max(MGRP, SMTC)
	+ 1/P \* max(MGRP, SMTC)/TSSB  is the total number of left SSB occasions.
	+ Since SFNoffset for SSB of SC and SSB of CDP is the same, the SSB with less remaining occasions will be fully overlapped by the other SSB. Therefore, using SC as example.
		- P = , if PSC\*TSSB < PCDP\*TSSB\_CDP.
		- P = 1, if PSC \*TSSB > PCDP \*TSSB\_CDP.
		- P = 2, if PSC \*TSSB = PCDP \*TSSB\_CDP.
		- P = PSC, if PCDP is not valid.
 |
| MediaTek | Support to use the sharing factor which is similar to R17 gap enh framework. As our proposal in our paper, we think it would be more simple to determine the P sharing factor for RR17 inter cell beam management. But we are open to discuss other solution provided by other companies. |

**Issue 2-3-5 Number of non-serving TRPs to be measured for FR1**

* *Tentative Agreements*
	+ Number of other PCI UE can measure for L1-RSRP on FR1 is same as RAN1 capability and i.e., it can be more than 1 and up to 7.

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| CMCC | Support the tentative agreement |
| Intel | Agree with tentative agreement |
| Samsung | We are fine with the tentative agreement. |
| vivo | OK to the tentative agreement |
| MediaTek | Fine with tentative agreement |

**Issue 2-4-1 Scheduling restriction for dynamic TDD**

* Option 1:
	+ Introduce scheduling restriction for dynamic TDD when L1-RSRP measurement on cell with different PCI overlaps with serving cell UL slots.
* Option 1a:
	+ Introduce scheduling restriction for dynamic TDD when L1-RSRP measurement on non-serving cell overlaps with serving cell UL slots. In addition, one OFDM symbol before and after SSB should also be considered because of TA.
* Option 2:
	+ Do not introduce scheduling restriction for dynamic TDD when L1-RSRP measurement on cell with different PCI overlaps with serving cell UL slots.
* Option 3:
	+ For the scheduling restriction due to L1-RSRP measurement on cell with different PCI, RAN 4 has agreed that the timing offset between serving cell and cell with different PCI should be less than CP, thus no need to introduce additional 1 slot scheduling restriction even considering dynamic TDD.

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| Apple | We support option 1. We are not sure if 1 symbol is needed for inter-cell BM as we don’t have dual TA and single UL timing is assumed. Is option 3 same as option 1, but only restricted to the SSB symbols? |
| Samsung | Prefer Option 2. |
| vivo | Option 2. Same comment as 1st round.To Apple, in our understanding what RAN1 means by ‘RRM measurements’ would be L3 measurements. In R16, no scheduling restrictions have been introduced by the L1 measurements performed for serving cell. |
| MediaTek | Support option 1a. According to following figure, we think one additional restriction symbol to be considered should be considered.  |

**Issue 2-4-2 Update capability *simultaneousRxDataSSB-DiffNumerology***

* Option 1:
	+ Introduce scheduling restriction for dynamic TDD when L1-RSRP measurement on cell with different PCI overlaps with serving cell UL slots.
		- Update the capability signaling simultaneousRxDataSSB-DiffNumerology as below:

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| ***simultaneousRxDataSSB-DiffNumerology***Indicates whether the UE supports concurrent intra-frequency measurement on serving cell or neighbouring cell and PDCCH or PDSCH reception from the serving cell or an additional serving cell with a different numerology as defined in clause 8 and 9 of TS 38.133 [5]. |

* Option 2:
	+ No need for option 1.

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| Apple | Option 2. |
| Intel | Prefer option 2. |
| Samsung | Option 2. And it is out of RAN4 scope.And in our view, we are discussing [measurement RS from neighbouring cell] overlap with [data from SC], the case which has already included. |
| vivo | No need for option 1. We support option 2. |
| MediaTek | We can compromise option 2 if the majority view is option 2. Besides, the issue here we proposed is [measurement RS from serving cell or neighbouring cell] overlap with [data from SC and additional serving cell] |

**Issue 2-4-3 Whether to define scheduling restriction for non-serving cell**

* Option 1:
	+ Introduce scheduling restriction on non-serving cell when UE performs L1-SINR measurement, BFD, CBD, RLM on serving cell.
* Option 2:
	+ Option 1 is not needed.

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| Apple | This scheduling restriction already exists and applies if UE is receiving PDCCH/PDSCH from cell with diff PCI since the scheduling restriction doesn’t specify receiving PDSCH/PDCCH from serving cell alone.  |
| Intel | Prefer option 2. It seems that the legacy scheduling restriction can still apply. |
| Samsung | Option 2.If we understand correct, option 1 means measurement restriction. We are not sure why measurement restriction are introduced for L1-SINR measurement on NSC. As far as we know, for NSC, no L1-SINR measurement so far. We only have L1-RSRP measurement. |
| vivo | Support option 2 |
| MediaTek | We can compromise to option 2  |

**Issue 2-5-1: Applicability of ICBM feature**

* Option 1:
	+ The ICBM feature shall be applicable to SCell. (ZTE, Intel, MTK)
	+ For intra-band ICBM using common TCI configurations, different reference CCs in the same CC list between the serving cell and a cell with different PCI is not supported in R17.(ZTE,Intel)
	+ For intra-band ICBM using common TCI configurations, requirements are defined for the case when SSB measurements for a cell with different PCI are only performed in the cell that has the same SSB frequency as the reference CC.
	+ R17 ICBM feature is applicable to FR1 HST and FR2 HST. If RAN4 identifies any issue in applying HST related enhancements to ICBM related RRM requirements, RAN4 solve them in the R17 maintenance phase. (ZTE, CMCC)
	+ R17 ICBM feature is applicable to the scenarios when UE is configured with R17 enhanced gaps. If RAN4 identifies any issue in applying R17 enhanced gaps to ICBM related RRM requirements, RAN4 solve them in the R17 maintenance phase.
* Option 2:
	+ Not in favor of extending ICBM requirements for concurrent R17 WIs

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| CMCC | We support option1. As for the comments on concurrent R17 WIs, at least Rel-16 FR1 HST need to be supported. |
| Apple | Option 2, since more dedicated discussion is needed. |
| Intel | Fine with first two bullets. |
| vivo | We support the all bullets. Reading option 2, we think it is not contradicting with first 2 bullets and the R16 HST case. Therefore, we propose to try the following in the WF.* + The ICBM feature shall be applicable to SCell.
	+ For intra-band ICBM using common TCI configurations, different reference CCs in the same CC list between the serving cell and a cell with different PCI is not supported in R17.
	+ R17 ICBM feature is applicable to FR1 HST. If RAN4 identifies any issue in applying HST related enhancements to ICBM related RRM requirements, RAN4 solve them in the R17 maintenance phase.
		- FFS: FR2 HST
 |
| MediaTek | Support option 2 |

**Issue 2-6-1a: Scenario clarification in the LS [R1-2205640]: SSB and PDCCH/PDSCH are overlapped on the same RE**

* *Tentative Agreements*
	+ SSB from cell with different PCI is overlapped with PDSCH/PDCCH from serving cell on the same RE

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| CMCC | No strong view. According to the wording of LS, it seems for the same PCI. But if companies have common understanding that it is for the case that SSB from cell with different PCI is overlapped with PDSCH/PDCCH from serving cell on the same RE, we are also fine. |
| Apple | Fine with tentative agreement.  |
| Intel | Agree with tentative agreement. |
| Samsung | Totally agree. |
| vivo | Agree with tentative agreement. |
| MediaTek | Agree with tentative agreement. |

**Issue 2-6-2: Whether any clarification or update is needed in RAN4 spec when SSB and PDCCH/PDSCH are overlapped on the same RE**

* Option 1:
	+ No.
* Option 2:
	+ Clarify that performance degradation is expected when overlapping happen in RAN4 spec.
* Option 3:
	+ Clarify that there is no UE requirement when overlapping happen in RAN4 spec.
* Option 4:
	+ Define scheduling restriction to avoid overlap between SSB and data on the same RE in RAN4 spec.

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| Apple | Option 1 |
| Intel | Prefer option 2, 3 or 4. Some performance degradation is expected, it’s better to clarify. |
| Samsung | Option 1. Do not support Option 3, 4. RAN4 do not specify a single requirement that “no restriction applied for XXX”. Option 2 is also not preferred as it is not RAN4 convention. |
| vivo | Option 1. We think this is not within RAN4 scope. However, option 2,3,4 can be discussed after there is conclusion in RAN1. |
| MediaTek | Support Option 3. Because we do not have the requirement when SSB and PDCCH/PDSCH are overlapped on the same RE. So, to our understanding, it means no UE requirement in RAN4 spec. Besides, we also think we do not need to update the RAN4 spec. |

**Issue 2-6-3: detail wording for reply LS**

* Option 1:
	+ No. Just inform RAN1 about the current status in RAN4.
* Option 2:
	+ Mention that performance degradation is expected in the LS.
* Option 3:
	+ Mention that there is no requirement in the LS.

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| Apple | Option 1, 2 |
| Intel | Prefer option 2. |
| Samsung | Prefer Option 2, 3. |
| vivo | Option 2 and/or option 3. |
| MediaTek | Support option 1. |

## TRP specific link recovery

**Issue 3-1-1 Wording update and clarification for TRP specific link recovery**

* Agreements
	+ For TRP specific link recovery, it is suggested to use the wording “a serving cell” instead of “a serving cell and cell with different PCI”, where the serving cell can be either configured with additionalPCIList or not.
	+ For TRP specific link recovery, it is suggested to clarify that the SSBs in set and can be indicated to be associated with an additional PCI.

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| Intel | Further check in the CR. |
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**Issue 3-1-2 Measurement restrictions**

* *Tentative agreements*
	+ For TRP specific BFD/CBD measurements in FR2, it is suggested that there is no measurement restrictions between BFD/CBD RS resources from different sets.

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| Apple | Not clear what this means. Different sets are associated with different TRPs, we have scaling factor if they overlap in FR2. |
| Intel | Agree with tentative agreement. Measurement restriction is used to define requirement when collision happen between measurement. for overlapped case, scaling factor is already defined. Therefore, there is no need to define measurement restriction. |
| Samsung | “different resource sets”? For FR2, we already have sharing factor. |

**Issue 3-1-3 Prioritization for beam failure recovery procedure**

* *Tentative agreements*
	+ RAN4 not to introduce prioritization for beam failure recovery procedure when beam failure recovery happens simultaneously on both BFD-RS resource sets.

Collect companies’ view in 2nd round

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| **Company** | **Comments** |
| Intel | Fine with tentative agreement. |
| Samsung | Fine for us. |
| MediaTek | ok |