**3GPP TSG RAN WG1 #105-e R1-2106285**

**e-Meeting, May 10th – 27th, 2021**

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator summary for multi-beam enhancement: ROUND 4

**Document for:** Discussion and Decision

## Introduction

In this summary, the term “item 1” refers to the first item in the Rel.17 NR FeMIMO WID, i.e. multi-beam enhancement:

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| --- |
| * Enhancement on multi-beam operation, mainly targeting FR2 while also applicable to FR1:
	+ Identify and specify features to facilitate more efficient (lower latency and overhead) DL/UL beam management to support higher intra- and L1/L2-centric inter-cell mobility and/or a larger number of configured TCI states:
		1. Common beam for data and control transmission/reception for DL and UL, especially for intra-band CA
		2. Unified TCI framework for DL and UL beam indication
		3. Enhancement on signaling mechanisms for the above features to improve latency and efficiency with more usage of dynamic control signaling (as opposed to RRC)
	+ Identify and specify features to facilitate UL beam selection for UEs equipped with multiple panels, considering UL coverage loss mitigation due to MPE, based on UL beam indication with the unified TCI framework for UL fast panel selection
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This summary includes the following:

* Observation and proposal
* Summary of current companies’ positions on each of the aspects within the category

## Summary of companies’ inputs

The listed issues are structured primarily to facilitate some progress on pending issues identified in the agreements (see Appendix A).

### Issue 1 (Rel.17 unified TCI framework – note: for intra-cell beam management)

UL PC

**Proposal 1.1A:** On the setting of UL PC parameters except for PL-RS (P0, alpha, closed loop index) for Rel.17 unified TCI framework, for PUSCH and PUCCH, the setting is either included in UL TCI state or (if applicable) joint TCI state or associated with UL TCI state or (if applicable) joint TCI state.

* Whether it is ‘included in’ or ‘associated with’ (including the manner it is performed and the signaling) is up to RAN2

Note: It has been agreed that the setting of (P0, alpha, closed loop index) is associated with UL channel or UL RS (therefore the setting is channel- and signal-specific)

**OR**

**Proposal 1.1B:**On the setting of UL PC parameters except for PL-RS (P0, alpha, closed loop index) for Rel.17 unified TCI framework,

* For each of PUSCH and PUCCH, the setting of (P0, alpha, closed loop index) can be associated with UL or (if applicable) joint TCI state.
	+ In this case, multiple settings are configured. Each setting can be associated with at least one TCI state, and, for a given TCI state, only one setting for PUSCH and only one setting for PUCCH can be associated at a time.
	+ Details of the association (including the manner it is performed and the signaling) is up to RAN2
* If not associated, for each of the PUSCH and PUCCH, the setting(s) of (P0, alpha, closed loop index) per channel/signal is independent the UL or (if applicable) joint TCI states
* FFS: If the setting of (P0, alpha, closed loop index) for SRS can also be associated with UL or (if applicable) joint TCI state.
* FFS: (to be decided in RAN1#106-e) whether to configure the same setting of (P0, alpha, closed loop index) per TCI state across channels and apply a channel dependent component, or configure a channel dependent setting of (P0, alpha, closed loop index) per TCI state

Table 1 Additional inputs: issue 1 – UL PC

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | **(Last attempt per Mr. Bo’s request) Since technical arguments have been made, please complete the following. If you want to present some new or summarize your arguments, or suggest a compromise, please use the rows below:****Proposal 1.1A:*** **Support (11): Samsung, ZTE, LG, OPPO, Qualcomm, MTK, NTT Docomo, NEC, Xiaomi, CMCC, Spreadtrum**
* **Concern: vivo**

**Proposal 1.1B:*** **Support (21): Apple, Samsung, ZTE, LG, OPPO, MTK, NTT Docomo, NEC, Xiaomi, CATT, CMCC, Spreadtrum, Futurewei, Fraunhofer IIS/HHI, Sony, Ericsson, Futurewei, Huawei/HiSi, Intel**
* **Concern: vivo**

**If there is no consensus in selecting either 1.1A or 1.1B (or a compromise between the two acceptable to all), the proposed conclusion in the chairman notes will be the outcome.**  |
| Apple | We are ok with majority view – 1.1B.  |
| LG | For a sake of progress, either 1.1A or 1.1B is fine for us. |
| OPPO | Either 1.1A and 1.1B is ok to us.  |
| Qualcomm | We can live with 1.1B if SRS can be included in PUSCH/PUCCH in 1st bullet. This may not be optimal signaling, but it should work to our understanding. We prefer not to spend more time on this topic as compromise.[Mod: OPPO would have concern if we add SRS here. In that case I’ll remove Qualcomm from 1.1B. In that case, should I add Qualcomm on 1.1B concern list if SRS is not added?] |
| Docomo | Either 1.1A or 1.1B is fine for us. |
| NEC | Either 1.1A or 1.1B is fine. |
| Xiaomi | Either 1.1A or 1.1B is fine to us.Maybe a small typo in 1.1B, “If not associated, for each of the PUSCH and PUCCH, the setting(s) of (P0, alpha, closed loop index) per channel/signal is independent of the UL or (if applicable) joint TCI states” |
| CATT | Support option 1.1B.  |
| CMCC | Either 1.1A or 1.1B is fine. |
| Spreadtrum | We are ok with majority view. |
| Mod V17 | **Question for Qualcomm**: please check above[Mod: Yan has confirmed no concern on original 1.1B] |
| Fraunhofer IIS/HHI | Prefer proposal 1.1B. A minor revision of the third sub-bullet: “FFS: If the setting of (P0, alpha, closed loop index) for SRS can also be associated with UL or (if applicable) joint TCI state.” |
| Sony | Support Proposal 1.1B. |
| Ericsson | Our first preference is Proposal 1.1B, but we would also be OK with the conclusion in the chair’s notes. |
| Futurewei | We support Proposal 1.1B. |
| vivo | Our position remains the same. |
| Huawei, HiSilicon | After hearing the discussions, we now slightly prefer 1.1B.  |
| Mod V30 | **Updated companies’ preference** |
| Intel | OK with 1.1B |
| Mod final | Given that 21 companies (including those supporting 1.1.A) support proposal 1.1B and only 1 company with concern (no further agreement/enhancement), it seems fitting from moderator’s perspective to recommend proposal 1.1B to be agreed. |

M>1 or N>1 support:

**Proposal 1.2**: On Rel-17 unified TCI, in RAN1#106-e, for M>1 and/or N>1:

* Identify and agree on use cases
* Decide whether to support M>1 and/or N>1, and if so, the maximum value of M and/or N
* If supported, identify feasible candidate schemes for beam indication signaling mechanism (including TCI state activation)

Note:

* Previous agreement in RAN1#104b-e that remaining unused DCI fields and codepoints are reserved in R17 are not to be reverted.
* The use case of simultaneous UL transmission from multiple UE panels are not to be considered in Rel-17 as it is out of scope

Table 2 Additional inputs: issue 1 – M/N>1

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | **Please share your input on the above proposal**  |
| Apple | Use cases: mTRP only and we have strong concern to use it for sTRPBeam indication signaling mechanism: TCI codepoint mapped to 2 DL/UL TCI or 2 joint TCIMaximum value: M=2, N=2 |
| Samsung | In general, fine with proposal, but we would like to reorder bullet 2 and 3**Proposal 1.2**: On Rel-17 unified TCI, in RAN1#106-e, for M>1 and/or N>1:* Identify and agree on use cases
* Decide whether to support M>1 and/or N>1, and if so, the maximum value of M and/or N
* If supported, identify feasible candidate schemes for beam indication signaling mechanism (including TCI state activation)
 |
| ZTE | Firstly, we prefer the updated version from Samsung.Then, regarding use case, we do think mTRP is very important case, and the top issue (maybe tough) should be how to split DL/UL channel/RS resources per TRP, like what we did for CORESET(s) in mDCI-mTRP.Finally, we share the same views with Apple that maximum value: M=2, N=2 is sufficient.  |
| LG | We support M>1 for MTRP and N>1 for MPUE |
| OPPO | Use case: we share similar view as Apple. The only feasible use case is multi-DCI based mTRP. For single-TRP: no use case.The updated version from Samsung looks better. |
| Qualcomm | Fine with the proposal. Use case: Both sTRP and mTRP. Do not see why sTRP is not important for reliability enhancementM=N=2 is fine |
| MediaTek | Share the same view with Apple, ZTE, and OPPO. We see only mTRP is the valid use case. In this case, M =2, N=2 is sufficient. |
| Docomo | Fine with FL proposal or Samsung’s update.Use case: Both S-TRP and M-TRP. For S-TRP, different TCI states for different subsets of CCs (e.g. inter-band CA). |
| NEC | Support the proposal, and at least multi-TRP is the use case to be supported. |
| Xiaomi | Support the updated version by Samsung. |
| CATT | Support the updated version by Samsung.  |
| CMCC | Support the updated version by Samsung.  |
| Convida Wireless | Support the updated version by Samsung.  |
| Spreadtrum | We also think M-TRP is the most valid use case, and M=N=2 is sufficient. Samsung’s update is fine. Besides, since different use cases may have different spec impact, maybe we can try to support one use case first.  |
| Mod V17 | **Revised per Samsung’s input**. Re use cases, we will discuss in the next meeting. I may start a **summer offline ☺** on this topic to accelerate progress. |
| Fraunhofer IIS/HHI | Support current FL proposal. We support M, N>1 for MTRP. |
| Sony | Support the updated version by Samsung. At current stage, we also think M=2 and/or N=2 only applies for M-TRP scenario. If so and supported, does it mean we extend unified TCI state in AI 8.1.1 to M-TRP in AI 8.1.2.x, where the latter is built on Rel.15/16 beam management. It may lead to a load of work, including some tough ones as ZTE mentioned.  |
| Ericsson | Support the updated version from the FL. In our view, the relevant use case is mTRP that involves joint transmission and/or reception: if limited to DPS, M=N=1 is sufficient. |
| MediaTek | Support the updated version |
| Futurewei | Support FL’s proposal. Use cases include support of mTRP and support of CORESET beam diversity. We support M or N > 2.Beam indication signaling mechanism: a TCI codepoint can be mapped to M DL TCIs, N UL TCIs, or M=N joint TCIs. |
| vivo | Support FL’s proposal |
| Huawei, HiSilicon | We suggest adding two notes:* Previous agreement in RAN1#104b-e that remaining unused DCI fields and codepoints are reserved in R17 are not to be reverted.
* The use case of simultaneous UL transmission from multiple UE panels are not to be considered in R17.

[Mod: Done, also added (2nd note) that it is out of scope]We believe M>1 BPLs can also be used for single-TRP operation, but that can be discussed later.  |
| Mod V30 | **Updated proposal** |
| Intel | This proposal is not needed in our view. We already have multiple FFSs captured in various agreements and in our understanding, companies can bring proposals to address them in future meetings. [Mod: It is customary to have an agreement to set a deadline for such topics. The proposal also includes issues to be sorted out leading to decision making] |
| Mod final | All companies except for one support this proposal, but no strong concern is expressed.I will recommend this proposal for endorsement. |

### Issue 2 (L1/L2-centric inter-cell mobility)

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### Issue 3 (signaling medium)

Below is the current outcome of the offline discussion.

**Proposal 3.3A**: On Rel-17 unified TCI, for a UE configured with both joint TCI and separate DL/UL TCI, TCI states can be activated via MAC-CE-based TCI state activation for either only joint DL /UL TCI or only separate DL /UL TCI

* When TCI states are activated for joint TCI, the TCI field in DCI formats 1\_1/1\_2 used for beam indication can update only a TCI state associated with joint TCI
* When TCI states are activated for separate DL/UL TCI, the TCI field in DCI formats 1\_1/1\_2 used for beam indication can update only a TCI state associated with either DL-only TCI or UL-only TCI, or update a pair of TCI states associated with DL TCI and UL TCI, respectively
* Detailed MAC-CE-based design is up to RAN2

FFS: the cases of M/N > 1

FFS: Whether/how to clarify UE behavior on TX beam for UL channels when DCI only indicates a DL TCI (of separate DL/UL TCI) after a joint TCI is indicated

**Proposal 3.3B:**

On Rel-17 unified TCI framework, for a UE configured with both joint TCI and separate DL/UL TCI, an activated TCI state (via MAC-CE-based TCI state activation) can be a TCI state associated with either joint TCI or separate DL/UL TCI

* Activation of TCI states where at least one activated TCI state is associated with joint TCI and at least another activated TCI state is associated with separate DL /UL TCI is an optional UE capability
* Detailed MAC-CE-based design for the above functionality is up to RAN2
* FFS: Other related UE capabilities on the number of active QCL and/or UL spatial relation assumptions

FFS: Whether/how to clarify UE behavior on TX beam for UL channels when DCI only indicates a DL TCI (of separate DL/UL TCI) after a joint TCI is indicated

Table 3 Additional inputs: issue 3 – switching

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | **Since technical arguments have been made, please complete the following. If you want to present some new or summarize your arguments, or suggest a compromise, please use the rows below:** **Proposal 3.3A:*** **Support (19): Samsung, LG, OPPO, Qualcomm (1st), MTK (1st), ZTE(1st), NTT Docomo, NEC, Xiaomi, CATT (2nd), CMCC, Spreadtrum (1st), Futurewei, Fraunhofer IIS/HHI, Ericsson, vivo, Huawei/HiSi**
* **Concern (1): Intel**

**Proposal 3.3B:*** **Support (21): Apple, Samsung, LG, OPPO, Qualcomm (2nd), MTK, ZTE(2nd), NTT Docomo, Nokia/NSB, NEC, Xiaomi, CATT (1st), Convida, Spreadtrum (2nd), Futurewei, Fraunhofer IIS/HHI, Sony, Ericsson, Intel**
* **Concern (3): vivo, Huawei/HiSi**

**If there is no consensus on selecting either proposal 3.3A or 3.3B (or a compromise between the two), the proposed conclusion (RRC configuration) in the chairman notes will be the outcome.** |
| Apple | Support majority view – 3.3B |
| LG | For a sake of progress, we are fine either 3.3A or 3.3B. |
| OPPO | Either A or B is ok to us.  |
| Qualcomm | Prefer 3.3A, but can live with 3.3B. For 3.3B, suggest to add the following FFS, e.g. should UE ignore the later separate DL TCI or stick to the earlier joint TCI for UL channels? Because joint TCI must be shared by DL and UL channels based on current definition. FFS: Whether/how to clarify UE behavior on Tx beam for UL channels when DCI only indicates a separate DL TCI after a joint TCI is indicated.[Mod: Added] |
| ZTE | We slightly prefer 3.3A that is a complete solution, and we do NOT believe that leaving all aspects to RAN2 is a good solution. |
| Docomo | Either 3.3A or 3.3B is fine for us. |
| Nokia/NSB | We see an edge in 3.3B, despite the fact that it comes with a UE capability, something we do not like but we understand that we need to live with it... |
| NEC | Either 3.3A or 3.3B is fine, and it seems RRC configuration is not prefered by majority companies? We should decide one from 3.3A or 3.3B rather than RRC configuration… |
| Xiaomi | Either 3.3A or 3.3B is fine to us. |
| CATT | Support 3.3B. Can live with 3.3A.  |
| CMCC | Prefer 3.3A. |
| Convida Wireless | Support 3.3B, which was reached after taking many companies concerns into account. |
| Spreadtrum | Based on the discussion, we feel that RRC based switching resulted from no consensus is not too bad. The only drawback is when gNB wants to switch only UL beam due to the cases such as MPE event, but configured with a list of joint TCI states. gNB has to change UL beam and DL beam together, which will degrade DL performance. gNB can choose to configure joint TCI or separate TCI based on whether changing only UL beam will happen and whether DL performance degradation is acceptable. However, we are not proposing a new alternative for further discussion, since it’s highly possible that someone will disagree with our analysis. Still, Proposal 3.3A is our first preference, Proposal 3.3B is also fine for progress. |
| Mod V17 | **So far no company has raised any concern on either 3.3A or 3.3B.** **I am glad that companies (so far) are willing to be constructive – not risking the worst-possible solution (RRC, not preferred even by the FL) – despite their preference** |
| Fraunhofer IIS/HHI | Fine with either 3.3A or 3.3B. |
| Sony | Support 3.3B.  |
| Ericsson | Our first preference is actually RRC configuration, but we are OK with either 3.3A or 3.3B |
| Futurewei | On Proposal 3.3B, it can apply to the cases of M or N > 1 as well. Therefore the bullet “FFS: the cases of M or N > 1” is no longer needed and can be removed.[Mod: Done] |
| vivo | Support 3.3A.We have strong concerns on dynamic switch between joint and separate mode. |
| Huawei, HiSilicon | Prefer 3.3A, and share similar concern as vivo on 3.3B.  |
| Mod V30 | **Updated companies’ preference and proposal 3.3B** |
| Intel | Strongly support 3.3B. We have concerns on MAC-CE based mode-like operation in 3.3A. For 3.3A, the last FFS is not relevant and should be removed.  |
| Mod final | It is quite unfortunate that some companies who strongly prefer dynamic over semi-static (RRC) for supposedly technical reason(s) (use cases, etc.) would rather have no dynamic unless it is fully conformed to their preference. I am quite disappointed with this outcome. I will leave this at the discretion of the chairman – which in all likelihood will lead to the proposed FL conclusion of RRC.  |

### Issue 4 (MPUE)

**Proposal 4.2**: Support configuring a UE with two SRS resource sets by RRC having different numbers of ports for codebook-based UL transmission

* Only one of the configured SRS resource sets is valid for SRS transmission at a time
* FFS: UE reported information, and how gNB signals whether SRS resource set based on the UE reported information
* FFS: this can be applied to non-codebook-based UL transmission
* This feature is UE optional
* FFS: If there is any spec impact

Table 4 Additional inputs: issue 4 – SRS for MPUE

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | **Please share your input on the above proposal**  |
| Apple | We have concern for this proposal. We think the panel selection should not be in per channel level, otherwise UE may face the situation to activate more panels or simultaneous transmission from multiple panels from multiple CCs. Since unified TCI is applied for multiple channels across CCs, to maintain the same understanding on panel entity based on unified TCI between gNB and UE would be a better way. The intention for the proposal is to support different number of ports for different panels. Then the two sets should be for two panels, but it seems only 1 panel is valid for transmission based on the indicated TCI. In addition, it may not be necessary to configure 2 sets, but another possible way is to configure 1 SRS resource set and to dynamically update the configuration for the SRS.With that we suggest the following as a starting point.**Proposal*** **Down-select one of the following options to facilitate UL panel selection for CB based PUSCH transmission at least for FR2 in sTRP mode:**
	+ **Option 1: gNB can configure 2 SRS resource sets for CB with different number of ports**
		- **Only 1 resource set is valid to be triggered for SRS transmission and SRI indication for PUSCH**
		- **UE does not transmit SRS in the invalid SRS resource set no matter whether it is triggered or not**
		- **FFS: How to determine an SRS resource set is valid or invalid**
	+ **Option 2: gNB can configure only 1 SRS resource set for CB**
		- **The number of ports for the SRS resources in the set can be dynamically updated**
			* **FFS: signaling details**
		- **The number of SRS ports should be aligned with reported UE capability for the corresponding panel entity for SRS/PUSCH**
* **The panel entity for the uplink channel is determined based on the RS used to provide spatial relation indication in the indicated unified UL/joint TCI**
	+ **This applies for PUSCH/PUCCH/SRS**
	+ **The panel entity for a RS is based on a L1-RSRP report instance**
		- **FFS: details**
* **Support UE reports maximum number of ports/layers per panel entity**

[Mod: I will note this and may try to address after I see more views – but please check the latest version per Darcy’s suggestion] |
| Samsung | Fine with proposal 4.2. Fine with studying FFS highlighted in yellow |
| ZTE | We suggest to remove the highlight FFS bullet that is just to make this issue much more complicated and weaken the motivation, and if so, we are fine with this proposal.[Mod: Done] |
| LG | We support 4.2. We prefer to use this feature in FR1 as well, but we are ok to make a decision on this later. For the second FFS, either keeping it or deleting it seems to have no critical difference. We are fine either way.Re Apple’s suggestion, we are fine with adding the last bullet from Apple. But the other option (i.e. Option 2) proposed by Apple seems not aligned with the WID (i.e. ‘fast’ panel selection) and this proposal would allow MAC-CE or DCI overwrites RRC. Since we are running out of time, although we have concerns on Option 2, it is one possibility to list up two alternatives and make a decision in next meeting (it is better than nothing). If we have to go this way, our suggestion is to keep original proposal for Option1.  |
| OPPO | We prefer to remove “At lease for FR2” because we also see use case of this for FR1.Re the highlighted FFS: prefer to remove it to simplify the design.[Mod: Done] Re the version suggested by Apple: we are not ok to associate the panel entity here. The spec should not use the word “panel”, right? |
| Qualcomm | Fine with Proposal 4.2. For Apple’s proposal, although we are fine for most points, it may be a bit too late to converge on so many details. It would be more feasible to have 4.2 agreed in general and put detailed aspects in FFS, given the limited remaining time. |
| MediaTek | Suggest the following changes to the proposal 4.2 due to:* Share the similar view with Apple. Two sets with different ports can be configured to support UE panel configurations with different number of TXRUs. However, since UE only activates one UE panel configuration for UL, only one set is needed for SRS transmission at a time. Regarding the indicated SRI, according to current spec, since it should be associated with the most recent transmission of SRS resource identified by the SRI, it is natural the indicated SRI refers to the valid set.
* We also don't see the need of the highlight FFS. Suggest to focus on how to use the two configured sets.
* We think the 2nd and 3rd bullets in Apple’s proposal are valid points. However, they may be the next level detail of UE reported information. We prefer to discuss the detail in the next meeting due to running out of the time of this meeting.

**Proposal 4.2**: At least for FR2, support configuring a UE with two SRS resource sets by RRC having different numbers of ports for codebook-based UL transmission* Only one of the configured SRS resource sets is valid for SRS transmission at a time
* FFS: UE reported information, and how gNB signals the valid SRS resource set based on the UE reported information
* FFS: this can be applied to non-codebook-based UL transmission
* This feature is UE optional

[Mod: Done] |
| Docomo | Support FL’s proposal 4.2 and share similar view with LG/OPPO that this can also be used for FR1. |
| NEC | Support the FL proposal. |
| CATT | Fine with proposal 4.2.  |
| CMCC | The motivation of the highlighted FFS is not clear. |
| Convida Wireless | Support the FL proposal, and OK to keep the highlighted FFS bullet. |
| Spreadtrum | We are OK if there’s a majority view since it’s UE optional anyway, although we think this will potentially cause NW based panel selection without knowing UE panel status.  |
| Mod V17 | **Revised proposal per inputs** |
| Fraunhofer IIS/HHI | Support the latest updated version from the FL |
| LG | Support the latest updated version from FL |
| Ericsson | After the long email discussion, we fail to see that proposal 4.2 is beneficial on its own. The critical FFS is what information should be reported by the UE to facilitate relevant triggering by the gNB. Without any such information, the gNB would have to trigger one SRS resource set blindly. If P4.2 is agreed, companies may subsequently argue that we must specify some additional reporting/signaling scheme to make SRS resource sets with different number of ports useful. Since we do not know what signaling is required, we are in a sense signing a blank check. To avoid that order of argumentation, we propose to study the issue on how to optimize transmission from UEs with varying number of max UL MIMO layers. This would seem to be the central question, as formulated by several companies. Clearly, this is applicable also to FR1. Hence we propose**Proposal:** Study and if necessary specify enhancements to optimize transmission from UEs with varying number of max number of UL MIMO layers. Alternatively, we could agree on P4.2 and option 3 on the panel ID issue together:**Proposal 4.2**: Support configuring a UE with two SRS resource sets by RRC having different numbers of ports for codebook-based UL transmission* No additional specification support is introduced for a panel entity
* Only one of the configured SRS resource sets is valid for SRS transmission at a time
* FFS: UE reported information, and how gNB signals the valid whether SRS resource set based on the UE reported information
* FFS: this can be applied to non-codebook-based UL transmission

This feature is UE optional |
| Nokia/NSB | Not support the updated one.We have severe concerns on mixing this SRS resource set configuration issue with panel ID or panel related UE reporting issues. If this SRS resource set configuration issue cannot be solved without considering together with UE’s panel specific reporting, then we should finish panel ID or panel specific reporting issue first, then revisit this one later. We support original proposal from email discussion or one from Ericsson. But not support updated one.  |
| MediaTek | We are fine with Ericsson’s suggestion to P4.2. However, we are not quite understand Nokia’s concern. These is no panel ID in the updated proposal.Regarding the additional proposal suggested by Ericsson, if P4.2 is agreed, it is natural companies will start to study some additional reporting/signaling scheme to make SRS resource sets with different number of ports useful. We think the 1st FFS in P4.2 has the same intension as the additional proposal.One minor correction the following FFS bullet:* FFS: UE reported information, and how gNB signals the valid SRS resource set based on the UE reported information
 |
| ZTE2 | We have strong concern on Ericsson’s updated one. The only motivation from our perspective is to handle multi-UE panel, and we fail to understand why we have the following two controversial bullet together.* No additional specification support is introduced for a panel entity
* FFS: UE reported information, and how gNB signals the valid whether SRS resource set based on the UE reported information

If the motivation is not relevant to MPUE operation and WID is changed to handle varying number of max UL MIMO layers, we suggest to go RAN Plenary meeting and change WID firstly. Based on the new inputs and good discussion, we suggest to agree the following Opt2 and the proposal 4.2 together.* Opt1-2: A panel entity is referring to a new panel ID within CSI/beam reports
	+ FFS: Detailed design of the new panel ID including the information conveyed by the new panel ID
	+ Note: The association between the new panel ID and the panel entity is determined by the UE
 |
| vivo | With current formulation, BWP switch seems already supports the following feature. We would like to further study whether there is any specification impact.**Proposal 4.2**: Support configuring a UE with two SRS resource sets by RRC having different numbers of ports for codebook-based UL transmission* Only one of the configured SRS resource sets is valid for SRS transmission at a time
* FFS: UE reported information, and how gNB signals the valid whether SRS resource set based on the UE reported information
* FFS: this can be applied to non-codebook-based UL transmission
* This feature is UE optional

FFS there is any specification impact  |
| Huawei, HiSilicon | In principle, fine with this proposal.  |
| Mod V30 | **Current situation****Proposal 4.2:*** **Support: Samsung, ZTE, LG, OPPO, Qualcomm, MTK, NTT Docomo, NEC, CATT, CMCC, Convida, Spreadtrum, Fraunhofer IIS/HHI, vivo (but FFS spec impact), Huawei/HiSi**
* **Concern: Apple, Ericsson, Nokia/NSB**

**Apple’s proposal (two options):*** **Support: Apple, LG**
* **Concern: MTK, Ericsson**

**Ericsson’s package proposal:*** **Support: Ericsson, Nokia/NSB, MTK**
* **Concern: ZTE**

**Ericsson’s study proposal:*** **Support: Ericsson, Nokia/NSB, MTK**
* **Concern: --**

**Question to Apple, Ericsson, Nokia/NSB: If we added vivo’s proposed bullet, I assume your concern is resolved?** |
| Intel | We still think it is only valid for FR2 and would prefer it be added back.  |
| Apple | It seems the intention of vivo’s suggestion is to configure different SRS sets in different BWPs. We are ok to start with it, but we think it is better that the intention could be clear. We also suggest we include the restriction for SRI indication as well.**Proposal 4.2**: Support configuring a UE with two SRS resource sets by RRC having different numbers of ports for codebook-based UL transmission* Only one of the configured SRS resource sets is valid for SRS transmission and SRI indication for PUSCH
* FFS: UE reported information, e.g. maximum number of UL layers and SRS ports, and how to maintain the same understanding between gNB and UE on whether a SRS resource set is valid or not based on the UE reported information
* FFS: this can be applied to non-codebook-based UL transmission
* This feature is UE optional

FFS there is any specification impact, e.g. whether the SRS resource sets with different number of ports is configured in the same BWP or different BWPs in a CC |
| Ericsson | The input from ZTE is quite helpful. Clearly, there are different interpretations of the implications of the proposed agreement, including no spec impact and an introduction of a panel ID. We also note that the formulations are constantly changing.As it is also very late in the meeting, we are not comfortable in agreeing to Proposal 4.2, even with vivo’s addition.  |
| Mod final | This is quite unfortunate. From FL perspective, the best we can do is to propose Ericsson’s study proposal (no lingering concern). Note that regarding 4.2, based on the agreement made in 104b-e, the deadline to finalize this is 106-e. So we need to conclude this issue in the next meeting. |

### Issue 5 (MPE)

**Proposal 5.1**: On Rel.17 enhancements to facilitate MPE mitigation, support one of the following schemes (to be down-selected in RAN1#106-e):

* Opt1A. Rel.16 P-MPR based (TCI or SSBRI/CRI-specific) together with Virtual PHR (or a modified version)
	+ The modified version may be associated with each activated UL TCI or, if applicable, joint TCI, or associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured) from candidate pool, if reported.
	+ The reporting reuses the event-driven mechanisms from the Rel-16 P-MPR reporting
	+ FFS: Definition of virtual PHR and how it is used
* Opt2A. Reporting at least {SSBRI(s)/CRI(s)} (beam/panel level) to indicate gNB beam(s) that are preferred for UL transmission in NW-initiated CSI-report on PUCCH/PUSCH
	+ Down-select one option from the followings by RAN1#106-e:
		- Alt1: In a single reporting instance, reporting SSBRI(s)/CRI(s) to indicate gNB beam(s) that is preferred for UL transmission + offsetting L1-RSRP that accounts for MPE effect associated with the SSBRI(s)/CRI(s)
			* FFS: how the offsetting L1-RSRP is calculated with regard to MPE effect
		- Alt2: In a single reporting instance, reporting SSBRI(s)/CRI(s) to indicate gNB beams that is preferred for UL transmission, DL reception (only), or both + L1-RSRP associated with the SSBRI(s)/CRI(s) + virtual PHR or a modified version
			* For each reported SSBRI/CRI, UE determines whether virtual PHR (or a modified version) is reported along with the SSBRI/CRI is reported or not
			* For virtual PHR or a modified version, reuse the same definition in Opt1A
			* FFS: how to inform NW whether a virtual PHR or a modified version is reported or not
* Note:  The determination of power backoff due to power management is the same for Opt2A as for Opt1A

Table 5 Additional inputs: issue 5 – MPE

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V0 | **Please share your view on the above proposal** **For proponents of Opt2, please state your preference (Alt1, 2, or 3). I would like to see if it is possible to remove the least supported alternative or, even better, down select****Opt2A:*** **Alt1: Apple, Qualcomm, CATT, NTT Docomo, CMCC, Sony, Nokia/NSB**
* **Alt2: Apple, Samsung, ZTE, MTK, Qualcomm, Nokia/NSB**
* **Alt3: Samsung, LG, NTT Docomo, Sony**

**Strong concern on the entire proposal: vivo, Huawei/HiSi** |
| Apple | For Opt2, we are open to Alt1/2.If acceptable, we would like to suggest a slim version.**Proposal 5.1**: On Rel.17 enhancements to facilitate MPE mitigation, support [one of] the following schemes [(to be down-selected in RAN1#106-e)]:* Opt1A. Rel.16 P-MPR based (TCI or SSBRI/CRI-specific) together with Virtual PHR (or a modified version)
	+ The modified version may be associated with each activated UL TCI or, if applicable, joint TCI, or associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured) from candidate pool, if reported.
	+ The reporting reuses the event-driven mechanisms from the Rel-16 P-MPR reporting
	+ FFS: Definition of virtual PHR and how it is used
* Opt2A. Reporting at least {SSBRI(s)/CRI(s)} (beam/panel level) to indicate gNB beam(s) that are preferred for UL transmission in NW-initiated CSI-report on PUCCH/PUSCH
	+ FFS: Whether the L1-RSRP is calculated with regard to MPE effect
* FFS: Whether/how to support connection for opt1A and opt2A, e.g. Opt1A/Opt2A is triggered/ reported by the same signaling, whether there should be some connections for the reported SSBRI(s)/CRI(s)
* Note:  The determination of power backoff due to power management is the same for Opt2A as for Opt1A
 |
| Samsung | Support proposal. Preference Opt2A. We are fine with Alt2 and Alt3 |
| ZTE | We are fine with the proposal. But, of course, down-selection for three candidates in Opt2A seems better. We support Opt1A and Alt2 in Opt2A. |
| LG | Support the proposal with Alt3 in Opt2A |
| OPPO | We support Opt1A. |
| Qualcomm | Support both Opt1A and 2A, which have different use cases to our understanding. For Opt2A, prefer Alt1 or Alt2 to report detailed UL metric |
| MediaTek | Support both Opt1A and Opt2A. Prefer to remove at least one alternatives from Opt2 (adding rows under Mod’s comment see the temperature). |
| Docomo | First, we would like to clarify our understanding on the second FFS in Alt.3. Is it correctly understanding that L1-RSRP is reported for beams that is preferred for DL reception, and whether/what is reported for beams preferred for UL is FFS, e.g., UL metric similar as in Alt.1 or alt.2 may be reported for beams preferred for UL?With the above understanding, our first preference is Alt.1 and second preference is Alt.3. Meanwhile we think supporting more than one alternatives can be considered and NW can decide whether to trigger only UL beam reporting (Alt.1) or to trigger both UL and DL beam reporting (Alt.3). For example, when MPE happens, NW can trigger only UL beam reporting if DL beam reporting does not need to be updated.[Mod: Since only 3 meetings are left, supporting more than one options doesn’t seem wise] |
| Xiaomi | Thanks for Ericsson more explanation in Round 3. Now I can understand that if all beams in the recent beam report was failed for UL transmission because of MPE, gNB may don’t know which beam can be used for UL transmission. But we think in order to solve the problem in this case, UE can be triggered to report the L1-RSRP for DL reception of preferred beam together with P-MPR or in next beam measurement report. And beam/panel specific P-MPR can be used to indicate preferred beam/panel.  Thus, we think in addition to beam/panel specific P-MPR, it is not necessary to contain “reporting SSBRI(s)/CRI(s) to indicate gNB beam(s) that is preferred for UL transmission” in Option 2A.And one clarification is that for Alt 2 and Alt 3 in Option 2A, what is the motivation to report the preferred beam for DL reception? [Mod: I will let the proponents answer.] |
| CATT | Support option 2A (alt-1) |
| CMCC | Support Opt 2A with Alt-1. |
| Convida Wireless | Support the proposal. Prefer option 1A. |
| Spreadtrum | Thanks Ericsson for answering our question on why Opt1D cannot work. Copied as below,*Ericsson: if we have only opt1A/1D, the UE will detect MPE when it happens and report that to the NW. However, the NW will then continue to collect L1-RSRP reports using normal beam reporting, and it is quite likely that the NW will switch back to bad beams – there is no way for the NW to know. This will cause the UE to report an MPE event, and then the procedure is repeated.*However, we are not convinced. If panel information along with CRI/SSBRI can be reported based on MP-UE discussion, NW will know the available beams for each panel, and will not ‘switch back to bad beams’.We will be happy to hear some more clarification from more companies, thanks. |
| Mod V17 | Since only 3 meetings are left, considering the immense workload on finalizing the details, I **revised the proposal** * Alt3 of Opt2A is removed since it has the fewest supporters. As more views are available, I may remove one of the Alt1 or Alt2
* After witnessing the progress (and the process of arriving at the progress) in this meeting I realize that proposing to support Opt1A and Opt2A is too ambitious and unrealistic. We do need to down select in the next meeting (ideally in this meeting but it is too late).

If some companies have serious concern on not supporting both Opt1A and Opt2A (or reducing the number of alternatives in Opt2A), we do not need to endorse this proposal. I am fine to discuss again in the next meeting **from scratch** (but of course ... at the risk of much less progress and no completion by Nov 2021).  |
| Sony | Support the proposal with preference on Alt.1 and Alt.3 under Opt2A. In our understanding, mixing virtual PHR (event-based) into beam reporting (NW-initiated) seems not necessary.  |
| Nokia/NSB | For Opt 2A, we support both Alt 1, Alt 2.No strong concerns on Opt 1A, but the meaning is still a bit unclear. “What P-MPR based” would mean? Can supporting companies explain?  |
| LG | We suggest adding Alt3 back. This meeting is the first meeting to list up specific alternatives for 2A so there is no reason to down-select now, and the number of supporting companies for each alt are quite even. We have concern on Alt1 due to its unclear usage and overhead. NW does not know when MPE issue will happen. So, Alt1 is valid for periodic report only, meaning that two separate periodic beam reporting are needed, one for DL and one for UL. When there is no MPE issue, DL beam and UL beam are likely to be same (i.e. same CRI/SSBRI), so two different reporting cause a redundancy. For Alt2, same view as Sony, we failed to see the reason to mix virtual PHR into beam reporting. [Mod: But we have 3 meetings left and previous agreement includes down-selection in RAN1#105-e (which we have failed).]@Docomo, your understanding of Alt3 is correct. Key difference between Alt1 and Alt3 is whether to reuse DL beam report for UL beam report or not as explained above.@Xiaomi, Alt2 and Alt3 is to reuse L1-RSRP based beam report as much as possible. In a single report (e.g. periodic beam report), UE can report both DL beam and UL beam so that NW does not need to configure two different reporting, causing a redundancy when there is no MPE issue (i.e. CRI/SSBRI for DL and UL is same). |
| Ericsson | We think that opt2A alone is sufficient, in combination with the R16 P-MPR reporting.For the alternatives of opt2A, there are two independent questions to sort out: 1. Should we mix UL-preferred and DL-preferred beams in one reporting instance?
2. What reporting quantity should we use for the UL-preferred beams?

As we see it, most of the discussions concern 2, whereas 1. is not discussed at all.It would seem that decision on these two issues could be made separately. The Alts now contain a mix. We think this is unfortunate. To structure the discussion, we propose the following modification:**Proposal 5.1**: On Rel.17 enhancements to facilitate MPE mitigation, support one of the following schemes (to be down-selected in RAN1#106-e):* Opt1A. Rel.16 P-MPR based (TCI or SSBRI/CRI-specific) together with Virtual PHR (or a modified version)
	+ The modified version may be associated with each activated UL TCI or, if applicable, joint TCI, or associated with each of the reported SSBRI(s)/CRI(s) and/or panel indication (if configured) from candidate pool, if reported.
	+ The reporting reuses the event-driven mechanisms from the Rel-16 P-MPR reporting
	+ FFS: Definition of virtual PHR and how it is used
* Opt2A. Reporting at least {SSBRI(s)/CRI(s)} (beam/panel level) to indicate gNB beam(s) that are preferred for UL transmission in NW-initiated CSI-report on PUCCH/PUSCH
	+ In RAN1#106-e, decide if gNB beams that are preferred for DL transmission should also be included in the same reporting instance of the NW-initiated CSI-report on PUCCH/PUSCH
	+ In RAN1#106-e, decide on the reporting content of the NW-initiated CSI-report on PUCCH/PUSCH related to the beam(s) that are preferred for UL transmission
* Note:  The determination of power backoff due to power management is the same for Opt2A as for Opt1A

[Mod: This is one way to do it but I tend to agree with MTK’s assertion – it seems the total # combinations is larger in this case]To Xiaomi: Thanks for the follow-up. I think what you propose sounds like opt2A: the NW will trigger a beam report which provides information about a suitable UL beam. This beam report cannot be the normal beam report – because that report will contain only information related to DL performance. One of the proposals for opt2A is to include P-MPR in the beam report, just as you propose. The details are still to be sorted out, but as we see it, there is a need for a NW-triggered CSI-report that provides information about the UL quality. Relying only on the R16 events (change of P-MPR) would not provide rich enough information.To Spreadtrum: Thanks for the follow-up. We feel that the details of option 1A are still somewhat open, but our best interpretation is that the UE in case of an MPE event would report an SSBRI/CRI that is preferred for UL transmission. The UE would only report this when the P-MPR changes. We fail to see how the NW could prevent the UE from reporting the ‘bad beams’ again. Note that the NW must continuously request beam reports from the UE to discover if new beams get better and/or current beam gets worse. |
| MediaTek | We are also fine with Ericsson’s revision that only captures the two open issues only. However, the three alternatives listed in current proposal are the answers to that open issues. One concern would be there will be even more possible answers in the next meeting if we just agree to study the two open issues in this meeting.Issue 1: Decide if gNB beams that are preferred for DL transmission should also be included in the same reporting instance of the NW-initiated CSI-report on PUCCH/PUSCH* Yes: Alt2, Alt3
* No: Alt1

Issue 2: Decide on the reporting content of the NW-initiated CSI-report on PUCCH/PUSCH related to the beam(s) that are preferred for UL transmission* Atl1: offsetting L1-RSRP
* Alt2: virtual PHR
* Alt3: FFS
 |
| Samsung2 | Ericsson proposal looks nice, but it is kind of backwards since we now move discussion of the reporting context meeting. It is still preferable in our view to agree to 1-2 alts, so that, discussion can be more focused next meeting. We still prefer to keep at least Alt2 for future discussion. |
| vivo | We have strong concerns on removing the simplest Option1D and complicate the issues unnecessarily. Thus we don’t support the FL proposal.To E///: why would the UE report bad beam/panel in P-MPR report? |
| Huawei, HiSilicon | Similar as vivo, we still have concerns on the proposal above, as the proposal did not specify how to modify virtual PHR or L1-RSRP to account for MPE, and the feasibility should be checked by RAN4 before agreed upon. We are also concerned on revised Opt 2A that reports gNB beam preferred by UE, which may restrict gNB implementation and is not preferred. For progress, we suggest sending the three alternatives in previous meeting (plus additional information if needed) to RAN4 for them to check and confirm feasibility, before proceeding to detailed signaling design.  |
| Mod V30 | **No change in proposal****Updated companies’ preference (similar situation)** |
| Apple | I am not sure whether it is helpful, but if we can change the FFS for option 1A as follows, we can select not to support Alt2 in opt2A* + FFS: Definition of virtual PHR, e.g. whether L1-RSRP is reported associated with PH, and how it is used
 |
| Mod final | Another unfortunate outcome since 3 companies still have strong concerns on proposal 5.1. A conclusion is targeted for this meeting. But as a group we failed again. On the other hand, Huawei’s suggestion on sending an LS to RAN4 may help. This would be my recommendation.  |

### Issue 6 (Advanced beam R/T)

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