**3GPP TSG-RAN WG1 Meeting #119. R1-241XXXX**

**Orlando, US, November 18th – 22nd, 2024**

**Agenda item:** 9.13

**Source:** Moderator (NTT DOCOMO, INC.)

**Title:** [draft] FL Summary #1 on Rel-19 TEIs

**Document for:** Discussion and Decision

1. Introduction

This contribution summarizes the discussions and proposals in AI 9.13 for Rel-19 TEI related discussion and following email discussion.

Based on the discussions summarized in Section 2, following TEI proposals are identified in AI 9.13. According to the guidance in [7], it should be checked first whether each TEI proposal is supported by at least 1 operator, 1 infra vendor and 1 UE vendor so that the discussion on the TEI proposal can be prioritized over other TEI proposals. **Companies are encouraged to clarify which TEI proposal can be supported in the list below with red color, i.e., please add your company name if you support the TEI proposal. Detailed feedback/question on each TEI proposal can also be provided in Section 2.**

* **TEI proposal #1: SRS beamforming for FR2 positioning**
	+ Supported by Huawei, HiSilicon, China Unicom, ZTE, Sanechips, CATT
* **TEI proposal #2: Maximal HARQ process numbers for TN in FR1 and FR2-1**
	+ Supported by ZTE Corporation
* **TEI proposal #3: Link adaptation**
	+ Supported by Ericsson
* **TEI proposal #4: Power constraint for type II codebook**
	+ Supported by Orange, ZTE, BT
* **TEI proposal #5: Counting of active CSI-RS resources**
	+ Supported by Nokia, Apple, Ericsson, MediaTek, NTT DOCOMO, Spreadtrum
1. Discussion on Rel-19 TEI proposals
	1. SRS beamforming for FR2 positioning

Following proposal is made in the contribution.

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| [1] | Tab. 1 shows the evaluation results of single-BS RTT+AoA positioning, where the RTT group delay error is assumed with Gaussian distribution with the std of 2ns. It is worth noting that 2ns is already a very stringent requirement from the perspective of BS/UE group delay calibration.It can been that 0.2m and 0.1m accuracy can be achieved under 400MHz and 800MHz, respectively, using two selected SRS beams, while the group delay error dominates the error if only single SRS beam is used.Tab. 1 Evaluation results for single-BS RTT+AoA positioning

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| **Location evaluation InF-DH: (Central frequency=30GHz, ISD=20m)** |
|  | Single-BS, RTT+AOA | Bandwidth | Group delay error STD | 50% | 67% | 80% | 90% |
| Horizontal accuracy | Single SRS beam (LoS) | 400MHz | 2ns | 0.326 | 0.525 | 0.695 | 0.875 |
| 800MHz | 2ns | 0.317 | 0.513 | 0.682 | 0.857 |
| Two SRS beams (LoS+MP) | 400MHz | 2ns | 0.029 | 0.051 | 0.085 | 0.157 |
| 800MHz | 2ns | 0.016 | 0.023 | 0.036 | 0.063 |

***Observation 1: Positioning SRS transmission using beam sweeping is desired for positioning feature.***In the current specification, for positioning SRS not configured with spatial relation, it is up to UE to choose the SRS spatial relation as in [TS 38.214] as follows:

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| If the UE is not configured with the higher layer parameter *spatialRelationInfoPos* the UE may use a fixed spatial domain transmission filter for transmissions of the SRS configured by the higher layer parameter *SRS-PosResource* across multiple SRS resources or it may use a different spatial domain transmission filter across multiple SRS resources.  |

Nevertheless, this UE implementation is not friendly to network to perform positioning. For example, for some UE implementations, when the spatial relation RS is not configured, UE may be prone to transmit the SRS resources using the spatial domain transmission filters based on the Rx beamformed RSRP from serving cell downlink RS, resulting in a fixed SRS Tx beam. However, the network expectation would be rather requesting UE to transmitting SRS in a way that explores the spatial diversity, e.g. based on blind beam sweeping, or path-power based beam correspondence.In addition, a fixed spatial domain transmission filter could already be realized by configuring multiple positioning SRS resources with the same SRS resource as the spatial relation RS as exemplified in Fig. 2.SRS resource #0SRS resource #1SRS resource #2*spatialRelationInfoPos* not configured*spatialRelationInfoPos* = SRS resource #0*spatialRelationInfoPos* = SRS resource #0Fig. 2: Realizing the same spatial transmission filer***Observation 2: There exists a configuration method to allow multiple SRS resources transmitted using the fixed beam, e.g. by configuring one SRS resource as the spatial relation RS of other SRS resources in the resource set.***Overall, towards boosting the mmWave positioning performance, the issue would like to be addressed is the case when UE is “not configured with the spatial relation RS” but UE is expected to use different beams for SRS transmissions. The solution is defining a new UE capability based on which network can indicate UE to transmit SRS using a different spatial domain transmission filter across multiple SRS resources.***Proposal 1: Introduce a new RRC parameter for a positioning SRS resource set, indicating that the UE is expected to use different spatial transmission filters for the positioning SRS resources not configured with spatialRelationInfoPos.**** + ***A per-band UE capability is introduced.***

***Proposal 2: Endorse the TP in Annex.*** |

This TEI proposal was proposed and discussed in the last RAN1 meeting, and the discussion at the RAN1#118bis meeting is shown below [6].

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| Company | Suppport (Y/N) | Comment |
| Qualcomm | No | In its current format, we believe this proposal does not address the proponents' purpose/use-case, nor is it aligned with the current procedures and principles of NR positioning. Specifically, even if the UE is configured to use the same Tx beam, there may be implementation reasons that prevent this. For example, if the two SRS resources are too far apart in time, or even if they are close in time but the UE measures the spatial relation RS in between, the beams may change. Additionally, it is unclear whether using the same beam for multiple SRS resources in the set applies across periods or within the same period only.We believe the discussion should be more general and should allow for greater UE flexibility, similar to the Tx-TEG-ID framework specified in Rel-17. Using the Rel-17 Tx-TEG reporting principles, this new feature would be more aligned with the current specifications as follows:* Request the UE to report which of the already-transmitted SRS resources for positioning in an SRS resource set use the same spatial domain transmission filter.
* Introduce a Tx-BeamIndex for SRS for Positioning transmission, which is reported in RRC for UL-TDOA in UEPositioningAssistanceInfo, or in LPP for M-RTT in the M-RTT measurement report.

Huawei-> what QC suggests is a more complete solution which needs more spec change. However, even only considering the ‘request’ as proposed in the paper, as least UE can perform as NW expects to some extent. For example, for only two SRS resources for the resource set, UE probably transmits SRS using the same beams currently based on the current spec. Now we are enabling UE to use the same or the different beams per NW request. In addition, ‘Request the UE to report which of the already-transmitted SRS resources’ as QC suggests is probably not needed because it is SRS transmission and receiving is handled by gNB, and what gNB reports to LMF is still the legacy measurements without any change necessary. |
| vivo |  | Firstly, the feature can be considered in the case the *spatialRelationInfoPos* is not configured.So we prefer to modify the feature as below Subject to UE capability, the UE may be provided *useSameTxBeam* for an SRS resource set for positioning.- If *useSameTxBeam* is set to 1, the UE is expected to use the same spatial domain transmission filter for the SRS resources for positioning of an SRS resource set for positioning ~~configured with the same~~ *~~spatialRelationInfoPos~~*~~.~~- If *useSameTxBeam* is set to 0, the UE is expected to use different spatial domain transmission filters for the SRS resources for positioning of an SRS resource set for positioning ~~configured with the same~~ *~~spatialRelationInfoPos~~*~~.~~Huawei-> Even though UE is configured with spatial relation RS, the proposed solution can also work. However, we can be open to discuss whether such restriction is needed if acceptable to others as well.  |
| Xiaomi | No | In legacy, Spatial relation is resource specific and not path- specific. This proposal proposes UE to transmit SRS resources configured with same spatialrelationinfo by different Tx beam, which need a new UE capability. From our point of view, it is a corner case which can be solved by gNB to transmit PRS with a narrow beam. In this case, there will be only one best Rx beam for one PRS resources. Even it happens, we think the spec impact is not restricted to the only one RRC parameter. Besides the RRC parameter, how to determine the maximum number of different Tx beam is also needed to be discussed. e.g, according to the number of RSRPP reported by UE?Huawei-> UE capability will be defined as proposed. The proposed solution taking the minimum spec change will be restricted to a SRS resource set with two SRS resources, which will be requested by gNB to transmit using the same or different beams. |
| Samsung | N | It depends on a scenario that for one DL, the UE happens to have two similarly good beams to Rx (and also corresponding for Tx), and when using that DL PRS as QCL source, the UE may use a different Tx beam. First, it is a corner case for optimization where, in the figure, one LoS link RSRP is comparable to one NLoS link RSRP, and that may only happen when the LoS link has strong penetration loss. However, for FR2 which is the considered scenario, such LoS link will be typically blocked. Second, even in such case, a UE may find two Rx beams that can work, and the UE can choose one to use. Not only for positioning, but for other beam related transmission, it's up to UE implementation to do so.Huawei-> As responded to QC, it is the solution with minimum change but can work in some cases. Considering strong wall or ground reflection may happen, making use of such paths would be meaningful in such cases. |
| China Unicom | Y | SRS spatial relations can naturally offer additional flexibility for positioning. Therefore, adding a new RRC parameter for a positioning SRS resource set can efficiently free up some resources from the beam sweeping process. This enhancement can improve UE capabilities without compromising performance. |
| Moderator |  | According to the above comments, this proposal is supported by 5 companies, and meets the condition support by at least 1 operator, 1 infra vendor and 1 UE vendor.Since several concerns were raised from companies, proponent is encouraged to address the concern from companies. |
| Huawei, HiSilicon |  | We as proponent thanks to the comments received and also responded to each, please check out.  |
| Moderator |  | According to the chair guidance in Tuesday online session, we will not continue the discussion on this proposal in this meeting.  |

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Based on the above contribution, the following TEI proposal can be discussed in RAN1#119 meeting.

### **TEI proposal #1**

* **Introduce a new RRC parameter for a positioning SRS resource set, indicating that the UE is expected to use different spatial transmission filters for the positioning SRS resources not configured with spatialRelationInfoPos.**
	+ **A per-band UE capability is introduced.**
* **Endorse the following TP for clause 6.2.1.4 in TS 38.214.**

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| ========================= Unchanged parts =========================6.2.1.4 UE sounding procedure for positioning purposesWhen the SRS is configured by the higher layer parameter *SRS-PosResource* and if the higher layer parameter *spatialRelationInfoPos* is configured*,* it contains the ID of the configuration fields of a reference RS according to Clause 6.3.2 of [TS 38.331]. The reference RS can be an SRS configured by the higher layer parameter *SRS-Resource* or *SRS-PosResource*, CSI-RS, SS/PBCH block, or a DL PRS configured on a serving cell or a SS/PBCH block or a DL PRS configured on a non-serving cell. If the UE is configured for transmission of *SRS-PosResource* in RRC\_INACTIVE mode, the configured *spatialRelationInfoPos* is also applicable.The UE is not expected to transmit multiple SRS resources with different spatial relations in the same OFDM symbol.If the UE is not configured with the higher layer parameter *spatialRelationInfoPos* the UE may use a fixed spatial domain transmission filter for transmissions of the SRS configured by the higher layer parameter *SRS-PosResource* across multiple SRS resources or it may use a different spatial domain transmission filter across multiple SRS resources. In RRC\_CONNECTED mode, the UE is only expected to transmit an SRS configured by the higher layer parameter *SRS-PosResource* within the active UL BWP of the UE.When the configuration of SRS is done by the higher layer parameter *SRS-PosResource*, the UE can only be provided with a single RS source in *spatialRelationInfoPos* per SRS resource for positioning.Subject to UE capability, if the UE is not configured with the higher layer parameter spatialRelationInfoPos, and is configured with the high layer parameter [DifSplFiler] for a SRS resource set configured by SRS-PosResourceSet, the UE is expected to use different spatial domain transmission filters across multiple SRS resources in the SRS resource set.For operation on the same carrier, if an SRS configured by the higher parameter *SRS-PosResource* collides with a scheduled PUSCH, the SRS is dropped in the symbols where the collision occurs. Unless specified otherwise, the UE does not expect to be configured with *SRS-PosResource* on a carrier of a serving cell with slot formats comprised of DL and UL symbols, not configured for PUSCH/PUCCH transmission.Timing Error Group (TEG) at UE side is defined: - UE Tx TEG is associated with the transmissions of one or more UL SRS resources for the positioning purpose, which have the Tx timing error difference within a certain margin. ========================= Unchanged parts ========================= |

This proposal is already supported by Huawei, HiSilicon, China Unicom, ZTE, Sanechips, CATT.

Companies are encouraged to check above TEI proposal and to provide feedback if any in below.

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| Company | Suppport (Y/N) | Comment |
| Qualcomm | N | The proponents argue that the proposal might be useful to some extent for UL-based positioning solutions, but it is unclear to what extent. Essentially, they believe the UE should be explicitly configured to perform 'beam switching' when not configured with specific spatial relation RS. Currently, the UE may or may not perform beam switching. However, without specification support or understanding of the extent of beam switching, the number of beams it will try, and the differences between the beams (all typically up to implementation), the value of this TEI appears very limited.In other words, even in the current specification, the UE can perform beam switching up to implementation. Even when the UE performs beam switching, the beams may still be similar to each other, or if the UE is not doing beam switching, the beams may still change due to changes in the absolute orientation of the UE. Conversely, a UE may not always be in a position to try a different beam (due to other constraints), or it may actually try a new beam in the local coordinate system, but due to the UE’s movement, the actual beam may appear the same eventually at the receiver.We believe that one thing that is potentially missing is whether the UE reports that it attempted multiple beams or not, and not whether the UE is configured to attempt multiple beams which is what the proponents are suggesting they want to add in the specification. Therefore, overall, we see limited value in this TEI.  |
| Samsung | No | The proponent has changed the content a bit. However, it did not change the main intention, and what’s worse, with current proposal, the potential “benefit” case is even less obvious. Current proposal is based on a UE capability and a gNB indication, however, with the understanding of the previous beneficial case, in which the UE has multiple workable beams under one spatial source. But this important condition has missed. It’s not only about the UE capability and gNB indication, but the UE status is actually quite important in the proponent’s beneficial case (which we already thought a not typical case). With current proposal, we barely see a merit. |
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* 1. Maximal HARQ process numbers for TN in FR1 and FR2-1

Following proposal is made in the contribution.

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| [2] | In Rel-17 NTN, the value ranges of corresponding RRC parameters in TS 38.331 are defined as follows. In RAN1#118bis, a clarification question was raised regarding why the value range defined for DCI 1\_2 and DCI 0\_2 is different, and whether or not to directly reuse these value ranges defined for Rel-17 NTN.

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| harq-ProcessNumberSizeDCI-0-1-r17 INTEGER (5) OPTIONAL, -- Need Rharq-ProcessNumberSizeDCI-1-1-r17 INTEGER (5) OPTIONAL, -- Need Rharq-ProcessNumberSizeDCI-0-2-v1700 INTEGER (5) OPTIONAL, -- Need Rharq-ProcessNumberSizeDCI-1-2-v1700 INTEGER (0..5) OPTIONAL, -- Need R |

By tracing back the discussion history in Rel-17, we found that the original value range of *harq-ProcessNumberSizeDCI-0-2-v1700* is defined as INTEGER (0..5) in RAN1#108 in [3], and also been reflected in TS 38.212 -h00/10/20. However, it seems RAN2 made some mistake and value range of INTEGER (5) is specified in TS 38.331. After Rel-17 ASN.1 is frozen, the issue was spotted and the corresponding RAN1 CR was raised to align TS 38.212 spec with TS 38.331 [4][5]. In our view, there is no fundamental difference of value range between INTEGER (0..5) and INTEGER (5). Considering the existing value range of *harq-ProcessNumberSizeDCI-0-2-v1700* is a mistake by RAN2 and not aligned with the value range defined for *harq-ProcessNumberSizeDCI-1-2-v1700,* we prefer to define value range of INTEGER (0..5) for both DCI 1\_2 and DCI 0\_2 in Rel-19. * Value range is set as INTEGER (0..5): If NW intends to use 32 HARQ processes, NW can configure *harq-ProcessNumberSizeDCI-0-2-Ext-r19* and set the value as ‘5’. Otherwise, the NW still configures *harq-ProcessNumberSizeDCI-0-2-Ext-r19* but configures the value as 0~4 bits.
* Value range is set as INTEGER (5) If NW intends to use 32 HARQ processes, NW can configure *harq-ProcessNumberSizeDCI-0-2-Ext-r19*. Otherwise, the NW can configure *harq-ProcessNumberSizeDCI-0-2-r16* which has a value range of (0..4).

***Proposal 1:*** *The value ranges of the new RRC parameters are defined as follows** *harq-ProcessNumberSizeDCI-0-1-Ext-r19 with value range of ‘INTEGER (5)’,*
* *harq-ProcessNumberSizeDCI-1-1-Ext-r19 with value range of ‘INTEGER (5)’,*
* *harq-ProcessNumberSizeDCI-0-2-Ext-r19 with value range of ‘INTEGER (0..5)’,*
* *harq-ProcessNumberSizeDCI-1-2-Ext-r19 with value range of ‘INTEGER (0..5)’,*
* *harq-ProcessNumberSizeDCI-0-3-Ext-r19 with value range of ‘INTEGER (0..5)’,*
* *harq-ProcessNumberSizeDCI-1-3-Ext-r19 with value range of ‘INTEGER (0..5)’.*

Whether to introduce other new RRC parametersBesides the RRC parameters for HPN indication in the DCI formats, we find that some other parameters related to a maximum of 32 HARQ process numbers are also specified for Rel-17 NTN as listed below. In the following, we analyze whether to also introduce corresponding RRC parameters in Rel-19.

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| DG PDSCH and DG PUSCH | nrofHARQ-ProcessesForPDSCH-v1700 ENUMERATED {n32} OPTIONAL nrofHARQ-ProcessesForPUSCH-r17 ENUMERATED {n32} OPTIONAL  |
| SPS PDSCH | nrofHARQ-Processes-v1710 INTEGER(9..32) OPTIONAL |
| CG PUSCH | nrofHARQ-Processes-v1700 INTEGER(17..32) OPTIONAL |

Considering we have agreed to introduce new RRC parameters for each DCI format in Rel-19, we don’t see any motivation to additionally introduce the RRC parameters in above table at least for a PDSCH or PUSCH transmission associated with a DCI (i.e., DG PDSCH/PUSCH, SPS PDSCH and CG type 2 PUSCH). In other words, the above RRC parameters can be reused for TN in FR1 and FR2-2. Because, even if TN and NTN would operate in a same band in the future, a UE can still identify whether support of 32 HARQ process number is enabled for NTN or TN by the already agreed new RRC parameters for Rel-19. Regarding whether to introduce a new Rel-19 parameter *nrofHARQ-Processes* for CG Type 1 PUSCH, Further clarification is needed. On one hand, if TN and NTN would operate in a same band, a new RRC parameter for CG Type 1 PUSCH is needed so that a UE can know whether it is enabled for NTN or TN. On the other hand, it may be also arguable whether it is a typical case to support 32 HARQ processes for TN for CG Type 1 PUSCH in case of TN and NTN operating in a same band. From our perspective, we slightly prefer not to introduce the RRC parameter. ***Proposal 2:*** *Do NOT introduce any additional new RRC parameters for this TEI in Rel-19.* Draft TP for the TEIBased on the agreement and proposals above, we provide a draft TP to TS 38.212 below.

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| 7.3.1.1.2 Format 0\_1<Unchanged parts are omitted>- HARQ process number - 5 bits if higher layer parameter *harq-ProcessNumberSizeDCI-0-1* or *harq-ProcessNumberSizeDCI-0-1-Ext-r19* is configured; otherwise 4 bits<Unchanged parts are omitted>7.3.1.1.3 Format 0\_2<Unchanged parts are omitted>- HARQ process number - number of bits determined by the following:- 5 bits determined by higher layer parameter *harq-ProcessNumberSizeDCI-0-2-v1700* if configured;- 0, 1, 2, 3, 4 or 5 bits determined by higher layer parameter *harq-ProcessNumberSizeDCI-0-2-Ext-r19* if configured;- otherwise 0, 1, 2, 3 or 4 bits determined by higher layer parameter *harq-ProcessNumberSizeDCI-0-2*<Unchanged parts are omitted>7.3.1.1.4 Format 0\_3<Unchanged parts are omitted>- HARQ process number - number of bits determined by the following:- block number 1, block number 2,…, block number Each block corresponds to the HARQ process number for a cell, and the blocks are placed according to an ascending order of a serving cell index, with block number 1 corresponding to the HARQ process number for the cell with the smallest serving cell index. Each block is 0, 1, 2, 3, 4 or 5 bits determined by higher layer parameter *harq-ProcessNumberSizeDCI-0-3* or *harq-ProcessNumberSizeDCI-0-3-Ext-r19* configured for the cell corresponding to the block. <Unchanged parts are omitted>7.3.1.2.2 Format 1\_1<Unchanged parts are omitted>- HARQ process number - 5 bits if higher layer parameter *harq-ProcessNumberSizeDCI-1-1* or *harq-ProcessNumberSizeDCI-1-1-Ext-r19* is configured; otherwise 4 bits<Unchanged parts are omitted>7.3.1.2.3 Format 1\_2<Unchanged parts are omitted>- HARQ process number - number of bits determined by the following:- 0, 1, 2, 3, 4 or 5 bits determined by higher layer parameter *harq-ProcessNumberSizeDCI-1-2-v1700* or *harq-ProcessNumberSizeDCI-1-2-Ext-r19* if configured;- otherwise 0, 1, 2, 3 or 4 bits determined by higher layer parameter *harq-ProcessNumberSizeDCI-1-2*<Unchanged parts are omitted>7.3.1.2.4 Format 1\_3<Unchanged parts are omitted>- HARQ process number - number of bits determined by the following:- block number 1, block number 2,…, block number Each block corresponds to the HARQ process number for a cell, and the blocks are placed according to an ascending order of a serving cell index, with block number 1 corresponding to the HARQ process number for the cell with the smallest serving cell index. Each block is 0, 1, 2, 3, 4 or 5 bits determined by higher layer parameter *harq-ProcessNumberSizeDCI-1-3* or *harq-ProcessNumberSizeDCI-1-3-Ext-r19* configured for the cell corresponding to the block. <Unchanged parts are omitted> |

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Based on the above contribution, following TEI proposal can be discussed in RAN1#119 meeting.

### **TEI proposal #2**

* **For up to 32 HARQ process numbers for TN in FR1 and FR2-1,**
	+ **The value ranges of the new RRC parameters are defined as follows**
		- **harq-ProcessNumberSizeDCI-0-1-Ext-r19 with value range of ‘INTEGER (5)’,**
		- **harq-ProcessNumberSizeDCI-1-1-Ext-r19 with value range of ‘INTEGER (5)’,**
		- **harq-ProcessNumberSizeDCI-0-2-Ext-r19 with value range of ‘INTEGER (0..5)’,**
		- **harq-ProcessNumberSizeDCI-1-2-Ext-r19 with value range of ‘INTEGER (0..5)’,**
		- **harq-ProcessNumberSizeDCI-0-3-Ext-r19 with value range of ‘INTEGER (0..5)’,**
		- **harq-ProcessNumberSizeDCI-1-3-Ext-r19 with value range of ‘INTEGER (0..5)’.**
	+ **Do NOT introduce any additional new RRC parameters for this TEI in Rel-19.**

This proposal is already supported by ZTE Corporation.

Companies are encouraged to check above TEI proposal and to provide feedback if any in below.

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| Company | Suppport (Y/N) | Comment |
| DCM | Y |  |
| Ericsson | Y | Agree in principle. One question on the new RRC parameters: Do we really need the following new RRC parameters?- harq-ProcessNumberSizeDCI-0-1-Ext-r19 with value range of ‘INTEGER (5)’, - harq-ProcessNumberSizeDCI-1-1-Ext-r19 with value range of ‘INTEGER (5)’,- harq-ProcessNumberSizeDCI-0-2-Ext-r19 with value range of ‘INTEGER (0..5)’, - harq-ProcessNumberSizeDCI-1-2-Ext-r19 with value range of ‘INTEGER (0..5)’, These parameters are identical as the Rel-17 parameters, why can’t we just reuse the Rel-17 parameters? harq-ProcessNumberSizeDCI-0-1-r17 INTEGER (5) OPTIONAL, -- Need Rharq-ProcessNumberSizeDCI-1-1-r17 INTEGER (5) OPTIONAL, -- Need Rharq-ProcessNumberSizeDCI-0-2-v1700 INTEGER (5) OPTIONAL, -- Need Rharq-ProcessNumberSizeDCI-1-2-v1700 INTEGER (0..5) OPTIONAL, -- Need ROnly for DCI 0-3 and DCI 1-3 we need new parameters for this TEI. |
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* 1. Link adaptation

Following proposal is made in the contribution.

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| [3] | In below, we show an evaluation of the DL throughput as a function of SNR for a 10% CQI BLER target (and same for NW side BLER target) while using CQI Table 3 (which currently only support 0,001% BLER target). It can be seen that the cell edge DL throughput increases. Hence, this improves the throughput at cell edge, which benefits the use of apps, hence better app coverage eg for apps that require 200 MBps in this example. Note that the maximum DL throughput for MCS table 3 is lower than table 1, hence this should only be configured for near cell edge UEs (-12 to -4 SNR in this example) or CPEs (for absolute cell edge UEs at eg -18 dB the configured table doesn’t matter). Figure 3 DL throughput as a function of SNR when MCS table 1 and 3 is configured with 10% CQI BLER target. The specification change is related to introducing a new RRC parameter, e.g., ***BLER\_target-r19***with range [0.1, 0.01, 0.001, 0.0001, 0.00001] (and the associated UE capability) and update specification as follows for TS 38.214:[..]A single PDSCH transport block with a combination of modulation scheme, target code rate and transport block size corresponding to the CQI index, and occupying a group of downlink physical resource blocks termed the CSI reference resource, could be received with a transport block error probability not exceeding the value configured by the higher layer parameter *BLER\_target-r19, if configured, otherwise*: -     0.1, if the higher layer parameter *cqi-Table* in *CSI-ReportConfig* configures 'table1' (corresponding to Table 5.2.2.1-2), or 'table2' (corresponding to Table 5.2.2.1-3), or-     0.00001, if the higher layer parameter *cqi-Table* in *CSI-ReportConfig* configures 'table3' (corresponding to Table 5.2.2.1-4).[..]The following comments were received from companies and here we provide a per-company response:

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| Company | View | Ericsson response |
| Huawei | The motivation needs further justification: when a NW configures a CQI table 3 for e.g. coverage purpose while relaxes the target BLER, the achieved successfully decodable data (rate) will also be lower, which effectively means the coverage is not extended. The issue needs more clarification: it is strange that a UE does not make CQI report based on the expected target BLER because normally it shall know that mismatch of CQI report vs scheduled MCS will lower its performance.The technique needs to be further verified: even if the issue happens, it is not clear how the proposed solution can really restrict how UE derives the CQI w.r.t the BLER since it is UE implementation. | The app coverage is extended but the absolute coverage is not extended. Since the ratio of cell edge to mean UPT is an important metric for operators, this enhancement improves this ratio by extending the coverage at a given throughput. Regarding the misbehaving UEs, this was discussed and will be handled by introducing the sentence in the chairman note as exemplified in Section 1.  |
| vivo | We don’t see it as a critical issue. Since the CQI feeds back according to the BLER target of the configured CQI table, the CQI target BLER is aligned on both sides. In addition, each CQI table is associated with multiple BLER targets may require UE to store more information, which adds additional complexity for UE. Lastly, it may be an implementation issue that can be solved with a gNB implementation, e.g., gNB can reduce the OLLA step size if the UE is found to have CQI adjustments.[..]As discussed yesterday, the root cause of the problem is still not clear, if there would be existing UEs who did not follow 10% BLER target when reporting CSI, then we need to find a solution to identify such wrong implementations, a RAN4 test case would be more direct to the problem. If such root problem cannot be solved, i.e. UE may not follow the specified/configured BLER target, having more BLER target would not help. | The measurements in our tdoc shows that what you are describing is not the case in reality. The UE is taking into account the PDSCH reception performance in the the CQI reporting. We are trying to cope with this on the NW side by OLA but since there is a competing OLA loop in the UE we observe very strange anomalies in the link adaptation and poor performance for the UE. Hence, it cannot be solved by NW implementation. I’d like to understand better the issue of memory shortage in UEs, it would be helpful to have more insights on this issue. Regarding the misbehaving UEs, this was discussed and will be handled by introducing the sentence in the chairman note as exemplified in Section 1.  |
| DCM | We can understand the problem and solution, but at the same time we are not sure whether changing UE behavior from this release is really beneficial. More discussion may be necessary | Note that what you refer to is the misbehaving UEs, The TEI proposal is related by has also app coverage benefit for UEs that are not “misbehaving” |
| Mediatek | Any legacy link adaptation issue observed in field would not be resolved by this proposal. We also believe that the proposed new functionality would lead to more effort for UE to adapt to additional config parameters with associated testing and verification. | Note that what you refer to is the misbehaving UEs, The TEI proposal is related by has also app coverage benefit for UEs that are not “misbehaving”.New RAN4 test cases may be needed, but the test methodology is already developed for this, only new datapoint (BLER target) needs to be tested. Hence, RAN4 impact is minimal.  |
| Samsung | Not clear on performance benefit. It can be done based on NW implementation by estimating BLER value. Furthermore, NR provides flexible scheduling such as mini-slot scheduling so that it is not that accurate CQI reporting because reference resource for CQI is fixed.The gNB can estimate different BLERs around the target BLER and small possible variations/errors have no impact on throughput due to HARQ The actual targeted BLER can be variable (e.g. different between transmissions and retransmissions of a TB, among UEs with low/high SINRs (which are also variable), among UEs requiring/not requiring coverage enhancement, when MU-MIMO is or is not used, …) | Performance benefit is shown in our evaluation results. Note sure how you mean this can be done by NW implementation, please elaborate. I don’t see how estimating a BLER value (?) helps not the issue of mini-slots?  |
| CATT | We are not clear how the proposal addresses the issue raised in the contribution. It seems to be more straightforward to change UE implementation if it takes ACK/NACK into account for CQI derivation and reporting without specification impact. | Regarding the misbehaving UEs, this was discussed and will be handled by introducing the sentence in the chairman note as exemplified in Section 1.  |

5. ConclusionHence, we propose to capture the following in chairman notes:*It is RAN1 understanding that the reported CQI and RI shall be independent on any ongoing reception of shared data or control channels (e.g, HARQ-ACK statistics), and what is described in TS 38.214, Clause 5.2.2.1 shall be followed by UE.*And we propose:Proposal 1 As a TEI-19, introduce an RRC parameter that indicates one target from a set of BLER targets [0.1, 0.01, 0.001, 0.0001, 0.00001] to be used for CQI reporting, independently of which CQI table is configured |

This TEI proposal was proposed and discussed in the last RAN1 meeting, and the discussion at the RAN1#118bis meeting is shown below [6].

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| Huawei, HiSilicon | N | The motivation needs further justification: when a NW configures a CQI table 3 for e.g. coverage purpose while relaxes the target BLER, the achieved successfully decodable data (rate) will also be lower, which effectively means the coverage is not extended. The issue needs more clarification: it is strange that a UE does not make CQI report based on the expected target BLER because normally it shall know that mismatch of CQI report vs scheduled MCS will lower its performance.The technique needs to be further verified: even if the issue happens, it is not clear how the proposed solution can really restrict how UE derives the CQI w.r.t the BLER since it is UE implementation.Ericsson-> The app coverage is extended but the absolute coverage is not extended. Since the ratio of cell edge to mean UPT is an important metric for operators, this enhancement improves this ratio by extending the coverage at a given throughput. Regarding the misbehaving UEs, this was discussed and will be handled by introducing the sentence in the chairman note as exemplified in Section 1.  |
| QC | No | Some history if my recollection is correct: Rel-16 URLLC discussed BLER for CQI calculation. The observation is that the BLER curve falls very quick with SNR so the SNR difference is very small between different BLER target, which is why those finer granularity BLERs (such as 0.01) for CQI were not introduced in Rel-16. Now, coming back to this particular problem observed in field, we are open to have a discussion. But in our view, the root cause of the problem is some UEs implemented CQI calculation with an unnecessary input used to calculate CQI. Our view is that the correct fix is UE vendor change implementation (for future UEs) to stop to use that input in CQI calculation (By the way, for UEs already deployed, neither this proposal nor UE implementation based solution can fix them). We are not sure adding new CQI BLER target can solve the problem. Plus, this proposal will force all UEs pass new CQI RAN4 tests, which seems unnecessary big burden for both standardization and implementation. In summary, our view is this field problem can/should be fixed by UE implementation (to correct CQI calculation algorithm) transparent to 3GPP.  |
| vivo | No | We don’t see it as a critical issue. Since the CQI feeds back according to the BLER target of the configured CQI table, the CQI target BLER is aligned on both sides. In addition, each CQI table is associated with multiple BLER targets may require UE to store more information, which adds additional complexity for UE. Lastly, it may be an implementation issue that can be solved with a gNB implementation, e.g., gNB can reduce the OLLA step size if the UE is found to have CQI adjustments.Ericsson-> The measurements in our tdoc shows that what you are describing is not the case in reality. The UE is taking into account the PDSCH reception performance in the the CQI reporting. We are trying to cope with this on the NW side by OLA but since there is a competing OLA loop in the UE we observe very strange anomalies in the link adaptation and poor performance for the UE. Hence, it cannot be solved by NW implementation. I’d like to understand better the issue of memory shortage in UEs, it would be helpful to have more insights on this issue. Regarding the misbehaving UEs, this was discussed and will be handled by introducing the sentence in the chairman note as exemplified in Section 1. |
| DCM |  | We can understand the problem and solution, but at the same time we are not sure whether changing UE behavior from this release is really beneficial. More discussion may be necessary.Ericsson-> Note that what you refer to is the misbehaving UEs, The TEI proposal is related by has also app coverage benefit for UEs that are not “misbehaving” |
| MediaTek | N | Any legacy link adaptation issue observed in field would not be resolved by this proposal. We also believe that the proposed new functionality would lead to more effort for UE to adapt to additional config parameters with associated testing and verification.Ericsson-> Note that what you refer to is the misbehaving UEs, The TEI proposal is related by has also app coverage benefit for UEs that are not “misbehaving”.New RAN4 test cases may be needed, but the test methodology is already developed for this, only new datapoint (BLER target) needs to be tested. Hence, RAN4 impact is minimal. |
| Samsung | N | * Not clear on performance benefit. It can be done based on NW implementation by estimating BLER value. Furthermore, NR provides flexible scheduling such as mini-slot scheduling so that it is not that accurate CQI reporting because reference resource for CQI is fixed.
* The gNB can estimate different BLERs around the target BLER and small possible variations/errors have no impact on throughput due to HARQ
* The actual targeted BLER can be variable (e.g. different between transmissions and retransmissions of a TB, among UEs with low/high SINRs (which are also variable), among UEs requiring/not requiring coverage enhancement, when MU-MIMO is or is not used, …)

Ericsson-> Performance benefit is shown in our evaluation results. Note sure how you mean this can be done by NW implementation, please elaborate. I don’t see how estimating a BLER value (?) helps not the issue of mini-slots? |
| Ericsson | Y | * Also supported by Verizon, Apple and T-Mobile USA
 |
| Ericsson  | Y | * @vivo: The measurements in our tdoc shows that what you are describing is not the case in reality. The UE is taking into account the PDSCH reception performance in the the CQI reporting. We are trying to cope with this on the NW side by OLA but since there is a competing OLA loop in the UE we observe very strange anomalies in the link adaptation and poor performance for the UE.
* @MediaTek what is your proposal to solve the link adaptation issue?
* @samsung the performance benefit is shown by simulations in our tdoc. Pleasde elaborate more on the NW side solution you suggest, I don’t see how estimating a BLER value (?) helps.
* @Qualcomm, the proposal has two purposes, 1) to align NW and UE side BLER targets better. And 2) to improve app coverage, i.e. the coverage for a given, moderate, bitrate. New RAN4 performance tests may be needed, but the methodology used today can be reuses, this is merely new test for additional (BLER, SNR) points.
* @huawei, we show that the app coverage is increased in our tdoc. It is not strange in our view, but the theoretically achievable peak data rate is reduced for these UEs near cell edge, but that is not a concern to us. You are right that the solution doesn’t prevent the UE to not follow specifications (e.g. largest CQI that fulfills <10% BLER), but it makes is less likely since we can use any table with any target.
 |
| CATT | No | We are not clear how the proposal addresses the issue raised in the contribution. It seems to be more straightforward to change UE implementation if it takes ACK/NACK into account for CQI derivation and reporting without specification impact.Ericsson-> Regarding the misbehaving UEs, this was discussed and will be handled by introducing the sentence in the chairman note as exemplified in Section 1. |
| Nokia2 | Y | We agree with the observation that the UEs seem to use other inputs for CQI than the ones expected and setting same BLER target may help to reduce the variation. However, it may not guarantee that UE does not perform any other adjustments, just keep CQI more stable. Ideally we would prefer to clarify the UE behaviour, but it may not be easily agreeable solution. Thus, we are ok with proposal, so at least CQI variations are reduced; but prefer to extend the values in the proposed configuration list, e.g. 5%, 15%. Regarding Table 3, we support to relax the BLER target as current target makes it unusable in fading channels. |
| Moderator |  | According to the above comments, this proposal is supported by 5 companies, and meets the condition support by at least 1 operator, 1 infra vendor and 1 UE vendor.Since several concerns were raised from companies, proponent is encouraged to address the concern from companies. |
| Moderator |  | According to the chair guidance in Tuesday online session, we will not continue the specification impact discussion on this proposal in this meeting. Instead, we will focus on the discussion about how to make the observation to prevent undesirable UE behavior by implementation. Based on the offline discussion with the proponent, proposal is updated as follows:**TEI proposal #6a*** **It has been observed by at least two network vendors that some NR UE in the field deployments tend to adjust their reported CQI and RI, based on received PDSCH. It is RAN1 understanding that this is not according to specifications, TS 38.214, Clause 5.2.2.1, where the CQI reporting is independent on any ongoing reception of shared data channels.**

Companies are encouraged to check the above TEI proposal and to provide feedback if any. |
| QC |  | The wording for the TEI proposal #6a is too strong which impose unnecessary restriction to UE CQI reporting. It is nothing wrong to use PDSCH demod/decode information to help deriving CQI, as long as that information are used properly. For example, decoding SNR information of previous PDSCH can be used as side information to improve CSI-RS based SNR estimation. With the above, we don’t think the conclusion in TEI proposal #6a is needed. It seems to us that each UE vendor already got the message in Ericsson Tdoc, and UE vendor can adjust CQI calculation algorithm by implementation if needed.By the way, regarding the side proposal Ericsson mentioned about introducing a 10% BLER target for CQI for the URLLC MCS\_Table for coverage extension use case, we are open to discuss as we see it is a valid use case.  |
| AT&T | Yes | We support the proposal to clarify UE behaviour and/or introduce an RRC parameter to indicate a BLER target for CQI |
| vivo |  | As discussed yesterday, the root cause of the problem is still not clear, if there would be existing UEs who did not follow 10% BLER target when reporting CSI, then we need to find a solution to identify such wrong implementations, a RAN4 test case would be more direct to the problem. If such root problem cannot be solved, i.e. UE may not follow the specified/configured BLER target, having more BLER target would not help. |
| Ericsson | Yes | @vivo The **“problem”** introduced in this TEI, is resolved to not happen again by adding the Note in the meeting notes as discussed in the online session and suggested by Mr.Chairman. The proposal #6a by the moderator is adequate to achieve this. There is no need to introduce new RAN4 test methodology since following the 214 specification should be sufficient. Then we can continue to discuss the **“enhancement”** introduced in this TEI, i.e. to use any MCS table together with a configured BLER target (as opposed to current spec which explicitly ties a table to a target). It now seems that also Qualcomm and AT&T are open to support this small technical enhancement and improvement.  |
| Samsung |  | Agree with Vivo. Based on the discussions and the clarifications from the proponent, the mentioned issue does not relate to whether the target BLER is 10% or any other (configured or fixed) value, but it relates to whether the implementation of affected UEs is consistent with the specifications. |
| MediaTek |  | We agree that making such a Conclusion is not necessary and does not necessarily help, as there is some flexibility for UE implementations today. |
| Ericsson |  | @samsung, let me iterate: The **“enhancement”** introduced in this TEI, i.e. to use any MCS table together with a configured BLER target (as opposed to current spec which explicitly ties a table to a target) is not more or less unrelated to the problem seen in the field. As I said online, even for well behaving UEs, the enhancement is beneficial. @mediatek, @samsung: I hope your “flexibility” does not involve using the BLER statistics of the ongoing PDSCH receptions. This is what we believe is the reason why these UEs have bad throughput in the field when the OLA on the NW side is not the same as the CQI BLER target configured to the UE. The 214 specifications is clear on how the UE shall estimate the CQI.  |
| Moderator |  | Due to the limited time, this proposal could not be treated in online session. Companies are welcome to provide views on this proposal for the next meeting. |

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Based on the above contribution, the following TEI proposal can be discussed in RAN1#119 meeting.

### **TEI proposal #3**

* **Capture the following in chairman notes:**
	+ **It is RAN1 understanding that the reported CQI and RI shall be independent on any ongoing reception of shared data or control channels (e.g, HARQ-ACK statistics), and what is described in TS 38.214, Clause 5.2.2.1 shall be followed by UE.**
* **Introduce an RRC parameter that indicates one target from a set of BLER targets [0.1, 0.01, 0.001, 0.0001, 0.00001] to be used for CQI reporting, independently of which CQI table is configured.**

This proposal is already supported by Ericsson.

Companies are encouraged to check above TEI proposal and to provide feedback if any in below.

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| Company | Suppport (Y/N) | Comment |
| DCM |  | At least we are open to have discussion further. |
| QC |  | We don’t agree to add new BLER targets 0.01, 0.001, 0.0001 for CQI, as we don’t see they are the solutions to solve the issue reported Ericsson’s Tdoc. However, we see the value of coverage extension use case mentioned in Ericsson’s Tdoc. As a compromise, we are fine to add BLER target 0.1 to the CQI table 3 for URLLC to enable this use case. We also don’t see the need to take the conclusion. If some UEs’ implementation is not following the spec, this UE implementation should be corrected by corresponding vendors. 3GPP don’t need to capture such a conclusion.  |
| Apple |  | We are open for NW to configure BLER target related to the CQI table. However, our support is under the condition that there is no additional RAN4 performance requirement.  |

* 1. Power constraint for type II codebook

Following proposal is made in the contribution.

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| [4] | Fig.3 shows that significant gain can be obtained provided that the UE knows the power amplifier configuration per AP of the gNodeB. The "Bound GPC" can be approached despite the existence of LPCs at the gNodeB if the CSI computation considers the LPCs. A value of ΔP0=2dB is sufficient to reach this boundary. It should be noted that the "Bound GPC" boundary is theoretically achievable for a value , i.e., for a number of ports as in Fig. 3, a value ΔP0=15dB. The demonstration is given in Annex D. Furthermore, when the LPCs are not considered at the UE side for the CSI computation (CSI mismatched from a power perspective) and the gNodeB can transmit with an additional power P02 dB per antenna port, the power back-off applied by the gNodeB significantly degrades the performance in the low to average SNR region. In particular, “GPC+LPC P0 = 0” outperforms “GPC@UE + backoff @BS =1.5dB”, especially at low SNR. As expected, when a sufficiently large additional power headroom P0 (3 dB or more) per antenna port is available at the gNodeB, the LPCs performance impact gets negligible, i.e., “GPC@UE + backoff @BS ” with achieves a performance close to the GPC bound. However, it necessitates to over-dimension the PA which does not sound as a cost-effective solution, particularly, for MIMO panel with a high number of TXRUs. **Observation 7: PA configuration allowing a high power headroom per antenna port with respect to the nominal EPRE is a solution to lower the performance impact of the LPCs, however, it does not sound as a cost efficient solution particularly for MIMO antenna panel with a large number of TXRUs.**Figure 3: Proposal evaluation for eType-II codebook for CDL-C 363nsFig. 4 is reusing the same simulation parameters as Fig. 3 for CDL-A with an RMS Delay spread of 363ns instead of CDL-C.Figure 4: Proposal evaluation for eType-II codebook for CDL-A 363ns**Observation 8: If the UE is provided a power offset to determine the maximum EPRE per antenna port, the performance related to the CSI feedback is significantly improved.****Observation 9: If the feedback CSI is mismatched from a power perspective, the gNodeB needs to over-dimension more its PAs compared to the matched case to reach the same performance.****Proposal 1: For the UE computation of the CSI reporting of non-constant modulus codebook (e.g., eType-II), in order to fully exploit the local power constraints of the gNodeB associated to the PA configuration, the UE should consider the RRC configured power offsets per CSI-RS antenna port.*** **Introduce an RRC Information Element DeltaPower containing an offset *DeltaPowerPerAP* (for each CSI-RS antenna port such that the PDSCH EPRE across the antenna ports assumed by the UE for each sub-band is where**
	+ **is the nominal EPRE across the antenna ports,**
	+ **is the precoder coefficient associated to antenna port and spatial layer for the considered sub-band.**
* **Note 1: above does not imply specific PA architecture implementation in gNodeB**
* **Note 2: the precoder selection is not impacted by the local power constraints per antenna port**
* **Note 3: it includes the simplified case for all CSI-RS antenna ports**

**Observation 10: The proposal includes the legacy CSI computation, for example, in absence of the RRC power offset(s) Information Element, the CSI computation by the UE considers the global power constraint only, i.e., the (maximum) nominal EPRE across the antenna ports.**  |

This TEI proposal was proposed and discussed in the last RAN1 meeting, and the discussion at the RAN1#118bis meeting is shown below [6].

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Company | Suppport (Y/N) | Comment |
| Apple | N | We acknowledge that the per antenna/CSI-RS port power limitation may exist for some operators. However, the proposed solution can significantly increase the UE implementation complexity and not suitable for Rel-19 TEI. |
| Huawei, HiSilicon |  | There are several issues regarding the proposal.It’s very difficult for gNB to configure one particular , because at different slots, network may use different due to power boosting of some channels (PDCCH, PDSCH for some particular UE etc.). This will make the UE calculation of power allocation is different from the real power allocation, resulting in performance loss.UE complexity of CSI processing will be increased a lot if LPC is considered.  |
| Orange |  | @HW, Apple Proposal 1 and 2 offer an additional complexity which is low. The UE additional complexity is to compute for each rank conditional on the selected PMI and for each sub-band  the power backoff  given by the formulas and for proposal 1 and 2, respectively. This power backoff is then used to optimize the MCS and the rank in order to maximize the throughput @BLER\_target 10%. Note that the PMI selection where lies most of the complexity is NOT impacted.@HWIt is very difficult to configure the nominal EPRE across the antenna ports, but we do it. For a high number of TXRUs, the solution to over-dimension the PA such that the LPCs can be neglected does not sound cost efficient. The proposal aim is to allow some trade off here.“GPC@UE + backoff @BS ΔP\_0=x dB” corresponds to a CSI computation at the UE which considers the GPC only, the gNodeB applies directly the feedback CSI but needs to correct the transmission power such that the transmit power per antenna port do not exceed with x=0, 1, 1.5, 2, 3 dB.If the feedback CSI is mismatched from a power perspective, the gNodeB needs to over-dimension more its PAs compared to the matched case. |
| Lenovo/ MotM |  | Agree with Apple, HW. We acknowledge the issue however the proposed solution further complicates the process and limits the NW flexibility in dynamically changing this RRC configured per port PCO  |
| ZTE | Y | We identify the benefit for DL CSI, while considering the margin of TX power for gNB antenna port. Regarding UE complexity, it may be much relevant to final CQI calculation and can be well handled.  |
| Spreadtrum | N | We also have similar view as Apple and Lenovo. Besides, our initial thought is that the power backoff can be added to a CSI-RS resource by gNB implementation when the CSI-RS resource is transmitted for Type-II codebook calculation. |
| Qualcomm |  | We are not sure what is expected for UE to utilize of each port, for the proposed config.We have two understandings:1. Restrictions on PMI coefficient when UE does SVD.
2. Mainly impact CQI report, and improve link adaptation convergency faster with more accurate CQI/MCS.

If it is 1), we think UE complexity is very high, and would like the proponent companies to elaborate more;If it is 2), we have questions for the performance curve: How to understand SE v.s. SNR curve for link adaptation simulation? |
| vivo |  | First, *powerControlOffset* is configured by gNB, which can address some power constraint issue. Second, gNB can adjust the CQI of UE feedback based on their own hardware limitations and the reported PMI. Lastly, it may be an implementation issue that can be solved with a gNB implementation. |
| Xiaomi | N | We have concern on the impact on computation complexity of UE after introducing the power constriction per CSI-RS ports. As pointed by QC, it needs to clarify whether/How it has impact on PMI selection and CQI calculation. * Regarding PMI selection, if the selected SD/FD basis and coefficients need to consider power restriction per CSI-RS ports, the computation complexity is significantly large.

Regarding CQI calculation, we think UE still needs to find optimal power restriction via exhaustive search all the coefficients of PMI for each rank. |
| MediaTek | N | The already large MIMO WI was up-scoped further at last RAN plenary, so we doubt the essential need for further MIMO proposals under TEI. The UE can always fall back to type 1 CSI if there are PA power constraints at gNB side, we don’t see it essential to further optimize Type 2 for this case. Moreover, UE's role is to report a Type-II Codebook that matches the channel conditions well, thus the PA capability issue at gNB side should not be a consideration at the codebook design level. |
| Samsung |  | It is our understanding that 1. the main target use case of eType-II is for MU-MIMO where gNB will recalculate precoder, MCS, and rank based on their scheduler algorithm, hence design philosophy seems different from the considered use case (SU-MIMO) in this TEI.
2. LPC constraint is not a problem in gNB implementation as long as the power per antenna port does not exceed a certain maximum value (which is sufficiently large), so finding precoders under the LPC constraints are not applicable to most of the scenarios.
3. For some reason, if LPC is critical to gNB implementation and gNB wants to schedule SU-MIMO, gNB can simply configure Type-I CB which holds LPC/GPC in the codebook. The performance gap between T1 and T2 for *SU-MIMO* is not that significant in system level simulation (not LLS).
4. We already had a similar constraint (multiple-level amplitude restriction) for Rel-15 Type-II codebook, but it had been not included later enhancements Rel18/19 due to questionable use case.

This feature seems forcing UE implementation in a restricted manner and making UE computational complexity high, which is not favorable.  |
| Ericsson  | N  | It’s not clear if this would give any benefits in reality since when Type-II codebook family is used, MU-MIMO is most commonly assumed and the precoder reported by the UE is not the actual precoder used by the NW transmission (i.e., the NW may apply eg ZF or any other algorithm to derive DL precoder).  |
| Nokia | TBD | We are open to discuss this proposal further to understand the merits and how the solution could be applied. |
| OPPO | N | As mentioned by companies, for MU-MIMO which is the main scenario of eType II CB, it is unclear whether there is an issue.  |
| Moderator |  | According to the above comments, this proposal is supported by 3 company, and does not meet the condition of support by at least 1 operator, 1 infra vendor and 1 UE vendor yet.Proponent is encouraged to address the concern from companies. |
| Moderator |  | According to the chair guidance in Tuesday online session, we will not continue the discussion on this proposal in this meeting.  |

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Based on the above contribution, the following TEI proposal can be discussed in RAN1#119 meeting.

### **TEI proposal #4**

* **For the UE computation of the CSI reporting of non-constant modulus codebook (e.g., eType-II), in order to fully exploit the local power constraints of the gNodeB associated to the PA configuration, the UE should consider the RRC configured power offsets per CSI-RS antenna port.**
	+ **Introduce an RRC Information Element DeltaPower containing an offset *DeltaPowerPerAP* (for each CSI-RS antenna port such that the PDSCH EPRE across the antenna ports assumed by the UE for each sub-band is where**
		- **is the nominal EPRE across the antenna ports,**
		- **is the precoder coefficient associated to antenna port and spatial layer for the considered sub-band.**
	+ **Note 1: above does not imply specific PA architecture implementation in gNodeB**
	+ **Note 2: the precoder selection is not impacted by the local power constraints per antenna port**
	+ **Note 3: it includes the simplified case for all CSI-RS antenna port**

This proposal is already supported by Orange, ZTE, BT.

Companies are encouraged to check above TEI proposal and to provide feedback if any in below.

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| Company | Suppport (Y/N) | Comment |
| Orange |  | Based on the comments received last meeting, we submitted a new version of our TEI contribution. Compared to the previous one (R1-2409075), we added Section 4 entitled “UE additional complexity analysis” as well as 3 new observations: Obs. 6, Obs. 7, Obs. 11. We also plotted the performance of Type-I CB in all the figures as a benchmark for SU-MIMO. |
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* 1. Counting of active CSI-RS resources

Following proposal is made in the contribution.

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| [5] | **Observation 1: The FG 2-33 component 4a on active NZP-CSI-RS allows for very low UE capabilities****Observation 2: The FG2 2-33 component 4 may further restrict the number of active NZP-CSI-RS per CC when carrier aggregation is configured**T38.214 V18.4.0 subclause 5.2.1.6 CSI processing criteria defines how the abovementioned capability is counted for aperiodic, semi-persistent and periodic NZP-CSI-RS [4] (formatting changed for readability):

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| In any slot, the UE is not expected to have more active CSI-RS ports or active CSI-RS resources in active BWPs than reported as capability. NZP CSI-RS resource is active in a duration of time defined as follows. * **For aperiodic CSI-RS**, starting from the end of the PDCCH containing the request and ending at the end of the scheduled PUSCH containing the report associated with this aperiodic CSI-RS. When the PDCCH candidates are associated with a search space set configured with *searchSpaceLinkingId*, for the purpose of determining the NZP CSI-RS resource active duration, the PDCCH candidate that ends later in time among the two linked PDCCH candidates is used.
* **For semi-persistent CSI-RS**, starting from the end of when the activation command is applied, and ending at the end of when the deactivation command is applied.
* **For periodic CSI-RS**, starting when the periodic CSI-RS is configured by higher layer signalling, and ending when the periodic CSI-RS configuration is released.
 |

 It can be noted that for A-CSI-RS the resource is only considered active during the timeline of the one A-CSI reporting procedure, starting from the end of the triggering DCI and ending at the end of the PUSCH delivering the CSI report, while for P-CSI-RS the resource is considered active all the time even if the periodicity maybe large. Similarly for SP-CSI-RS, the CSI-RS resource is active over the whole duration when SP-CSI-RS is activated even if the periodicity maybe large.The fact that the P-CSI-RS and SP-CSI-RS resources are counted as always active puts pressure on the UEs to support a larger number of simultaneously active NZP-CSI-RS resources while low UE capability restricts the network operation. The low cap on the aggregate number of active NZP-CSI-RS resources across all component carriers further hinders the usage of carrier aggregation.Figure 1: Example of a staggered CSI reporting with 4 component carriers.  - If the CSI-RS are periodic, 4 NZP-CSI-RS resources are active all the time. - If the CSI-RS are aperiodic, at most 1 NZP-CSI-RS resource is active at any given time**Observation 3: With the same CSI-RS => CSI report timings, the periodic CSI-RS/reporting may need multiple times the number of active NZP-CSI-RS resources than aperiodic CSI-RS/reporting**RAN1#118bis discussed the problem and an updated proposal #16-a was formulated [4]:

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| **TEI proposal #16-1a (update)*** **For periodic and semi-persistent NZP-CSI-RS counting, consider a NZP CSI-RS resource as “active” from the slot of the CSI-RS.**
	+ **for a fixed number of slots determined by the longest CSI computation time for the SCS.**
 |

Thus the following proposals are made:**Proposal 1: For periodic and semi-persistent NZP-CSI-RS counting, consider a NZP-CSI-RS resource as “active” from the slot of the CSI-RS for a fixed number of slots determined by the longest CSI computation time for the SCS.****Proposal 2: Take the text proposal below as the baseline for introducing the new counting of NZP-CSI-RS resource as “active”**

|  |
| --- |
| In any slot, the UE is not expected to have more active CSI-RS ports or active CSI-RS resources in active BWPs than reported as capability. NZP CSI-RS resource is active in a duration of time defined as follows. - For aperiodic CSI-RS, starting from the end of the PDCCH containing the request and ending at the end of the PUSCH containing the report associated with this aperiodic CSI-RS. When the PDCCH candidates are associated with a search space set configured with *searchSpaceLinkingId*, for the purpose of determining the NZP CSI-RS resource active duration, the PDCCH candidate that ends later in time among the two linked PDCCH candidates is used.- For a UE not indicating support for [*active NZP-CSI-RS resource counting UE capability*] for semi-persistent CSI-RS, starting from the end of when the activation command is applied, and ending at the end of when the deactivation command is applied. - For a UE not indicating support for [*active NZP-CSI-RS resource counting UE capability*] for periodic CSI-RS, starting when the periodic CSI-RS is configured by higher layer signalling, and ending when the periodic CSI-RS configuration is released. - For a UE indicating support for [*active NZP-CSI-RS resource counting UE capability*] for semi-persistent and periodic CSI-RS, starting from the start of the slot containing the NZP-CSI-RS for a duration of *Z* symbols rounded up to full slots, where *Z* is the longest CSI computation time for the SCS configuration of the NZP-CSI-RS. |

 |

This TEI proposal was proposed and discussed in the last RAN1 meeting, and the discussion at the RAN1#118bis meeting is shown below [6].

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| Company | Suppport (Y/N) | Comment |
| DOCOMO | Y | From operators’ perspective, any solutions that can reduce active CSI-RS counting would be welcome. We prefer Alt2. Considering P/SP CSI-RS may be associated with A-CSI report, the slot of the corresponding CSI report might be any slots, which leads to that configured/activated P/SP CSI-RS is always active (same as legacy) by Alt1. |
| Apple | Y | We prefer Alt 2. Regarding Alt 2, further discussion is still needed to determine the number of slots.  |
| Huawei, HiSilicon | N | This will degrade the performance of CSI measurement, as in current spec, UE can performance measurement and refine the CSI based on every CSI-RS occasion. The proposal will force UE to perform CSI-RS based on reference CSI-RS occasion only, which degrades performance.There is also the case that the reference CSI-RS resource is before the DCI triggering the CSI report, with the proposed counting UE has to buffer every CSI-RS resource, which further increases the UE buffer requirement.The benefit to current spec is not clear either. If counting of active periodic CSI-RS is a problem then network can configure aperiodic CSI-RS, which can have the same functionality as the proposal, and can also reduce the overhead. |
| Lenovo/ MotM | Y | We also prefer Alt2. Even if the UE is to reuse CSI-RS measurement from prior CSI-RS occasions beyond the CSI-RS counting range, these “past” CSI-RS measurements are mainly aggregated to a channel covariance measure that is stored in the UE side, and re-processing of this CSI measurement separately is not well motivated. If UE vendors have different views based on their own implementations, their assumptions can be considered |
| ZTE |  | We are open to discuss that, and then, in our views, Alt-2 can be assumed as a starting point. But, the longest CSI computation time for the SCS may be relevant to enabled CSI report setting, and then, some further study should be made. From our preference, for forward compatibility, we prefer to a fix value which can be indicated by UE capability signaling, rather than being based on a rule. |
| Spreadtrum | Y | We think it’s beneficial to align the definition of active time interval for CSI-RS resource and UE processing timeline. We also think Alt2 is more appropriate. |
| Qualcomm | N | For Alt1, existing spec has no correspondence b/w CSI-RS occasion and report, for example* Each CMR/IMR, and the report, can have different periodicities;
* P-CMR/-IMR can be configured with AP-report

For Alt2, existing spec has no correspondence b/w each occasion of each CMR/IMR* So, does Alt2 mean to count ARC active duration as lasting, after every CMR and IMR, for a fixed duration (e.g. timeline Z’)? This seems not to be the definition of CSI timeline.

We tend to think proposal 16-1 is more like a totally new framework on ARC (or CPU), and much larger than a TEI. |
| Vivo | N | UE may do averaging over few CSI-RS occasions. Depends on periodicity, what if periodicity is small? And, how about “If a UE is not configured with higher layer parameter *timeRestrictionForChannelMeasurements*,”? |
| Xiaomi |  | We are open to discuss the pros and cons of the proposal.For P/SP CSI-RS resource, we agree that reasonable counting active resources can help to avoid underutilizing the UE’s capability. Whether other cons introduced for the proposal needs to further discuss.  |
| MediaTek | Y | We think this can be useful to facilitate a more efficient usage of CSI processing units at UE side, and we prefer to discuss a bit further which Alternative to go with, as we see pros and cons with both. We prefer Alt 2, as Alt-1 may have problems in A-CSI/P-CSI-RS case on how to count active CSI-RS dynamically after P-CSI-RS arrival as shown in the figure below.  |
| Samsung | N | Firstly, this TEI affects several legacy rules that were defined in Rel-15, and therefore it would have a substantial specification/implementation impact on both UE/gNB. In addition, it is not clear what performance/throughput benefit can be achieved by the proposal over current operation.  |
| Ericsson | Y | We prefer Alt 2. We can discuss further regarding the number of slots as suggested by Apple. |
| Nokia | Y | We obviously support the proposalIt seems to us that there are CSI processing implementations that cannot be utilized to their full potential with the current UE capability reporting framework, and there is a good justification to improve the active CSI-RS counting to be able to utilize the CSI resources more efficiently.There obviously maybe CSI processing implementations that would not benefit from the proposed counting improvement, and these UEs would simply not opt to support this feature as they are already being used up to their potential with the existing counting and capability framework. However, this should not be a reason to prevent the other UE implementations to support the feature.We are open to discussing additional constraints and solution details if that is helpful. E.g. the capability for the new active CSI-RS counting could be linked to a minimum CSI reporting or CSI-RS periodicity. |
| Moderator |  | According to the above comments, this proposal is supported by 7 companies, and meets the condition support by at least 1 operator, 1 infra vendor and 1 UE vendor.Since several concerns were raised from companies, proponent is encouraged to address the concern from companies. |
| Moderator |  | According to the chair guidance in Tuesday online session, we will continue the discussion on this proposal in Rel-19 TEI. Based on the comments, Alt2 is supported by more companies. So let’s consider the following updated proposal**TEI proposal #16-1a (update)*** **For periodic and semi-persistent NZP-CSI-RS counting, consider a NZP CSI-RS resource as “active” from the slot of the CSI-RS.**
	+ **for a fixed number of slots determined by the longest CSI computation time for the SCS.**

Since the following concerns were raised from companies, proponent is encouraged to address the concern from companies.* substantial specification/implementation impact
* CSI content is calculated based on a few CSI-RS occasions according to configuration.
* the definition of CSI timeline is not applicable for this purpose
 |
| Nokia |  | Attempting to respond to the concerns raised:* On substantial **specification impact**, R1-2408958 already provided a proposal for specification implementation. Additionally a UE capability, and potentially RRC activation may be neded.
* On substantial **implementation impact**, this obviously comes down to specific underlying UE implementation on this method for counting active CSI-RS means. We are not in a position to educate or even assess the impact on all possible implementations, but based on the discussion and the support this TEI proposal is receiving it does look that this is feasible at least to some existing implementations, and if there are some other implementations that make this counting method infeasible, that should not be a blocking argument preventing introduction of the feature.
* **Calculation over a few CSI-RS occasions:** The CSI report can indeed be based on unrestricted observation interval, and span across undefined number of CSI-RS instances. However this doesn’t necessitate maintaining the CSI-RS resource as active across the whole averaging window, that would be just one particular implementation. It may also be that the storing of the report value for further averaging is a trivial step relative to the actual measurement, and the resource can be freed between the CSI-RS samples.
* **CSI timeline is not applicable for this purpose:** This is true as per the existing specification, but I am not able to follow the meaning of this argument. The whole point of this TEI proposal is to define a CSI timeline that would be applicable in this case. Arguing that the CSI timeline is not applicable as per the existing specification is peventing defining an applicable timeline in Release 19 seems circular; “if something is not defined it cannot be defined”.
 |
| vivo |  | We didn’t get response to our previous comment above.UE may do averaging over few CSI-RS occasions. Depends on periodicity, what if periodicity is small? And, how about “If a UE is not configured with higher layer parameter *timeRestrictionForChannelMeasurements*,..”? |
| Samsung |  | We still have negative views on this proposal.Active resource counting rule has been defined in Rel-15 which is indeed conservative from both UE and gNB side, but all UEs have followed this rule from Rel-15. Hence, it is most probably expected that almost all UEs and gNBs may implement their channel information acquisition and CSI-RS/CSI report triggering mechanism based on this principle.As vivo mentioned, for P/SP CSI-RS, UE may perform estimation/averaging by using one or multiple occasions for channel information acquisition, so even though periodicity is large, we are not sure how to deactivate UE’s active counting since it would be different from different UE (i.e., depending on UE capability). Hence, it seems that it is not easy to determine “a fixed number of slots determined by the longest CSI computation time for the SCS” as putted in the sub-bullet in the proposal.Also, it is not clear how much performance/throughput benefit can be achieved by the proposal over current operation if some time duration of P/SP CSI-RS can be deactivated. |
| Qualcomm |  | For the updated proposal 16-1a, some more specific questions regarding timeline we mentioned earlier.In our understanding, the proposed CSI timeline (or “CSI computation time”) here to define the “periodically” active duration of P(SP)-CSI-RS, it should follow the concept/logic of legacy timeline: Counting from the last symbol of CMR(s)/IMR(s) of a measurement, to the end of the timeline.However, for P/SP-CSI-RS(or IM), standard has no definition of what occasion(s) are used for computation of **one** measurement – no correspondence b/w CMR(s)/IMR(s) – therefore, how to identify the last symbol as the starting of the counted timeline? Starting from every CMR/IMR’s last symbol? |
| MediaTek | Y | We are fine with latest moderator proposal. We do see some value though in further progressing this topic. However, based on the comments, we are also open to discuss to identify a definition that could be workable.  |
| Moderator |  | Due to the limited time, this proposal could not be treated in online session. Companies are welcome to provide views on this proposal for the next meeting. |

 |

Based on the above contribution, following TEI proposal can be discussed in RAN1#119 meeting.

### **TEI proposal #5**

* **For periodic and semi-persistent NZP-CSI-RS counting, consider a NZP-CSI-RS resource as “active” from the slot of the CSI-RS for a fixed number of slots determined by the longest CSI computation time for the SCS**
* **Take the text proposal below for 5.2.1.6 in TS 38.214 as the baseline for introducing the new counting of NZP-CSI-RS resource as “active”.**

|  |
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| ========================= Unchanged parts =========================In any slot, the UE is not expected to have more active CSI-RS ports or active CSI-RS resources in active BWPs than reported as capability. NZP CSI-RS resource is active in a duration of time defined as follows. - For aperiodic CSI-RS, starting from the end of the PDCCH containing the request and ending at the end of the PUSCH containing the report associated with this aperiodic CSI-RS. When the PDCCH candidates are associated with a search space set configured with *searchSpaceLinkingId*, for the purpose of determining the NZP CSI-RS resource active duration, the PDCCH candidate that ends later in time among the two linked PDCCH candidates is used.- For a UE not indicating support for [*active NZP-CSI-RS resource counting UE capability*] for semi-persistent CSI-RS, starting from the end of when the activation command is applied, and ending at the end of when the deactivation command is applied. - For a UE not indicating support for [*active NZP-CSI-RS resource counting UE capability*] for periodic CSI-RS, starting when the periodic CSI-RS is configured by higher layer signalling, and ending when the periodic CSI-RS configuration is released. - For a UE indicating support for [*active NZP-CSI-RS resource counting UE capability*] for semi-persistent and periodic CSI-RS, starting from the start of the slot containing the NZP-CSI-RS for a duration of *Z* symbols rounded up to full slots, where *Z* is the longest CSI computation time for the SCS configuration of the NZP-CSI-RS.========================= Unchanged parts ========================= |

This proposal is already supported by Nokia, Apple, Ericsson, MediaTek, NTT DOCOMO, Spreadtrum.

Companies are encouraged to check above TEI proposal and to provide feedback if any in below.

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| Company | Suppport (Y/N) | Comment |
| ZTE |  | Some comments: * + - #1 The motivation of extending this time to slot level is unclear to us. Besides for adding some unnecessary/fancy extension, we do NOT identify the clear benefit behind that.
		- #2 Besides for SCS configuration, Z is also relevant to the report quantity, i.e., per CSI report configuration or not while being associated with multiple CSI report configuration. Some further clarification is needed. From our preference, for forward compatibility, we prefer to a fix value which can be indicated by UE capability signaling, rather than being based on a rule.
 |
| Qualcomm |  | We would like to raise our questions regarding how this new UE may work well, and at the same time try to provide some constructive inputs.1. Based on our understanding, the proposal assumes that the CSI calculation is from the slot of the CMR, and lasts for a few slots equaling to CSI processing time.
	* As we know, CSI calculation is with both CMR and IMR, therefore, to make this work, we’d like to add the following restriction:

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| Restriction1: For the NZP CSI-RS for channel measurement, if paired with a CSI-IM, the CSI-IM has a same periodicity as the NZP CSI-RS, and is located in the same slot as the NZP CSI-RS; |

1. Besides, for the case with Ks>1 NZP CSI-RS resources in a set (i.e. CRI-based report), things get more complicated, which we prefer this TEI to only deal with non-CRI.

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| Restriction2: The NZP CSI-RS resource set for channel measurement only comprises one NZP CSI-RS resource. |

If proponent companies think Restriction2 is too limited, and CRI use case is important, we can also be open to FFS, but we feel that may need a lot more time to reach consensus.1. One functionality of ARC, according to our understanding, is also to limit the memory buffering budget for the calculated report content (will be denoted as UL buffer, for short), which needs to be buffered “forever,” until updated by a new measurement in the next periodicity.
	* This is also one of the reasons why legacy ARC active duration is “always-on” for P/SP-CSI-RS.
	* However, with this proposal, more reports calculated in a TDM’ed manner may increase proportional to the periodicity, and blows-up UL buffer requirement
		+ For example, assuming periodicity P=20msec (i.e. 40 slots @30kHz SCS), and with CSI processing time =5 slots, the UL buffer would increase as 40/5=8 times (although in the figure below we only show P/=4 times) – Also note that there can be longer CSI-RS periodicities like 40 or 80msec.

* + One solution to prevent the blowing-up of UL buffer can be, we define a “report buffer active duration,” outside of which UE may report some “default CSI” (e.g. a fixed rank1 precoder) or “invalid CSI” (e.g. zero-padding)
		- Let’s the “report buffer active duration” is not too short e.g. 20msec, it should be enough to config/schedule a PUCCH/PUSCH to report – anyway longer than 20msec “stale” CSI should be less useful – channel may already be outdated.
		- From the following example in the figure, we can observe that, when CSI-RS periodicity is smaller, the “report buffer active duration” does not cause any “gap” to report “default” or “invalid” CSI – it is only to prevent the case of **accumulated buffering** of a large amount of reports over a long periodicity.

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| Restriction3: A “report buffer active duration” is defined after the ARC active duration, outside of which, UE reports “default” or “invalid” CSI report.* + Candidate values of the “report buffer active duration” is [20msec]
 |

Besides, for the two comments made by ZTE for this 119 meeting (#1 symbol-level timeline, and #2 report-specific timeline), we are open to discuss (tend to agree with the principle that we don’t need to change legacy timeline definition too much) |
| Apple |  | We are supportive of the TEI proposal in principle. But we believe it is more suitable to use Z’, instead of Z to define the timeline based on the current definition of Z (from DCI to CSI report) and Z’ (from measurement RS to CSI report).We also think that there are other UE capabilities that can be used to limit the memory, for example, maximum number of periodic/semi-persistent/aperiodic CSI report settings that can be configured per BWP.For the 3 restrictions proposed by Qualcomm, we think the UE capability may not be applicable for all the UEs. This is similar as the other UE features proposed in the past, i.e., some UE vendor may find the UE features beneficial, and some other UE vendor may find the UE feature not useful. Once we identify the restrictions or conditions that can may the TEI proposal acceptable, we can further discuss how to make the final solution less restrictive for different UE vendors, or allow UE vendor to report their capability without unnecessary restrictions.  |
| OPPO |  | We need to understand the motivation to use “the longest CSI computation time” as the active window. In Rel-15, if we understand correctly, the CSI-RS active window is for channel buffer, that is why the P/SP CSI-RS is assumed to be always active. The proposal seems to introduce a new definition/UE implementation for CSI-RS active assumption.If the active window here is the time for CSI calculation, the CSI computation window should start from the latest symbol of CSI-RS and CSI-IM resource associated with the same CSI report as the CSI-RS. However, the CSI-RS may be associated with different CSI-IM resources for different CSI report configurations (in which case it would be counted as N active resources), it would be difficult to define the start of the active window unless we define the active time for each CSI report rather than each CSI-RS resource. If the active window here is the time for channel measurement only, and the active window doesn’t consider the time for CSI calculation and CSI buffer, it is not reasonable to use the longest CSI computation time. As mentioned by ZTE, a value reported by UE capability for channel measurement can be applied, which could be much smaller than the longest CSI computation time.  |

* 1. UE frequency hopping enhancement for positioning

Following proposal is made in the contribution.

|  |  |
| --- | --- |
| [2] | In Rel-18, for positioning enhancements for RedCap UEs, Rx frequency hopping of DL PRS and Tx frequency hopping of UL SRS for positioning are supported with the maximum hop bandwidth for a single hop being 20MHz for FR1 and 100MHz for FR2. To improve positioning accuracy, the frequency hopping feature could also be applicable for non-RedCap UEs with limited UL SRS transmitting bandwidth capability or limited DL PRS processing bandwidth capability (e.g., 50MHz). The maximum bandwidth for a single hop can be extended to be larger than 20MHz for FR1 and larger than 100MHz for FR2 to support non-RedCap UE frequency hopping.***Observation 1:*** *For non-Redcap UEs with limited bandwidth capability, the feature of frequency hopping cannot be used to improve the positioning accuracy.*Moreover, in Rel-18, bandwidth/carrier aggregation is introduced for achieving an equivalent larger bandwidth than the hopping bandwidth and therefore achieving higher accuracy. The maximum aggregated bandwidth of 2 PFLs/carriers for positioning which is supported by UE can be up to 200MHz in FR1 (for 30 kHz SCS) and up to 800MHz in FR2, and the maximum aggregated bandwidth of 3 PFLs/carriers for positioning which is supported by UE can be up to 300MHz in FR1 (for 30 kHz SCS) and up to 1200MHz in FR2. However, for UEs not supporting the bandwidth aggregation feature, the frequency resources of intra-band contiguous CCs cannot be used for positioning accuracy improvement. In order to make use of the intra-band contiguous CCs and the up-to-300MHz frequency resources in FR1, the maximum SRS bandwidth across all hops can be extended such that the SRS hops can span across intra-band contiguous CCs. In such case, the frequency resources can be effectively utilized for a UE only supporting the SRS Tx hopping feature but not supporting the SRS bandwidth aggregation feature.***Observation 2:*** *For UEs not supporting bandwidth aggregation feature, the frequency resources of intra-band contiguous CCs cannot be used for positioning accuracy improvement.*UL SRS Tx frequency hopping is supported for both RRC\_CONNECTED state and RRC\_INACTIVE state. A UE can be configured to perform SRS Tx hopping separate from UL BWP where the UE may be configured with SCS, CP and bandwidth that are different from the UL active BWP (i.e., UL BWP for positioning SRS hopping). Also, there is no additional impact on measurement report since one TRP measurement is associated with one SRS resource ID, wherein the total bandwidth of all hops within that SRS resource is larger than a carrier/BWP bandwidth. The maximum SRS bandwidth across all hops can be 300MHz in FR1.For DL, DL PRS Rx hopping across multiple PFLs can be realized by bandwidth aggregation configuration. For example, if a DL PRS bandwidth aggregation across multiple PFLs is configured, a UE can achieve large bandwidth via frequency hopping by implementation, wherein the UE only receive one PFL at one time.Based on the above analysis, we propose to at least support SRS Tx hopping across carriers in both RRC\_CONNECTED state and RRC\_INACTIVE state.***Proposal 1:*** *Extend Rel-18’s DL and UL frequency hopping for DL-PRS reception and UL SRS for positioning transmission to non-RedCap UEs** *At least support the maximum SRS or DL PRS bandwidths across up to three intra-band contiguous carriers or PFLs respectively.*
 |

Since TEI proposal on maximal HARQ process numbers for TN in FR1 and FR2-1 was already led/initiated by ZTE in this quarter, this TEI proposal is not to be treated in this meeting according to TEI guidance [7]

1. Proposal for online session

To be updated

1. Conclusion

To be updated

1. Agreements in Rel-19 TEI

RAN1#118bis

Agreement

For the indication of whether a UE can simultaneously perform SRS carrier switches

* *srs-SwitchingAffectedBandsListNR-r17* is the baseline for indication.
	+ *Details about UE capability will be discussed in UE feature session.*
	+ *The structure of UE capability signalling is reused*
* Two SRS carrier switches are considered to be simultaneous if the SRS transmission (including RF retuning time) in both CCs overlap in time.
* A UE that indicates it is not capable of simultaneous SRS carrier switching among a set of switching pairs is not expected to be configured / scheduled with simultaneous SRS carrier switching in the set of switching pairs.
* Note: except for UE capability, the spec impact is only 38.214

Agreement

* Support a maximum of 32 HARQ process numbers for TN in FR1 and FR2-1 in Rel-19.
	+ Introduce new UE capabilities, by duplicating the Rel-17 UE FGs 24-8/24-9 defined for FR2-2 to FR1 and FR2-1.
		- The reporting granularity of the UE capabilities is changed to ‘per FSPC’.
	+ Introduce new RRC parameters, harq-ProcessNumberSizeDCI-0-1-Ext-r19, harq-ProcessNumberSizeDCI-1-1-Ext-r19, harq-ProcessNumberSizeDCI-0-2-Ext-r19, harq-ProcessNumberSizeDCI-1-2-Ext-r19, harq-ProcessNumberSizeDCI-0-3-Ext-r19, harq-ProcessNumberSizeDCI-1-3-Ext-r19.
	+ For FR1, the above downlink related parameters can only be configured when the maximum number of layers configured for PDSCH is up to 4.
	+ For FR1, the above uplink related parameters can only be configured when the maximum number of layers configured for PUSCH is up to 4.

Reference

[1] R1-2409401 Enhancement of SRS beamforming for FR2 positioning Huawei, HiSilicon, China Unicom, ZTE, Sanechips, CATT

[2] R1-2409542 On Rel-19 TEI proposals ZTE Corporation, Sanechips

[3] R1-2409990 TEI-19 proposal on link adaptation enhancement Ericsson

[4] R1-2410246 CSI Acquisition Improvement for Type-II codebook Orange, ZTE, BT

[5] R1-2410624 TEI19: Counting of active NZP-CSI-RS resources Nokia, Apple, Ericsson, MediaTek, NTT DOCOMO, Spreadtrum

[6] R1-2409296 FL Summary #3 on Rel-19 TEIs Moderator (NTT DOCOMO, INC.)

[7] RP-191602 Handling of TEI & contribution submission in RAN WGs for NR and LTE 3GPP RAN TSG and WG1/2/3/4 Chairmen

[8] RP-210826 Handling of TEI CRs ETSI MCC

Appendix: TEI guidance in [8]

**A. TEI Work Item codes shall only be used for small technical enhancements and improvements.**

This is how TEI was and is defined and it means that bigger topics should be done in an own WI.

**B. A TEI CR set shall be fully completed within one TSG cycle/quarter in all affected WGs.**

This requirement from TR 21.900 was never challenged. It also clarifies that only complete sets can be approved.

**C. TEI Work Item codes shall not be used where another appropriate Work Item code exists.**

This repeats the rule from TR 21.900 and it means that TEI cat.F CRs shall be an exception. Note: The CR author is supposed to find out which former CR introduced an error in the spec and the cat.F correction should then use the same WI code. So in theory, cat.F TEI CRs should only be needed to correct cat.B/C TEI CRs of the past.

D. Inter-TSG aspect:

**D1. Normally, for TSG SA/CT work that requires cat.B/C CRs from RAN WGs a RAN WI is required..**

This is what RAN applied in the last decade (if not longer). This also covers the strong discouragement of cross TSG TEI CRs expressed in RP-191602 slide 3.

**D2. In case the RAN work triggered via a TSG SA/CT WI\* is small and it affects only one RAN WG, then the RAN WG CR(s) shall use the WI code\* of the TSG SA/CT WI that triggered this work.
NOTE: \*: provisional WI codes, companion WIDs/"mini-WIDs" are not meant here but already TSG approved proper WIs.**

This is what RAN applied in the last decade. Note: As TSG RAN has no agenda items for all SA/CT WIs, this sort of CRs were usually submitted under a TEI agenda item but for traceability we shall not use a TEI WI code on such a CR.
(Note: D2. could work also in the other direction, i.e. if there is a RAN WI for which is turns out that only a small change would be needed in one SA WG or one CT WG. But you better consult TSG SA/CT before trying this approach.)

**D3. It is not possible to trigger work in RAN WGs via TEI CRs coming from TSG SA/CT or SA/CT WGs. The same applies for the reverse direction.**

Otherwise "small" (TEI) but affecting multiple TSGs would contradict each other. (Apart from this, inter-TSG TEI CRs would also not work well together for cat.B/C CRs if SA/CT use a companion WID but RAN does not.).

E. Inter-RAN WG aspects:

Section E. is addressing the problem that multiple RAN WGs work on the same feature but it is still intended to not have an own WI for this but to cover this feature under cat.B/C TEIxx (this is challenging time-wise and coordination-wise and therefore not a recommended approach but it is not forbidden). As RAN5 has introduced specific rules regarding the testing of TEI CRs, see RP-200931 [5] and since they use a different WI code (TEIxx\_Test) and testing work is usually coming at a later stage, this section E. is considering linked TEI CRs of RAN1/2/3/4.

In a similar way: RAN1/2/3/4 Core part work happens usually in the same time interval while RAN4 Perf. part work usually happens at the end of or after the RAN4 Core part work. In other words, having a TEI CR package that combines Core and Perf. part work requires a very careful timing to not violate requirement B.

RP-191602 [2] provided some guidance on Cross-WG TEI CRs in RAN WGs:

- Cross WG TEI CRs are strongly discouraged

- RAN1/2 TEI proposals with RAN4 impact to core requirements are strongly discouraged

- **RAN2 impact of RAN1/4-led TEI CRs shall be limited to RRC signalling of configuration parameters and UE capabilities (no MAC impact, no RRC procedural impact, etc.)**

Note: Ideally one RAN WG would take the decision about whether a TEI feature should be introduced or not and other RAN WGs then accept this decision and contribute their TEI CRs.

But as this guidance was not forbidding Cross-WG TEI CRs in RAN WGs some more requirements had to be defined how to guarantee traceability, consistency and visibility of this sort of CRs.

The basic requirements discussed in section E. were endorsed by TSG RAN in RP-202867 [7] but further clarification/guidance is provided here.

**E.1 It is mandatory to fill out the "other specs affected" for all CRs, i.e. either Yes or No shall be ticked and
 if Yes is ticked at least the TS/TR shall be indicated and this for the present WG and all other WGs that have CRs linked to the present CR.
 TEI CRs missing this information or having wrong information shall not be approved.**

These requirements were always there. But some clarification is required.

- "other specs affected" is used to link CRs that belong together which is essential for cat.F CRs and for cat.B/C TEI CRs to guarantee that a complete set of CRs is approved. Note: For cat.B CRs of other WIs, we have an extra RAN agenda item for each of them and we usually approve all stage 3 CRs together. But for closed WIs or TEI CRs we have normally just one agenda item collecting a larger number of CRs and then the relation of the CRs becomes unclear if "other specs affected" is not filled out properly.
 NOTE: Other specs affected should also list inter-TSG related CRs if it is clear that these CRs can only be applied together. This usually involves a conditional approval at TSG level

- "Other core specifications" under "Other specs affected" on the CR cover: Going back to RAN #46 of Dec.2009 where TSG RAN decided to have separate Core part WIs and Perf. part WIs (in RP-091374) you can see from comparing with CR form v9.6 that the term "Other core specifications" is only intended to distinguish those specs from "Test specifications" and "O&M specifications" but not to exclude Perf. part related specs from "Other specs affected": This means as long as CR form is not updated "Other core specifications" should cover Core part specifications AND Perf. part specifications as defined in TSG RAN.

- "Test specifications" under "Other specs affected" on the CR cover: Testing under TSG RAN is either done in RAN4 or in RAN5. Since RAN5 has separate WIs for testing that usually are also just started after RAN4 work is completed, it would not make much sense to reference RAN5 specs on a RAN4 CR as it is clear that the RAN5 CR will just follow later (here it is more appropriate to review the corresponding RAN5 WI when it becomes available).
 Examples where it could make sense to fill out this field: For RAN4 CRs to a WI that involve BS testing for the same WI/a linked CR. For CRs to SI TRs to which RAN4 and RAN5 contribute together with CRs. For a cat.B/C TEI CR of RAN1/2/3/4 that has a corresponding CR in RAN5 under TEIx\_Test.

- "O&M Specifications" under "Other specs affected" on the CR cover: O&M specifications are handled by SA5. SA5 has usually separate WIs for their changes and RAN CRs are not submitted to TSG SA or SA5, therefore the benefit of this field is higher within TSG SA. Nevertheless, there may be cases of tighter cooperation of RAN WGs with SA5 (like Minimization of drive tests) where it will be beneficial to indicate a related SA5 change coming to the same TSG meeting.

- What needs to be done if WGx is assuming that TS/TR ab.cde of WGy is affected but they are not sure?
 WGx should list under "other comments" on the CR cover: "WGx thinks that also TS/TR ab.cde of WGy could be impacted by this CR." Depending on the probability WGx would tick Yes (and mention the spec) or No.
 CR proponents shall check this with WGy (e.g. by sending an LS from WGx to WGy, submitting a Tdoc in WGy, talking to the chairman of WGy) so that at the TSG meeting where WGx submits this CR for approval it is either clear that there is no impact or that the WGy CR is available as well for approval.
 NOTE: MCC has the possibility to correct CR covers before RAN submission (e.g. remove a potential impact comment if it turned out that there is no impact). But CR proponents need to inform MCC about this.
 Incomplete CR sets (i.e. WGx CR there but linked WGy CR not available) can not be approved at TSG level and since cat.B/C TEI CRs have to be completed within one quarter, this is time critical.
 Therefore very good preparation of cat.B/C TEI CRs which affect multiple WGs is essential.

**E.2 Each TEI cat.B/C CR and each TEI cat.F/A CR that corrects functionality related to an earlier TEI cat.B/C CR shall have a unique TEI identifier in square brackets [ ] at the end of the CR title on the CR cover sheet.
 TEI cat.B/C CRs without such a unique TEI identifier cannot be approved at RAN.**

This principle was endorsed in RP-202867 [7] and further guidance for this approach is provided here:

- The TEI identifier should be short (4 to 18 characters using letters and/or digits or using \_ or - but avoiding blanks or other special characters which will complicate searches) and characterize the CR.

- The originating company takes care that related CRs in other WGs use the same TEI identifier.

- Unique identifiers are not added retroactively: Cat.F/A CRs for TEIs which did not have a unique identifier by RAN #91e will not get a unique identifier.

- Apart from plain TEI CRs, the unique TEI identifiers shall also be applied to NR\_newRAT-Core, TEIxx CRs because NR\_newRAT-Core was the huge WI for 5G.

- As the unique idendifiers are part of the CR title, they will be automatically stored in the CR database. Therefore CR authors have to make sure that the complete CR title in 3GU is in line with the title on the CR cover.

- For cases where it is not 100% clear whether a linked CR was agreed in another WG, it is the task of the CR author to double-check the situation in the week after the WG meeting and to inform MCC in case any updates of CR titles are required otherwise they risk that not properly linked CRs are rejected at RAN level.

**E.3 WG chairman reports report to TSG RAN about all agreed and technically endorsed cat.B/C TEI CRs of the last quarter. For each unique TEI identifier all related CRs of the considered WG are listed plus the corresponding CRs in the other WGs (if there are any) or the potential impacts on other WGs.**

How this is done is up to the chairman (e.g. it can be a slide with a table like the examples below, it can be an extra Excel table included in the zip file of the WG status report). The WG chairman could request inputs from MCC (Tdoc list filtered for agreed/endorsed TEI CRs) and all CR authors of the WG who had agreed/endorsed TEI CRs (to clarify whether there were related CRs in other WGs) and this could be condensed in such an overview.

Examples:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **unique TEI identifier** | **feature** | **Rel** | **CRs in own WG** | **CRs in/impacts on other WGs** |
| [HDUPLEX\_unpaired] | Modification to half duplex in unpaired spectrum | Rel-16 | R1-211234 (38.213, cat.C) | R2-2112345 (38.331 cat.C) |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **unique TEI identifier** | **feature** | **Rel** | **CRs in own WG** | **CRs in/impacts on other WGs** |
| [intRAT\_HO\_NR\_ENDC] | Introduction of inter-RAT handover NR to ENDC | Rel-16 | R2-2123456 (38.306, cat.B)R2-2123457 (38.331, cat.B) | potential impact on 38.133 for .... ? |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **unique TEI identifier** | **feature** | **Rel** | **CRs in own WG** | **CRs in/impacts on other WGs** |
| [E2E\_delay\_meas] | E2E delay measurement for QoS monitoring for URLLC | Rel-16 | R3-211234 (38.413, cat.B)R3-211235 (38.423, cat.B)R3-211236 (38.463, cat.B) | none |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **unique TEI identifier** | **feature** | **Rel** | **CRs in own WG** | **CRs in/impacts on other WGs** |
| [DRX\_coord] | Introduction of DRX coordination | Rel-16 | R4-2123456 (38.133, cat.B) | R2-2112345 (38.331, cat.B) |

- what's the main goal of this activity? To have a checkpoint in each WG (RAN1/2/3/4) where after the WG meeting it is checked whether a complete CR set is available for all cat.B/C TEI features for TSG RAN; by comparing the tables of different WGs a cross-check is possible.

- should this activity be limited to cat.B/C TEI CRs only? It would be useful to also list cat.F/A TEI CRs to correct formerly as cat.B/C TEI introduced features (corresponding CRs will have [ ] at the end of the Tdoc title and CR proponents will inform the WG chairman if there were any agreed/endorsed CRs lile this)

- what about CRs for WI code combinations like "<WI code>, TEIxx"?
 These CRs appear when <WI code> was a WI of a Rel-yy with yy<xx.
 These CRs are usually well identified via <WI code> and would therefore not need any more tracking.
 But one exception should be made for <WI code> = NR\_newRAT-Core as this was the generic NR WI that introduced the whole 5G and if we do not track "NR\_newRAT-Core, TEIxx" as well, it could be used as a way to bypass this tracking activity.

- How big is the expected effort: Double-checking TEI16 CRs of 2020, we had about 110 cat.B/C CRs from RAN1/2/3/4 together with ~50% TEI16, ~25% "NR\_newRAT-Core, TEIxx" and ~25% other WI code, TEI16 CRs. So this means ~20 CRs per TSG RAN meeting plus a few cat.F/A corrections to former cat.B/C TEIxx CRs.

- What is TSG RAN supposed to do with the tables of TEI CRs from the WG chairmen? The impacts on other WGs have to be carefully reviewed (the earlier the tables from the WG chairmen are available the better, ideally at latest 1 week after the WG meeting): If WGx expected a CR from WGy but WGy did not provide such a CR, then there are 2 possibilities: The CR from WGy was not needed (then this will be documented e.g. in the RAN minutes or in a revised WG chairman's report) or WGy did not manage to conclude on a CR which means we have an incomplete CR set that cannot be approved. It is then up to TSG RAN to discard the incomplete CR set or to request a company CR for the WGy spec (if it is easy to solve) or to consider the start of a new WI (if the problem is more complex).

**E.4 MCC will support this tracking activity with a list of TEI CRs for a considered release that were handled at RAN and that have the unique TEI identifier.**

- The resulting Tdoc list of each RAN meeting includes already a complete list of all CRs handled in this meeting. An additional list will be added after RAN #92e listing the TEI CRs with unique TEI identifiers in [ ].
 After RAN #93e, a further list will be appended to the TEI CR list so that in the end a list for all TEI cat.B/C CRs (and their corresponding cat.F/A corrections) will develop that allows easy search and filtering for new TEI features.

- Such a list could be generated per release and will allow an improved visibility and tracing of new TEI features.
 Note: Due to the unique TEI identifiers and the proper documentation as outcome of the RAN meetings, also 3GU will allow to search for TEI CR sets.