**3GPP TSG RAN WG1 #114 R1-230xxxx**

**Toulouse, France, August 21st – August 25th, 2023**

**Agenda item:** 9.15

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

**Title:** [draft]Summary #2 on Rel-18 TEIs

**Document for:** Discussion and Decision

1. Introduction

This contribution summarizes the discussions and proposals in AI 9.15 for Rel-18 TEI related discussion.

Based on the discussions summarized in Section 2, following TEI proposals are identified in AI 9.15. According to the guidance in [6], 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, 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: UE capability with up to 6-layer DL MIMO**
	+ Supported by OPPO, CMCC, China Telecom, NTT DOCOMO, Lenovo, China Unicom, Qualcomm
* **TEI proposal #2: PUSCH repetition type A for a PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI**
	+ Supported by ZTE, China Telecom, Sanechips, NTT DOCOMO
* **TEI proposal #3: Enhanced PDCCH reception for mDCI based mTRP**
	+ Supported by Qualcomm
* **TEI proposal #4: Enhancement for scheduling request**
	+ Supported by Qualcomm
* **TEI proposal #5: Further complexity reductions for FR2 RedCap**
	+ Supported by Spreadtrum

In addition, as per decision in Monday morning online session, following discussion is also handled in Section 3 in this contribution.

|  |
| --- |
| **Rel-18 TEI**R1-2306387 LS on longer CG-SDT periodicities RAN2, EricssonRAN2 is requesting RAN1 input on the support of longer CG-SDT periodicities. Discussion on response LS to be handled in agenda item 9.15. To be moderated by Shinya (DOCOMO).R1-2306561 Discussion on LS on longer CG-SDT periodicities ZTER1-2306562 Draft Reply LS on longer CG-SDT periodicities ZTER1-2306707 Discussions on RAN2 LS on longer CG-SDT periodicities vivoR1-2306824 Discussion on LS for CG-PUSCH periodicity for SDT operation Intel CorporationR1-2307132 Discussion on reply LS on longer CG-SDT periodicities NECR1-2308125 On LS on longer CG-SDT periodicities EricssonR1-2308155 Draft reply LS on longer CG-SDT periodicities Huawei, HiSilicon |

1. Discussion on Rel-18 TEI proposals
	1. UE capability with up to 6-layer DL MIMO

Following proposal is made in the contribution.

|  |  |  |  |
| --- | --- | --- | --- |
| [3] | **Background**In Rel-15 NR, the MIMO schemes with up to 8 layers were introduced to boost the DL throughput. Based on UE capability, NW may configure MIMO transmission with up to 8 layers for a UE. According to the existing RRC signaling, the number of MIMO layer can be configured as 1, 2, 3, 4, 5, 6, 7, or 8 [1].

|  |
| --- |
| PDSCH-Config ::= SEQUENCE { dataScramblingIdentityPDSCH INTEGER (0..1023) OPTIONAL, -- Need S dmrs-DownlinkForPDSCH-MappingTypeA SetupRelease { DMRS-DownlinkConfig } OPTIONAL, -- Need M dmrs-DownlinkForPDSCH-MappingTypeB SetupRelease { DMRS-DownlinkConfig } OPTIONAL, -- Need M ..., [[ maxMIMO-Layers-r16 SetupRelease { MaxMIMO-LayersDL-r16 } OPTIONAL, -- Need M minimumSchedulingOffsetK0-r16 SetupRelease { MinSchedulingOffsetK0-Values-r16 } OPTIONAL, -- Need M …}MaxMIMO-LayersDL-r16 ::= INTEGER (1..8) |

Meanwhile, the existing UE capability signaling allows a UE to report the support of up to 2-layer DL MIMO, up to 4-layer DL MIMO or up to 8-layer DL MIMO [1].

|  |
| --- |
| FeatureSetDownlinkPerCC ::= SEQUENCE { supportedSubcarrierSpacingDL SubcarrierSpacing, supportedBandwidthDL SupportedBandwidth, channelBW-90mhz ENUMERATED {supported} OPTIONAL, maxNumberMIMO-LayersPDSCH MIMO-LayersDL OPTIONAL, supportedModulationOrderDL ModulationOrder OPTIONAL}MIMO-LayersDL ::= ENUMERATED {twoLayers, fourLayers, eightLayers} |

For the practical deployment, it is common for smartphones to use 4 Rx or 2Rx antennas for typical bands. Thus, the current commercial smart phones can only support DL MIMO with up to 4 layers. ***Observation 1: The current commercial smart phones can only support DL MIMO with up to 4 layers.*** As hardware and design improve, some advanced smartphones are starting to trend towards using more Rx antennas to improve the DL performance. For example, some foldable phones have already implemented 6 Rx antennas. That brings in the following benefits to 5G system:* B1: A more advanced receiver exploiting more Rx antennas to mitigate interference for DL MIMO transmission with up to 4 layers that can
* B2: providing higher peak data rate through supporting higher number of DL MIMO layers (e.g., 5 or 6 layers). Fig.1 illustrates the LLS performance for DL MIMO schemes. “rank4” and “rank6” in the figure refer to the dynamic rank adaptation with up to 4 layers and up to 6 layers, respectively.

***Observation 2: Compared to 4-layer DL MIMO, 6-layer DL MIMO can offer higher data rate and better user experience.*** Figure 1. Performance comparison of up to 4-layer and up to 6-layer DL MIMOThe benefit B1 can be achieved by advanced implementation of chipset with no spec impact. But, unfortunately, the benefit B2 cannot be obtained under the current specification. According to the existing UE capability signaling, a UE not supporting 8-layer DL MIMO can only report either “twoLayers” or “fourLayers”. With reporting either one, the system is not able to configure 6-layer DL MIMO transmission to the UE, even though the UE is capable of 6-layer DL MIMO. During the discussion in the last meeting, there was a proposal that a UE reports the support of 8-layer DL MIMO but will only report the rank with up to 6. However, this implementation-based solution has some problems. The first one is that “cheating” network is not aligned with the basic principle of UE capability in 3GPP. The second one is UE cannot meet some other requirements specified by 3GPP or regulator (e.g., the requirements of 8-layer DL MIMO peak data rate, other test use cases in RAN4/RAN5). ***Observation 3: The current NR spec cannot allow UE to support DL MIMO with up to 6 layers if it cannot support 8-layer DL MIMO.***  Based on the above discussion, the main restriction of existing UE capability is the relatively coarse granularity, i.e., only 2-layer, 4-layer and 8-layer are supported. A finer granularity for the DL MIMO layers will encourage more advanced commercial smart phones to provide higher data rate as UE don’t need to jump from 4 layers to 8 layers directly. ***Observation 4: Allowing smart phones to support 6-layer DL MIMO will encourage UE vendors to provide advanced commercial smart phones with higher data rates.*** **Solution**Therefore, in order to achieve higher DL throughput by fully exploiting the capability of UE with 6-layer DL MIMO, it is proposed to introduce a new UE capability so that an advanced smart phone with 6 or more Rx antennas can report its support of up to 6-layer DL MIMO transmission.***Proposal 1: Introduce a new candidate value, sixLayers, for the UE capability of supported maximal number of DL MIMO layers to support up to 6-layer DL MIMO transmission**** ***Prerequisite feature group is FG 2-1***
* ***“Need for gNB to know whether the feature is supported by the UE” is “Yes”***
* ***Reporting type is per FSPC***
* ***“Mandatory/Optional” is Optional with capability signalling***
* ***Note1: R15 NR has already supported the candidate values of twoLayers, fourLayers and eightLayers via the RRC parameter MIMO-LayersDL ::= ENUMERATED {twoLayers, fourLayers, eightLayers}. It’s up to RAN2 for the signaling design of the corresponding UE capability.***
* ***Send an LS to RAN2 for necessary signalling design***

The key point of Proposal 1 is to introduce a new candidate value of UE capability so that UE vendors can provide some new types of advanced smart phones, which is more powerful than the current commercial smart phones. All the configuration mechanisms and transmission schemes are reusing existing ones. That is to say, no new mechanism/scheme/feature is introduced. ***Observation 5: Proposal 1 doesn’t introduce any new NR feature(s). That is to say, the smart phone will reuse NR existing mechanisms/schemes.*** During the last meetings, some companies suggested RAN4 work for this TEI. As we discussed above, the smart phone will reuse NR existing mechanisms/schemes. In our views, whether/how any RAN4 work is needed or not for legacy NR mechanism/schemes is a separate discussion. For example, for a UE with 8Rx and with up to 8-layer DL MIMO, RAN4 only defined requirements for 1/2/4/8-layer DL transmission, and not defined requirement for other layers. From the perspective of cross-WG collaboration procedure, RAN1 should not enforce RAN4 to define the requirements for some specific feature or capability. ***Observation 6: Whether/how any RAN4 work is needed or not for legacy NR mechanism/scheme/feature is a separate discussion. It is up to RAN4.***  |
| [4] | In the current UE capability signalling maxNumberMIMO-layersPDSCH for DL MIMO, there is an unnecessary limitation. * The allowed values for maxNumberMIMO-layersPDSCH are {twoLayers, fourLayers, eightLayers} where sixLayers are missing. Given that there is no product on market to support more than fourLayers for DL MIMO, the caveat is not a problem for now. But in the future, this is a problem for UE vendors to build new devices beyond 4 layers, because the new devices have to support up to 8 layers directly. It is quite challenging to build device which improves from supporting max of 4 layers to max of 8 layers directly. It is beneficial, from both market demand and UE implementation perspective, to allow UE vendors improve devices from max of 4 layers to max of 6 layers, then to max of 8 layers.

To address the limitation, a very simple proposal is made, which is adding value 6 in the candidate value list of maxMIMO-LayersPDSCH. In RAN1#112, several companies mentioned there is RAN4 impact due to this proposal. However, one should notice that there is RAN4 impact for other TEI proposal as well. To way to avoid RAN4 impact in Rel-18, for the following agreed TEI proposal in RAN#112 is simply adding a note “Not to define RAN4 RRM requirement, including core/performance in Rel-18”, as in the following agreement. Similar approach can be adopted for this TEI proposal on maxNumberMIMO-layersPDSCH.

|  |
| --- |
| **Agreement*** Introduce 1-symbol PRS with legacy comb sizes.
	+ UE expects the suitable expected RSTD windows provided by LMF such that peak ambiguity is addressed. Otherwise no measurement accuracy requirements are expected to be met.
	+ Not to define RAN4 RRM requirement, including core/performance in Rel-18
	+ Send an LS to RAN2 and RAN3 to ask necessary signalling enhancements
 |

With the above analysis, we make the following proposal. Proposal 2: Add a new UE capability of maxMIMO-LayersPDSCH-r18 with candidate values {2,4,6,8}.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Description** | **Per** |  | **Candidate values** |
| **maxMIMO-LayersPDSCH-r18** | **Supported maximum number of DL MIMO layers** | **FSPC** |  | **{2,4,6,8}** |

**Note: Not to define RAN4 requirements for maxMIMO-LayersPDSCH-r18=6, including core/performance in Rel-18.**  |

This TEI proposal has been proposed and discussed in the last RAN1 meeting, and the discussion at the RAN1#113 meeting is shown below [5].

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| Qualcomm | Y |  |
| Moderator |  | This proposal meets the condition of support by at least 1 operator, 1 infra vendor and 1 UE vendor.This proposal has been extensively discussed in previous RAN1 meetings but could not achive any consensus.Moderator does not think further discussion in this document can make progress.Proponents are encouraged to discuss with objecting companies whether we can make any progress.  |
| Moderator |  | No conclusion in this meeting |

 |

Based on the above contribution, following TEI proposal, which is the latest one in the last meeting, can be discussed in RAN1#114 meeting.

### **(closed)TEI proposal #1**

* **Introduce a new candidate value, sixLayers, for the UE capability of supported maximal number of DL MIMO layers to support up to 6-layer DL MIMO transmission**
	+ **Prerequisite feature group is FG 2-1**
	+ **“Need for gNB to know whether the feature is supported by the UE” is “Yes”**
	+ **Reporting type is per FSPC**
	+ **“Mandatory/Optional” is Optional with capability signalling**
	+ **Note: R15 NR has already supported the candidate values of twoLayers, fourLayers and eightLayers via the RRC parameter MIMO-LayersDL ::= ENUMERATED {twoLayers, fourLayers, eightLayers}. It’s up to RAN2 for the signaling design of the corresponding UE capability.**
	+ **Send an LS to RAN2 for necessary signalling design**

This proposal is already supported by OPPO, CMCC, China Telecom, NTT DOCOMO, Lenovo, China Unicom, Qualcomm.

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

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| Moderator |  | This proposal was discussed in Monday onlince session but could not achive any consensus. As per RAN1 chair’s guidance, no more discussion is expected in Rel-18. |
| (Closed) |  |  |

* 1. PUSCH repetition type A for a PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI

Following proposal is made in the contribution.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [2] | **Background**In Rel-17 CE SI, most UL channels are identified as the coverage bottleneck channels in many scenarios, e.g., Rual 700MHz FDD NLOS O2I scenario. Up to Rel-17, PUSCH repetition Type A is supported when transmitting PUSCH scheduled by a grant among the following cases. * DCI format 0\_1 or 0\_2 in PDCCH with CRC scrambled with C-RNTI, MCS-C-RNTI, or CS-RNTI with NDI=1;
* RAR UL grant, i.e., Msg3 initial transmission;
* DCI format 0\_0 with CRC scrambled by TC-RNTI, i.e., Msg3 re-transmission.

In Rel-18, PRACH repetition and repetition of PUCCH carrying Msg4 HARQ-ACK will be further supported. PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI is one important channel left that does NOT support repetition transmission. In this contribution, the coverage performance of PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI, e.g., Msg5 PUSCH, is evaluated. And potential issues and corresponding mechanisms to support Msg5 PUSCH repetition are also discussed.**Coverage analysis**As shown in Figure-1, after a UE performing 4-step RACH procedure, the network would schedule Msg5 PUSCH transmission to complete the RRC setup. Typically, the network performs the first RRC reconfiguration according to the UE capability information. Before the UE capability is reported, some functions that need to be determined based on the UE capability cannot be configured. Therefore, before the first *RRCReconfiguration* message is received, DCI formats other than format 0\_0 cannot be used for UL scheduling. So, Msg5 PUSCH, which is scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI, cannot be scheduled with repetition. ***Observation 1****: Msg5 PUSCH, which is scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI, is the only uplink channel does not support repetition transmission after a UE performing 4-step RACH procedure in Rel-18.* Figure-1: Higher layer procedure for a UE accessing the networkIt is observed that Msg5 transmission is the coverage bottleneck according to the real filed test. The situation would get worse when repetition transmission of PRACH/Msg3/Msg4 HARQ-ACK is enabled. This is because more UEs would access to the network after the RACH procedure while congested during Msg5 transmission. ***Observation 2****:* *Msg5 PUSCH is the coverage bottleneck according to the real filed test.*Msg5 PUSCH is now one of the few UL channels does not support repetition transmission in Rel-18. However, it may have even worse coverage than some other UL channels (e.g., Msg3 PUSCH according to the evaluation below). Therefore, no support of Msg5 PUSCH repetition would jeopardize the commercialization of other Rel-17 and Rel-18 coverage related features, especially for repetition based features including the ones for NTN. ***Observation 3****:* *No support of Msg5 PUSCH repetition would jeopardize the commercialization of other Rel-17 and Rel-18 coverage* *enhancement related features in both TN and NTN scenarios.*To further evaluate the transmission performance of the Msg5 PUSCH, some link-level simulations are performed. Regarding the information carried by the Msg5 PUSCH, the packet size is assumed as 118 Bytes, which contains *RRCSetupComplete* (~102 Bytes), potential PHR and BSR (10 Bytes), and sub-layer (including, PDCP, RLC and MAC) header overhead (6 Bytes). In our evaluation, TDD frame structure ‘DDDSU DDSUU’ with 30kHz SCS is used in the simulation. The other detail simulation assumptions can be found in the Appendix. In the simulation, the Msg5 PUSCH transmission performances under different maximum transmission times are evaluated. For example, ‘Msg5 with max 2 (re-)transmissions’ represents that there are at most 2 transmissions for Msg5 PUSCH, including initial transmission and one retransmission. The performance of Msg3 PUSCH transmissions with different repetition factors (i.e., 1, 2, 4 and 8) are taken as baseline. The simulation results are showed in Figure-2 and Table-1. Figure-2: Performance for Msg3 and Msg5 PUSCH transmissionTable-1: Performance for Msg3 and Msg5 at BLER = 0.1

|  |  |  |
| --- | --- | --- |
| Simulation cases | Target SNR (dB) w/o power normalization | Target SNR (dB) w/ power normalization to one PRB |
| Msg3 without repetition | -7.31 | -4.3 |
| Msg3 with 2 repetitions | -11.27 | -8.26 |
| Msg3 with 4 repetitions | -13.67 | -10.66 |
| Msg3 with 8 repetitions | -15.91 | -12.9 |
| Msg5 with max 2 (re-)transmissions | -9.21 | 5.84 |
| Msg5 with max 4 (re-)transmissions | -10.25 | 4.8 |
| Msg5 with max 8 (re-)transmissions | -11.18 | 3.87 |

According to the above simulation results, significant performance gap can be observed between Msg5 PUSCH and Msg3 PUSCH, even though HARQ re-transmissions are enabled for Msg5 PUSCH while not for Msg3 PUSCH. It means that Msg5 PUSCH has more severe coverage issue than Msg3 PUSCH and therefore is the coverage bottleneck. ***Observation 4****: The performance gap between Msg5 PUSCH transmission and Msg3 PUSCH transmission is large, which is summarized in the following table.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Performance gap(dB) between Msg5 and Msg3 at BLER = 0.1*  | *Msg3 without Repetition* | *Msg3 with 2 Repetitions* | *Msg3 with 4 Repetitions* | *Msg3 with 8 Repetitions* |
| *Msg5 with max 2 (re-)transmissions* | *>10* | *>10* | *>15* | *>15* |
| *Msg5 with max 4 (re-)transmissions* | *9.1* | *>10.* | *>15* | *>15* |
| *Msg5 with max 8 (re-)transmissions* | *8.17* | *>10* | *>10* | *>15* |

During RAN1#112 meeting, RLC segmentation is proposed by some companies to improve Msg5 PUSCH coverage. However, the layer 2 header overhead increases significantly with the increase of the number of segmentations. For each segmented packet, an RLC header with 4 Bytes and a MAC header with 2 Bytes will be additionally added and a PDCP header with 2 Bytes is shared by all segmented packet. While for PUSCH repetition, there are always 6 bytes header overhead for each repetition transmission. The payload size of Msg5 is much larger than Msg3. If segmentation is used, more than 10 segmentations are required to approach similar payload size as Msg3. Then, as given in Table-2, the ratio of layer 2 header overhead would reach 46.7% and 63.4% for 16 and 32 segmentations respectively, making it an unfeasible solution in reality. Table-2: Layer 2 header overhead for Msg5 PUSCH transmission w/ or w/o segmentation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of segmented packets (N) | Size of data (excluding header overhead) | Layer 2 header overhead | Payload size of each packet after segmentation | Ratio of layer 2 header overhead |
| 1 (repetition or w/o segmentation) | 112 Bytes | 2 (PDCP header) + 2 (RLC header) + 2 (MAC header) = 6 Bytes | 118 Bytes | 5.1% |
| 2 | 112 Bytes | 2 (PDCP header) + 4\*N (RLC header) + 2\*N (MAC header) = 14 Bytes | 63 Bytes | 11.1% |
| 4 | 112 Bytes | 26 Bytes | 35 Bytes | 18.8% |
| 8 | 112 Bytes | 50 Bytes | 21 Bytes | 30.9% |
| 16 | 112 Bytes | 98 Bytes | 14 Bytes | 46.7% |
| 32 | 112 Bytes | 194 Bytes | 10 Bytes | 63.4% |

***Observation 5****: If segmentation is used, more than 10 segmentations are required to approach similar packet size as Msg3. The layer 2 header overhead increases significantly (e.g., 46.7% for 16 segmentations, 63.4% for 32 segmentations), making it an undesirable solution in reality.* In addition, similar to other PUSCH channels supporting repetition, using a larger TBS without segmentation can provide better performance in terms of large encoding gain and small high layer overhead. This is also the reason why TBoMS transmission is supported in Rel-17 for PUSCH scheduled by DCI format 0\_1/0\_2. ***Observation 6****: Similar to other PUSCH channels supporting repetition or TBoMS, PUSCH transmission with less segmentation can provide better performance in terms of large encoding gain and small high layer overhead.* Except for Msg5, similar coverage issue could be observed for a PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI even after UE capability reporting. Thus, we propose to support PUSCH repetition type A for a PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI. ***Proposal 1****: Support PUSCH repetition type A for a PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI.* **Proposed enhancement**Both Msg5 PUSCH and Msg3 retransmission are scheduled by DCI format 0\_0, and the only difference is the RNTIs used. That is, TC-RNTI is used to scramble CRC of the DCI format for Msg3 retransmission scheduling, while C-RNTI is used for Msg5 PUSCH. For simplicity, similar repetition mechanism can be reused to support Msg5 PUSCH repetition, and the standardization effort would be limited. In this context, we can consider the following solution for support of PUSCH repetition type A for a PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI. * For the transmission schemes, reuse the same approach as Msg3 re-transmission which is scheduled by DCI format 0\_0 with CRC scrambled by TC-RNTI, including repetition indication, RV determination, available slot determination and frequency hopping etc.
* During initial access, a UE can request repetition transmission for PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI via a higher layer signaling in Msg3 PUSCH, e.g., reserved LCID codepoints or reserved bit(R) in the MAC subheader.
* Alternatively, using separate PRACH resources for the request can also be considered, while this would result in further PRACH partition and therefore not preferred.
* Similar mechanism has been agreed/discussed in several Rel-18 topics,
* It has been agreed in RAN2 in RAN2#121 that the early indication for Rel-18 eRedCap is included in Msg3/MsgA PUSCH; More specifically, it is agreed in RAN2#122 to use LCID values to support Msg3 early identification for all Rel-18 eRedCap UEs.
* Regarding PUCCH repetition for Msg4 HARQ-ACK, the following working assumption of using a higher layer signaling in Msg3 PUSCH to carry the repetition request or capability report was achieved in Rel-18 NTN WI. As described in the related LS [4] to RAN2, the WA will be confirmed if Option B is feasible from RAN2 perspective.

|  |
| --- |
| Working assumptionFor PUCCH repetition for Msg4 HARQ-ACK, support Option B as container of the repetition request or capability report indicated by UE.* Option B: Higher layer signaling in Msg3 PUSCH

Send an LS to RAN2 to ask the feasibility of Option B, and if feasible, to specify the details of Option B. |

***Proposal 2****: For support of PUSCH repetition type A for a PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI, adopt the following solution.* * *For the transmission schemes, reuse the same approach as Msg3 re-transmission which is scheduled by DCI format 0\_0 with CRC scrambled by TC-RNTI, including repetition indication, RV determination, available slot determination and frequency hopping etc.*
* *During initial access, a UE can request repetition transmission for a PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI via a higher layer signaling in Msg3 PUSCH.*
* *Send an LS to RAN2 ask the feasibility, and if feasible, to specify the details.*
* *Note: For early identification of Rel-18 eRedCap and PUCCH repetition for Msg4 HARQ-ACK in Rel-18 NTN, using higher layer signaling in Msg3 PUSCH is the current working assumption.*
 |

This TEI proposal has been proposed and discussed in the last RAN1 meeting, and the discussion at the RAN1#113 meeting is shown below [5].

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| DCM | Y ~~(w/ comment)~~ | We are supportive of this proposal at least for handheld UE support in NR NTN, which is discussed in R18 NR NTN WI. R18 NR NTN does not touch this PUSCH coverage on top of assumption that repetition is applicable. However now it is not the case, thus this way should be supported.~~Regarding the details, we are not sure whether the 2~~~~nd~~ ~~bullet is necessary. gNB can know UL performance level based on RX of Msg1/Msg3/Msg4 HARQ-ACK by its implementation. Further request signaling would not be beneficial for gNB side.~~ (Based on offline discussion with ZTE, now we understand the necessity of the 2nd bullet and thus the current proposal is fine for us.) |
| CATT | N | It seems becoming a weird case that PUSCH scheduled by C-RNTI DCI format 0\_0 will use available slot counting (Msg5, without capability report?) firstly and then can only use physical slot counting (other PUSCH, even if R17 available counting capability is reported). Spec impact may not be small. |
| MediaTek | N | After 2 Releases of discussion, this was not identified as a bottleneck. We have also not observed issues in the field here. Also it would seem to require a re-design of initial access to allow the NW to be aware and configure such repetitions, which seems quite some effort. If companies believe this needs to be addressed we would happy to study it in Rel-19. |
| Moderator |  | This proposal meets the condition of support by at least 1 operator, 1 infra vendor and 1 UE vendor.This proposal has been extensively discussed in previous RAN1 meetings but could not achive any consensus.Moderator does not think further discussion in this document can make progress.Proponents are encouraged to discuss with objecting companies whether we can make any progress.  |
| Moderator |  | No conclusion in this meeting |

 |

Based on the above contribution, following TEI proposal can be discussed in RAN1#114 meeting.

### **(closed)TEI proposal #2**

* **Support PUSCH repetition type A for a PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI.**
	+ **For the transmission schemes, reuse the same approach as Msg3 re-transmission which is scheduled by DCI format 0\_0 with CRC scrambled by TC-RNTI, including repetition indication, RV determination, available slot determination and frequency hopping etc.**
	+ **During initial access, a UE can request repetition transmission for a PUSCH scheduled by DCI format 0\_0 with CRC scrambled by C-RNTI via a higher layer signaling in Msg3 PUSCH.**
		- **Send an LS to RAN2 to ask the feasibility, and if feasible, to specify the details of the request.**
		- **Note: For early identification of Rel-18 eRedCap and PUCCH repetition for Msg4 HARQ-ACK in Rel-18 NTN, using higher layer signaling in Msg3 PUSCH is the current working assumption.**

This proposal is already supported by ZTE, China Telecom, Sanechips, NTT DOCOMO.

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

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| Ericsson | N | We would like to further discuss. It may be good to have this general support of repetition with DCI 0\_0, but reusing the Msg3 repetition design for beyond Msg3 may not be desirable. Moreover, we wonder if this really fits in a TEI, and should instead be handled in a Rel-19 WI, as we think some companies propose. |
| Moderator |  | This proposal was discussed in Monday onlince session but could not achive any consensus. As per RAN1 chair’s guidance, no more discussion is expected in Rel-18. |
| (Closed) |  |  |

* 1. Enhanced PDCCH reception for mDCI based mTRP

Following proposal is made in the contribution.

|  |  |
| --- | --- |
| [4] | Multi-DCI based multi-TRP is specified in Rel-16 with the following relevant features:* Two PDSCHs associated with different *coresetPoolIndex* values can be partially/fully overlapping in time in the same CC
	+ The max number of PDSCH per slot (in TDM manner) is defined per *coresetPoolIndex*, which can be indicated by UE capability.
* For PDCCH monitoring in multi-DCI based multi-TRP, the following are supported:
	+ The maximum number of CORESETs per BWP is increased to 5 CORESETs, with a maximum of 3 CORESETs per *coresetPoolIndex* value.
	+ The maximum number of BDs / CCEs is doubled subject to UE capability, with a limit per *coresetPoolIndex* value that is same as a single-TRP CC.

Furthermore, in Rel-18, it is agreed that two PUSCHs associated with different *coresetPoolIndex* values can be partially/fully overlapping in time in the same CC (for simultaneous transmission in MIMO AI).In order for the network to schedule overlapping PDSCHs / PUSCHs, the two TRPs need to transmit the two corresponding DCIs in any scheduling instance (e.g., in any slot or PDCCH monitoring occasion). As discussed above, the PDCCH monitoring capabilities (number of BDs / CCEs) are also enhanced accordingly. However, the following two issues make it practically infeasible for UE to receive two DCIs at the same time (issue 1 for FR2) or even in the same slot / PDCCH monitoring occasion (issue 2):* **Issue 1**: This issue is related to QCL-TypeD prioritization for overlapping CORESETs, which is specific to FR2. Based on the procedure defined in 38.213 Section 10.1, the UE selects one CORESET (based on a priority rule), and only that CORESET and other CORESETs with the same QCL-TypeD priorities are monitored when multiple CORESETs overlap in time.
	+ During the maintenance phase of Rel-16, extending this rule for multi-DCI based mTRP (to make it per TRP) was discussed. Such discussions were postponed with the understanding that Rel-17 can potentially address the issue. However, Rel-17 only enhanced this QCL-TypeD prioritization rule for the case of PDCCH repetition and for the case of SFN PDCCH, but it was not extended for the case of multi-DCI based multi-TRP.
* **Issue 2**: Even though the number of BDs / CCEs that the UE monitors is doubled (and number of CORESETs is increased to 5) in Rel-16, the capability to process DL DCIs or UL DCIs was not extended accordingly. That is, the UE can only monitor more PDCCH candidates, but cannot actually receive and process more DCIs.
	+ For basic PDCCH capability (FG 3-1), the UE can process one DL DCI and one UL DCI per slot for FDD, and one DL DCI and two UL DCIs per slot for TDD.
	+ For more advanced PDCCH monitoring capabilities such as FG 3-5a or FG 3-5b, the number of DL DCIs or UL DCIs that the UE can process is defined per PDCCH monitoring occasion or per PDCCH span. For these advanced PDCCH monitoring capabilities, it is possible to receive more than one DL DCI and more than one UL DCI per slot, but there is additional complexity associated with PDCCH monitoring as well.
	+ In either case, the max number of DL DCIs or UL DCIs is not extended accordingly for the case of multi-DCI based multi-TRP.
	+ Hence, in order to be able to receive DCIs from different TRPs in a slot in the case of multi-DCI based multi-TRP, the UE has to support one of these advanced UE capabilities, which is not reasonable. This can be a barrier for wide deployment of this feature. Effectively, the larger number of BDs / CCEs specified in Rel-16 for multi-DCI based multi-TRP cannot be utilized in practice to actually transmit more DL / UL DCIs from the two TRPs.

These two issues result in inefficient operation of multi-DCI based multi-TRP feature as they impose unnecessary restrictions on transmissions of DCIs from corresponding TRPs. Observation 1: Multi-DCI based multi-TRP operation based on existing specifications suffers from the following two issues:* **Issue 1: Existing QCL-TypeD prioritizations for overlapping CORESETs does not allow the UE to monitor PDCCHs with different beams from corresponding TRPs on the same / overlapping OFDM symbols.**
* **Issue 2: Even though the PDCCH monitoring capabilities (number of BDs / CCEs) are increased for multi-DCI based multi-TRP, the capability related to number of DL/UL DCIs that the UE can actually receive and process is not enhanced correspondingly.**

To address Issue 1, we propose to perform the legacy QCL-TypeD prioritization rules separately for *coresetPoolIndex* value 0 and for *coresetPoolIndex* value 1. An example of the change needed in 38.213 Section 10.1 is shown in the following TP:====TP for 38.213 Section 10.1 ==================================-----------------------Unchanged part omitted----------------------If a UE - is configured for single cell operation or for operation with carrier aggregation in a same frequency band, and- monitors PDCCH candidates in overlapping PDCCH monitoring occasions in multiple CORESETs that have been configured with same or different *qcl-Type* set to 'typeD' properties on active DL BWP(s) of one or more cellsthe UE monitors PDCCHs only in a CORESET, and in any other CORESET from the multiple CORESETs that have been configured with *qcl-Type* set to same 'typeD' properties as the CORESET, on the active DL BWP of a cell from the one or more cells - the CORESET corresponds to the CSS set with the lowest index in the cell with the lowest index containing CSS, if any; otherwise, to the USS set with the lowest index in the cell with lowest index- the lowest USS set index is determined over all USS sets with at least one PDCCH candidate in overlapping PDCCH monitoring occasionsIf a UE - is not provided *coresetPoolIndex* for first CORESETs, or is provided *coresetPoolIndex* with value 0 for first CORESETs, and - is provided *coresetPoolIndex* with value 1 for second CORESETs, and- is provided [*twoQCLTypeDforMulti-DCI*]the UE applies procedures described above independently across the first CORESETs and the second CORESETs.-----------------------Unchanged part omitted----------------------==========================================================To address issue 2, we propose to introduce a UE capability that can indicate the UE can process more DL / UL DCIs for a CC that is configured with two *coresetPoolIndex* values. Such capability may be separately indicated for DL DCI versus UL DCI. Also, this capability may explicitly indicate a number of DL/UL Dis that the UE can monitor, or can simply indicate that the number of DL/UL DCIs per *coresetPoolIndex* for the CC is the same as the number of DL/UL DCIs for a CC that is not associated with two *coresetPoolIndex* value (which is determined based on legacy UE capabilities). These details can be discussed as part of Rel-18 UE capability sessions. Proposal 1: For multi-DCI based multi-TRP operation, support the following:* **QCL-TypeD prioritization rules for overlapping CORESETs is performed per *coresetPoolIndex* value. The TP above can be used for this purpose.**
* **Introduce a UE capability that can indicate the UE can process more DL / UL DCIs for a CC that is configured with two *coresetPoolIndex* values.**
	+ **The details include whether separate FGs are needed for DL DCIs versus UL DCIs can be discussed in Rel-18 UE feature sessions.**
 |

This TEI proposal has been proposed and discussed in the last RAN1 meeting, and the discussion at the RAN1#113 meeting is shown below [5].

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| Qualcomm | Y |  |
| MediaTek | N | We question the real value of this proposal compared to the flexibility already in the specifications today, so we do not support its inclusion. We wonder how critical this is if not important enough to be proposed in the MIMO WI scope discussion. |
| Moderator |  | This proposal does not meet the condition of support by at least 1 operator, 1 infra vendor and 1 UE vendor.Once sufficient support from those companies is achieved, this proposal can be discussed at Thursday online. |
| Moderator |  | No conclusion in this meeting |

 |

Based on the above contribution, following TEI proposal can be discussed in RAN1#114 meeting.

### **TEI proposal #3**

* **For multi-DCI based multi-TRP operation, support the following:**
	+ **QCL-TypeD prioritization rules for overlapping CORESETs is performed per coresetPoolIndex value.**
		- **Adopt following TP in Clause 10.1 in TS 38.213.**

|  |
| --- |
| --Unchanged part omitted------------------------If a UE - is configured for single cell operation or for operation with carrier aggregation in a same frequency band, and- monitors PDCCH candidates in overlapping PDCCH monitoring occasions in multiple CORESETs that have been configured with same or different *qcl-Type* set to 'typeD' properties on active DL BWP(s) of one or more cellsthe UE monitors PDCCHs only in a CORESET, and in any other CORESET from the multiple CORESETs that have been configured with *qcl-Type* set to same 'typeD' properties as the CORESET, on the active DL BWP of a cell from the one or more cells - the CORESET corresponds to the CSS set with the lowest index in the cell with the lowest index containing CSS, if any; otherwise, to the USS set with the lowest index in the cell with lowest index- the lowest USS set index is determined over all USS sets with at least one PDCCH candidate in overlapping PDCCH monitoring occasionsIf a UE - is not provided *coresetPoolIndex* for first CORESETs, or is provided *coresetPoolIndex* with value 0 for first CORESETs, and - is provided *coresetPoolIndex* with value 1 for second CORESETs, and- is provided [*twoQCLTypeDforMulti-DCI*]the UE applies procedures described above independently across the first CORESETs and the second CORESETs.--Unchanged part omitted------------------------ |

* + **Introduce a UE capability that can indicate the UE can process more DL / UL DCIs for a CC that is configured with two coresetPoolIndex values.**
		- **The details include whether separate FGs are needed for DL DCIs versus UL DCIs can be discussed in Rel-18 UE feature sessions.**

This proposal is already supported by Qualcomm.

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

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| Moderator |  | This proposal was discussed in Monday online session but could not achieve consensus.As per RAN1 chair’s guidance, this proposal will be quickly checked in the 2nd online session (probably on Thursday). Proponent is encouraged to address the concern from companies provided during Monday online (e.g., limit to 1st sub-bullet). |
|  |  |  |
|  |  |  |

* 1. Enhancement for scheduling request

Following proposal is made in the contribution.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [4] | In Rel-17, when PDCCH skipping is configured for a UE, it is allowed that an SR transmission from the UE during a PDCCH skip duration can override the previous PDCCH skipping indication and the UE resumes PDCCH monitoring. The underlying principle of this behavior is that, when an SR is pending at the UE during a PDCCH skip duration, the network can realize it only after receiving an SR transmission from the UE. By terminating PDCCH skipping after the SR transmission, the UE and network do not need to wait until the end of the indicated PDCCH skip duration and, thus, a latency benefit is achieved.In addition to PDCCH skipping, search space set group (SSSG) switching, which is another UE power saving feature for licensed band, has been introduced in Rel-17. For example, when a UE is configured with two SSSGs, the first SSSG may be configured with frequent PDCCH monitoring, while the second SSSG may be configured with sparse PDCCH monitoring. In a heavy traffic situation, the UE may be indicated to monitor PDCCH according to the first SSSG. Otherwise, for UE power saving, the UE may be indicated to monitor PDCCH according to the second SSSG. If an SR is pending while the UE is monitoring PDCCH according to the first (i.e., dense) SSSG, the UE would receive a PDCCH scheduling an UL transmission quite soon after the SR transmission. However, if the UE is monitoring PDCCH according to the second (i.e., sparse) SSSG, the next PDCCH monitoring occasion would be quite far apart from the SR occasion, and the latency of the first PUSCH transmission after the SR may increase. Furthermore, after the UE transmits a BSR on the first PUSCH, it will expect additional UL grants to clear out the buffer, if the first UL grant is not large enough. Thus, unless the UE is indicated to switch to the first SSSG by the PDCCH carrying the first UL grant, the latency for the entire UL traffic burst would increase.To address the UL latency issue, the feature of SR overriding (SRO) for PDCCH skipping should be extended for SSSG switching. That is, in order not to delay the UL transmission, it should be allowed that an SR transmission overrides SSSG switching, as well as PDCCH skipping.To show the impact of SRO to the latency, we conducted system-level performance evaluation. We assumed three different PDCCH monitoring adaptation schemes: 1) Rel-17 PDCCH skipping, 2) Rel-17 SSSG switching, and 3) Rel-17 SSSG switching with SRO. Note that, for 1), SRO is already supported, while, for 2), SRO is not supported. The PDCCH monitoring adaptation schemes were assumed to be triggered by the last scheduling DCIs before the DL buffer is flushed. For each scheme, we tried different configurations as described in Table 1 to show the trade-off between the power saving gain and the latency. For the traffic model, we assumed an interactive web-browsing traffic model, which consists of both DL and UL traffics.In Figure 4‑1, the relationship between the power saving gain over the baseline and the latency is shown for the three PDCCH monitoring adaptation schemes. In Figure 4‑1 (a), it is observed that, at the same power saving gain, SRO significantly improves the UL latency of SSSG switching. Also, with SRO, SSSG switching achieves the same power saving gain vs. latency trade-off as PDCCH skipping. Interestingly, in Figure 4‑1 (b), it is observed that SRO can also improve the DL latency of SSSG switching. Since the assumed web-browsing traffic model is interactive, an UL transmission may trigger a follow-on DL transmission and vice versa. Thus, SSSG switching by SRO primes the network for the subsequent DL transmissions and reduces the DL latency. Table 1: Configurations of PDCCH monitoring adaptation schemes.

|  |  |  |
| --- | --- | --- |
| Power saving | PDCCH skipping | SSSG switching (both with and w/o SRO) |
| Baseline | PDCCH monitoring in every slot (No skipping/SSSG switching) |
| Scheme 1 | PDCCH skipping for 5 ms | Switching to SSSG with 5 ms PDCCH monitoring periodicity |
| Scheme 2 | PDCCH skipping for 10 ms  | Switching to SSSG with 10 ms PDCCH monitoring periodicity  |
| Scheme 3 | PDCCH skipping for 20 ms  | Switching to SSSG with 20 ms PDCCH monitoring periodicity  |
| Scheme 4 | PDCCH skipping for 30 ms  | Switching to SSSG with 30 ms PDCCH monitoring periodicity  |

|  |  |
| --- | --- |
| (a) | (b) |

Figure 4‑1: Power saving gain vs. latency: (a) uplink latency, (b) downlink latency.**Proposal 3: If a UE is indicated to monitor PDCCH according to search space sets with a group index other than a designated index, the UE stops PDCCH monitoring according to search space sets with the group index and start PDCCH monitoring according to search space sets with the designated group index from the first slot that is at least symbols after the last symbol of a PUCCH carrying an SR.** |

This TEI proposal has been proposed and discussed in the last RAN1 meeting, and the discussion at the RAN1#113 meeting is shown below [5].

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| Qualcomm | Y |  |
| CATT | N | The PDCCH monitoring could be configured by the network with short periodicity in one of the SSSG if SR latency is the concern.  |
| MediaTek | N | The interaction between PDCCH skipping and pending SR has been enhanced to reduce SR latency in RAN1 #112 (under agenda 8.7). It is questionable how much gain can be further achieved. |
| Moderator |  | This proposal does not meet the condition of support by at least 1 operator, 1 infra vendor and 1 UE vendor.Once sufficient support from those companies is achieved, this proposal can be discussed at Thursday online. |
| Ericsson | Y | Continue to support the proposal. |
| Huawei, HiSilicon | N | The PDCCH monitoring periodicity of a SSSG can be configured properly. Also in Rel-17, it allows to configure three SSSGs with different granularity of SSSG monitoring periodicity. No reason to have this TEI. |
| Moderator |  | No conclusion in this meeting |

 |

Based on the above contribution, following TEI proposal can be discussed in RAN1#114 meeting.

### **TEI proposal #4**

* **If a UE is indicated to monitor PDCCH according to search space sets with a group index other than a designated index, the UE stops PDCCH monitoring according to search space sets with the group index and start PDCCH monitoring according to search space sets with the designated group index from the first slot that is at least symbols after the last symbol of a PUCCH carrying an SR.**

This proposal is already supported by Qualcomm.

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

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| Moderator |  | This proposal was discussed in Monday online session but could not achieve consensus.As per RAN1 chair’s guidance, this proposal will be quickly checked in the 2nd online session (probably on Thursday). Proponent is encouraged to address the concern from companies provided during Monday online. |
|  |  |  |
|  |  |  |

* 1. Further complexity reductions for FR2 RedCap

Following proposal is made in the contribution.

|  |  |  |  |
| --- | --- | --- | --- |
| [1] | In Rel-17, we defined complexity reduction solutions for both FR1 and FR2, i.e., not limited in FR1, as there are cost/complexity reduction requirements in FR2 scenarios. However, with Rel-17 solutions (e.g., 100MHz BW), the supported maximum data rate of an FR2 RedCap UE is around 400 Mbps. This kind of peak rate is still high for some indoor RedCap cases (e.g., industry AGV, etc.). In order to enlarge the RedCap market for FR2, and to avoid subsequent standalone enhancement for FR2 in the next release, further complexity reduction for FR2 can be considered in Rel-18 TEI phase. ***Proposal 1: Specify further complexity reductions for FR2 RedCap in Rel-18 TEI phase.***In Rel-18, among all the discussed solutions in SI/WI phase, standalone PR1 (i.e., relaxation of the constraint (*vLayers*·*Qm*·*f* ≥ 4) for peak data rate reduction without UE BB bandwidth reduction) is a suitable candidate solution for FR2. The expected impacts would be very small. In order to define a relaxed constraint, a suitable target peak rate for FR2 should be confirmed first. In our understanding, the target peak rate for FR2 can be [100Mbps or 50Mbps], and then the constraint for FR2 can be relaxed from 4 to [1.5 or 0.8]. Similar to FR1, [100Mbps or 50Mbps] can be the only target peak rate.***Proposal 2: For UE peak data rate reduction in FR2, the target peak data rate is [100Mbps or 50Mbps].*** ***Proposal 3: The [100Mbps or 50Mbps] peak rate target corresponds to a vLayers*·*Qm*·*f of [1.5 or 0.8].***The expected spec impacts would be very small, including the following:* **38.306: constraint relaxation**

Similar to that of UE peak data rate reductions in FR1, a simple note for constraint relaxation in FR2 is required, e.g., “For RedCap UE with reduced peak data rate in FR2, the component *vLayers*·*Qm*·*f* is [1.5 or 0.8]”

|  |
| --- |
| ----------------------------------------------- Start of the modifications -------------------------------------------4.1.2 Supported max data rate for DL/UL…For single carrier NR SA operation, the UE shall support a data rate for the carrier that is no smaller than the data rate computed using the above formula, with and component is no smaller than 4. NOTE 3: As an example, the value 4 in the component above can correspond to , and . Note 4: For RedCap UE with reduced peak data rate in FR2, the component is [1.5 or 0.8].…------------------------------------------------ End of the modifications ------------------------------------------ |

* **38.822: UE feature for FR2**

A UE feature is needed for FR2. Based on the agreed UE features for FR1 [2], the UE feature for FR2 can be easily constructed.For components part, the first component of FG28-1 is not needed. Based on our assumption of peak data rate (i.e., 100Mbps) for FR2, the components for FR2 eRedCap can be the following:

|  |
| --- |
| The following components are the same as for supportOfRedCap-r17 (28-1):~~1. Maximum FR1 RedCap UE bandwidth is 20 MHz.~~2. Maximum FR2 RedCap UE bandwidth is 100 MHz.3. Early indication of RedCap UE in Msg.1 for 4-step RACH4. Separate initial UL BWP for RedCap UEs- It includes the configuration(s) needed for RedCap UE to perform random access- Enabling/disabling of frequency hopping for common PUCCH resources5. Separate initial DL BWP for RedCap UEs- It includes CSS/CORESET for random access- For separate initial DL BWP used for paging, CD-SSB is included- For separate initial DL BWP only used for RACH, SSB may or may not be included- For separate initial DL BWP used in connected mode as BWP#0 configuration option 1, CD-SSB is included6. 1 UE-specific RRC configured DL BWP per carrier7. 1 UE-specific RRC configured UL BWP per carrier8. RRC reconfiguration of any parameters related to BWP9. UE-specific RRC configured DL BWP with CD-SSB or NCD-SSB10. NCD-SSB based measurements in RRC-configured DL BWPThe following components are new compared to supportOfRedCap-r17 (28-1):[11. DL/UL peak data rate target of 100 Mbps or 50Mbps] [12. *vLayers*·*Qm*·*f* =1.5 or 0.8] |

Similar to FR1, The indication type can be per UE. If this feature is not supported by the UE, the network assumes the UE is not a RedCap UE with reduced peak data rate in FR2. In addition, no need of FDD/TDD differentiation, and no need of FR1/FR2 differentiation as this feature is for FR2 only. This feature should be optional with capability signaling. The FG for FR2 is listed in the appendix. |

Based on the above contribution, following TEI proposal can be discussed in RAN1#114 meeting.

### **TEI proposal #5**

* **Specify further complexity reductions for FR2 RedCap**
	+ **For UE peak data rate reduction in FR2, the target peak data rate is [100Mbps or 50Mbps]**
	+ **The [100Mbps or 50Mbps] peak rate target corresponds to a *vLayers*·*Qm*·*f* of [1.5 or 0.8]**
	+ **Send an LS to RAN2 to ask to update TS 38.306 for the peak data rate reduction.**
	+ **FFS UE capability, to be discussed in RAN1**

This proposal is already supported by Spreadtrum.

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

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| Ericsson | N | We think this proposal can be considered in a future release. |
|  |  |  |
|  |  |  |

1. Reply LS to RAN2 on the support of longer CG-SDT periodicities

In the LS R1-2306387 from RAN2, RAN1 is requested to provide any necessary feedback or concerns on RAN1 impact regarding the longer CG-SDT periodicities than 640 ms, and following contributions have been submitted to RAN1#114.

|  |
| --- |
| R1-2306561 Discussion on LS on longer CG-SDT periodicities ZTER1-2306562 Draft Reply LS on longer CG-SDT periodicities ZTER1-2306707 Discussions on RAN2 LS on longer CG-SDT periodicities vivoR1-2306824 Discussion on LS for CG-PUSCH periodicity for SDT operation Intel CorporationR1-2307132 Discussion on reply LS on longer CG-SDT periodicities NECR1-2308125 On LS on longer CG-SDT periodicities EricssonR1-2308155 Draft reply LS on longer CG-SDT periodicities Huawei, HiSilicon |

Following potential RAN1 impacts are discussed in the contributions.

* Issue 1: Mapping between PUSCH configuration period and association period
	+ Analysis:
		- Current mapping table in Table 19.1-1 in TS38.213 includes up to 640 ms CG-SDT periodicity. If longer periodicities are introduced, the table needs to be updated.
			* ZTE, vivo, Intel, NEC, E///, HW/HiSi
* Issue 2: PDCCH monitoring periodicity
	+ Analysis:
		- RAN2 agreed to start the T319a only after the first transmission happens on the CG-SDT resource and hence the actual SDT session starts only after the first transmission happens and only lasts at most until T319a expires. Assuming that the 1st CG-SDT procedure starts at time t, after UE transmits CG-SDT in CG occasion, UE will keep monitoring PDCCH until the timer T319a expires, which can be denoted as t+T1. Within the T319a timer, the PDCCH monitoring behavior is exactly the same as legacy. If the CG periodicity is extended to minutes or hours, the 2nd CG-SDT procedure will be triggered at t+T2, and UE does not need to monitor PDCCH within the time interval [t+T1, t+T2], where T2 is much larger than T1(maximum 4s). Therefore, the extended CG periodicity does not have impact on PDCCH monitoring periodicity and UE consumption as long as T319a is not changed and it should be noted that RAN2 has no intention to extend T319a as part of this feature.



* + - * ZTE
* Issue 3: Starting position of association period
	+ Analysis:
		- Original start of association period SFN0 may need to be associated with a hyper frame indicator, so that UE can understand the exact start point of association period using {hyper SFN, SFN0}. In addition, the parameter *hyperSFN-r17* has already been included in SIB1 in Rel-17 for e-DRX with cycle larger than 10.24s, which can be reused for CG-SDT, then there is no ambiguity on the starting position of association period when introducing larger CG periodicities. In short, extending CG-SDT periodicity requires an update to the starting position of association period by reusing the existing RRC parameter *hyperSFN-r17*
			* ZTE
* Issue 4: Outdated power control parameters
	+ Analysis:
		- The UE will transmit according to the configured periodicity only if there is data to transmit in its buffer. Allowing the UE to skip - unconditionally - can lead to outdated power control parameters, especially for longer periodicities. This can be resolved by instructing UE to send something (e.g., dummy bits) in the next occasion after the maximum skips, even if it has no MO data to transmit. This does not have any RAN1 impacts. Also, the impact to RAN2 specifications is expected to be minimal.
			* E///

Based on the above analysis, all companies assume the RAN1 impact is small/marginal. Therefore, following proposal is made.

### **Proposal 3-1:**

* **Send a reply LS to RAN2 to inform that RAN1 confirms that extension of CG-SDT periodicities would have low impact on RAN1 specifications**

Companies are encouraged to check above proposal and to provide feedback if any in below. Companies are also invited to provide views on whether/which issues discussed as above should be included in the reply LS.

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| ZTE | Y | We support the proposal. Moreover, it’s enough to confirm that the extension of CG-SDT periodicities would have low impact on RAN1 spec, and we don’t need to mention detailed spec impact in the reply LS, it somehow depends on the exact values introduced by RAN2, which is up to RAN2’s decision. |
| Huawei, HiSi | Y | We support the proposal. |
| NEC | Y | We support the proposal. |
| Ericsson | Y | We support the proposal. |
| Moderator |  | All companies are fine with the proposal without mentioning detaild spec impact. Draft LS is prepared accordingly in the following folder./RAN/RAN1/Inbox/drafts/9.15(TEIs)/LSCompanies are encouraged to check the draft LS and provide comments, if any. |
| ZTE | Y | The draft LS looks good. Thanks for Moderator’s effort! |
|  |  |  |

1. Conclusion

To be updated

Reference

[1] R1-2306882 Rel-18 TEI on complexity reduction solutions for FR2 Spreadtrum Communications

[2] R1-2306988 On PUSCH repetition type A scheduled by DCI format 0-0 with CRC scrambled by C-RNTI ZTE, China Telecom, Sanechips, NTT DOCOMO, INC.

[3] R1-2307518 TEI on the introduction of a UE capability with up to 6-layer DL MIMO OPPO, CMCC, China Telecom, NTT DOCOMO, Lenovo, China Unicom

[4] R1-2307958 Rel-18 RAN1 TEI proposals Qualcomm Incorporated

[5] R1-2306242 Summary #2 on Rel-18 TEIs Moderator (NTT DOCOMO, INC.)

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

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

Appendix: TEI guidance in [7]

**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.