**3GPP TSG RAN WG1 #114bis R1-231nnnn**

**Xiamen, China, October 9th – 13th, 2023**

**Agenda item:** 8.16.16

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

**Title:** Summary on UE features for TEIs

**Document for:** Discussion and Decision

# **Introduction**

This document summarizes contributions submitted to AI 8.16.16 regarding UE features for TEIs.

According to the updated UE features list agreed in RAN1#114 [1], there are following feature groups for TEI18.

* FGs for additional periodicity of the scheduling request
	+ 55-1 additionalSR-Periodicities-r18
* FGs for 1-symbol PRS
	+ 55-2a 1-symbol PRS for MG-based measurement in RRC\_CONNECTED state
	+ 55-2b 1-symbol PRS for outside MG in RRC\_CONNECTED state
	+ 55-2c 1-symbol PRS in RRC\_INACTIVE state
	+ 55-2d 1-symbol PRS for PDC
* FGs for multi-PUSCH scheduling with single DCI
	+ 55-3 Multiple PUSCHs scheduling by single DCI for non-consecutive slots in FR1
* FGs for HARQ multiplexing for PDSCH scheduling after UL grant on PUSCH
	+ 55-4a Multiplexing Type-1 HARQ-ACK codebook for PDSCH scheduling after UL grant on PUSCH
	+ 55-4b Multiplexing Type-2 HARQ-ACK codebook for PDSCH scheduling after UL grant on PUSCH
	+ 55-4c Multiplexing Type-3 HARQ-ACK codebook for PDSCH scheduling after UL grant on PUSCH
	+ 55-4d Determining a different PUCCH resource to transmit HARQ-ACK for PDSCH scheduled after UL grant
	+ 55-4e Determining different codebook size to transmit HARQ-ACK for PDSCH scheduled after UL grant
* FGs for pathloss RS updates for Type 1 CG-PUSCH
	+ 55-5 Enable MAC CE based pathloss RS updates for Type 1 CG-PUSCH
* FGs for span-based PDCCH monitoring with additional restrictions
	+ 55-6 (2, 2) span-based PDCCH monitoring with additional restriction(s)

Also, according to the initial UE features lists from endorsed TEI proponent [2], there are following feature groups for TEI18.

* FGs for multi-DCI based multi-TRP
	+ 55-7 Two QCL TypeD for CORESET monitoring in multi-DCI based multi-TRP

# **FGs for HARQ multiplexing** **for PDSCH scheduling after UL grant on PUSCH**

In [1], FGs for HARQ multiplexing for PDSCH scheduling after UL grant on PUSCH are captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (Sidelink WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 55. TEI18 | 55-4a | Multiplexing Type-1 HARQ-ACK codebook for PDSCH scheduling after UL grant on PUSCH | 1. UE multiplexes Type-1 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where ACK/NACK is generated for the HARQ-ACK codebook including HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmission. FFS dependency between 55-4d/55-4e | 4-1, 4-11, one of {5-17, 11-5, 11-6} | Yes | N/A | UE does not support to multiplex Type-1 HARQ-ACK codebook on non-initial a PUSCH repetition when the Type-1 codebook includes HARQ-ACK information for PDSCH scheduling after a UL grant. | Per Band | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4b | Multiplexing Type-2 HARQ-ACK codebook for PDSCH scheduling after UL grant on PUSCH | 1. UE multiplexes Type-2 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where the HARQ-ACK codebook includes HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmission. FFS dependency between 55-4d/55-4e | 4-1, 4-10, one of {5-17, 11-5, 11-6} | Yes | N/A | UE does not support to multiplex Type-2 HARQ-ACK codebook on non-initial a PUSCH repetition when the Type-1 codebook includes HARQ-ACK information for PDSCH scheduling after a UL grant. | Per Band | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4c | Multiplexing Type-3 HARQ-ACK codebook for PDSCH scheduling after UL grant on PUSCH | 1. UE multiplexes Type-3 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where the HARQ-ACK codebook includes HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmissionFFS dependency between 55-4d/55-4e | 4-1, 10-16, one of {5-17, 11-5, 11-6} | Yes | N/A | UE does not support to multiplex Type-3 HARQ-ACK codebook on non-initial a PUSCH repetition when the Type-1 codebook includes HARQ-ACK information for PDSCH scheduling after a UL grant. | Per Band | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4d | Determining a different PUCCH resource to transmit HARQ-ACK for PDSCH scheduled after UL grant | 1. Support determining a different PUCCH resource in a slot from the PUCCH resource indicated by the last DCI format before a UL grant in the slot, to include HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling a PUSCH transmission with repetitions and the HARQ-ACK information are multiplexed on a repetition of the PUSCH transmission other than a first repetition in the same slot. | 4-1, 4-10 | Yes | N/A | UE does not support to determine a different PUCCH resource to transmit HARQ-ACK for PDSCH scheduled after UL grant. | Per Band | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4e | Determining different codebook size to transmit HARQ-ACK for PDSCH scheduled after UL grant | 1. Support determining different codebook size in a PUCCH slot from the size determined based on HARQ-ACK information associated with PDSCH reception(s) scheduled before a UL grant, to include HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling a PUSCH transmission with repetitions and the HARQ-ACK information are multiplexed on a repetition of the PUSCH transmission other than a first repetition in the same slot. | 4-1, 4-10 | Yes | N/A | UE does not support to determine different codebook size to transmit HARQ-ACK for PDSCH scheduled after UL grant. | Per Band | N/A | N/A | N/A |  | Optional with capability signaling |

Following inputs are provided in contributions for the RAN1#114bis meeting.

|  |  |  |
| --- | --- | --- |
| [2] | Qualcomm Incorporated | To resolve the dependency between FGs 55-4a to 55-4e, we suggest adding the restriction that a UE does not expect codebook size or PUCCH resource to change once UL grant is received. This ensures that the first three FGs offer a baseline behavior that can then be further enhanced by the subsequent two FGs. We suggest following:**Proposal 3**: Add the following sentences to FGs 55-4a, 55-4b, and 55-4c.* + UE does not expect to determine a different codebook size in a PUCCH slot from the codebook size determined based on HARQ-ACK information associated with PDSCH reception(s) scheduled before a UL grant that schedules a PUSCH in a slot overlapping with the PUCCH slot.
	+ UE does not expect to determine a different PUCCH resource in a slot from the PUCCH resource determined based on HARQ-ACK information associated with PDSCH reception(s) scheduled before a UL grant that schedules a PUSCH in that slot.

**Proposal 4**: For FG 55-4d and 55-4e, add “one of {FG 55-4a,55-4b, 55-4c}” as prerequisites.**Proposal 5**: Indicate FGs 55-4a to 55-4e with per band granularity.  |
| [4] | Huawei, HiSilicon | **Dependency between FG 55-4a/b/c and 55-4d/e**In RAN1#114, an FFS is left for 55-4a/b/c that dependency between 55-4d/e. The features 55-4a/b/c are intending to introduce the capabilities to support HARQ codebook construction scheduled after UL grant, and the features 55-4d/e would reflect UE support PUCCH resource changing and HARQ codebook size changing after UL grant respectively. The details of UE features are referred to the Appendix.Two possible outcomes can be predicted when UE apply the HARQ codebook generation considering the PDSCH scheduled after UL grant. For example, if gNB indicate a total DAI in UL grant as 3, and schedule 5 bits HARQ information before the UL grant and 2bits HARQ information after, then the codebook size multiplexing on a PUSCH repetition is not changed, i.e. always 7 bits based on the TDAI value. Similarly, same PUCCH resource can be indicated by same PRI value before and after the UL grant. On the contrary, the codebook size could be changed, for example, 4bits HARQ are scheduled after, then the codebook size is 11bits after the UL grant, comparing with 7bits before. PUCCH resource can be also distinguished by indicating different PRI. Thus, feature 55-4a/b/c could be the prerequisite of feature 55-4d/e and reported to gNB, whether same codebook size/PUCCH resource can be indicated by gNB based on reported UE capabilities. FFS in 55-4a/b/c can be removed***Proposal 1: FG 55-4a/b/c are the prerequisite of FG 55-4d/e, and FFS in FG 55-4a/b/c are removed.*****Prerequisite of each UE features**To support FG 55-4a/b/c, UE requires HARQ-ACK codebook generation FGs and PUSCH repetition FGs as prerequisite features. For HARQ codebook generation, FG 4-11/4-10/10-16 corresponding to Type 1/2/3 codebook respectively are considered. Since both Type-A and Type-B PUSCH repetitions are supported and the number of PUSCH repetitions can be scheduled or configured by the gNB, at least one of the FGs from {5-16, 5-17, 11-5, 11-6} should be supported as well.To support FG 55-4d/e, as analyzed in above, the prerequisite could be at least one of FG 55-4a/b/c***Proposal 2: The prerequisites of FG 55-4a/b/c are FG 4-1, FG 4-11/4-10/10-16 corresponding to Type 1/2/3 codebook respectively, and at least one of the FGs from {5-16, 5-17, 11-5, 11-6}.*****Granularity of UE features**The granularity of prerequisite feature is listed as below.Table 1. Reporting Granularity for Prerequisites

|  |  |
| --- | --- |
| **FG** | **Granularity** |
| 4-11 | Per UE |
| 4-10 | Per UE |
| 10-16 | Per Band |
| 5-16 | Per UE |
| 5-17 | Per UE |
| 11-5 | Per FS |
| 11-6 | Per UE |

Following the LS [2] from RAN2, it would be simpler to define UE capabilities in the same or finer granularity than its pre-requisite, to avoid ambiguity. Considering the granularity of each prerequisite in Table 1, therefore, following granularity is proposed,***Proposal 3: The reporting granularity of 55-4a/b/c/d/e should be the smallest granularity among all the prerequisites, i.e. per FS.*****Others highlight part**The FGs 55-4a/b/c/d/e can be applied FDD as well, and no TDD/FDD differentiation.The FGs 55-4a/b/c/d/e can be applied to both FR1 and FR2.***Proposal 4: Endorse UE feature list in the Appendix for TEI-18 on HARQ-ACK multiplexing.***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 55. TEI18 | 55-4a | Multiplexing Type-1 HARQ-ACK codebook for PDSCH scheduling after UL grant on PUSCH | 1. UE multiplexes Type-1 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where ACK/NACK is generated for the HARQ-ACK codebook including HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmission. ~~FFS dependency between 55-4d/55-4e~~ | ~~4-1,~~ 4-11, at least one of {5-16, 5-17, 11-5, 11-6} | Yes | N/A | UE does not support to multiplex Type-1 HARQ-ACK codebook on non-initial a PUSCH repetition when the Type-1 codebook includes HARQ-ACK information for PDSCH scheduling after a UL grant. | Per ~~Band~~ FS | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4b | Multiplexing Type-2 HARQ-ACK codebook for PDSCH scheduling after UL grant on PUSCH | 1. UE multiplexes Type-2 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where the HARQ-ACK codebook includes HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmission. ~~FFS dependency between 55-4d/55-4e~~ | ~~4-1,~~ 4-10, at least one of {5-16, 5-17, 11-5, 11-6} | Yes | N/A | UE does not support to multiplex Type-2 HARQ-ACK codebook on non-initial a PUSCH repetition when the Type-1 codebook includes HARQ-ACK information for PDSCH scheduling after a UL grant. | Per ~~Band~~ FS | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4c | Multiplexing Type-3 HARQ-ACK codebook for PDSCH scheduling after UL grant on PUSCH | 1. UE multiplexes Type-3 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where the HARQ-ACK codebook includes HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmission~~FFS dependency between 55-4d/55-4e~~ | ~~4-1,~~ 10-16, at least one of {5-16,5-17, 11-5, 11-6} | Yes | N/A | UE does not support to multiplex Type-3 HARQ-ACK codebook on non-initial a PUSCH repetition when the Type-1 codebook includes HARQ-ACK information for PDSCH scheduling after a UL grant. | Per ~~Band~~ FS | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4d | Determining a different PUCCH resource to transmit HARQ-ACK for PDSCH scheduled after UL grant | 1. Support determining a different PUCCH resource in a slot from the PUCCH resource indicated by the last DCI format before a UL grant in the slot, to include HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling a PUSCH transmission with repetitions and the HARQ-ACK information are multiplexed on a repetition of the PUSCH transmission other than a first repetition in the same slot. | ~~4-1, 4-10~~At least one of {55-4a, 55-4b, 55-4c} | Yes | N/A | UE does not support to determine a different PUCCH resource to transmit HARQ-ACK for PDSCH scheduled after UL grant. | Per ~~Band~~ FS | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4e | Determining different codebook size to transmit HARQ-ACK for PDSCH scheduled after UL grant | 1. Support determining different codebook size in a PUCCH slot from the size determined based on HARQ-ACK information associated with PDSCH reception(s) scheduled before a UL grant, to include HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling a PUSCH transmission with repetitions and the HARQ-ACK information are multiplexed on a repetition of the PUSCH transmission other than a first repetition in the same slot. | ~~4-1, 4-10~~At least one of {55-4a, 55-4b, 55-4c} | Yes | N/A | UE does not support to determine different codebook size to transmit HARQ-ACK for PDSCH scheduled after UL grant. | Per ~~Band~~ FS | N/A | N/A | N/A |  | Optional with capability signaling |

 |
| [5] | ZTE | * **Dependency on 55-4d/55-4e**
	+ UE FGs 55-4d/55-4e are agreed as additional UE capabilities on top of the FG 55-4a/b/c. Therefore, FG 55-4a/b/c should be the prerequisite of FG of 55-4d/55-4e.
* **Prerequisite FGs**
	+ FG 55-4a: the prerequisite FGs are FG 4-11 (Type 1 HARQ-ACK codebook), one of {FG 5-17 (DG PUSCH repetition A), FG 11-5 (DG PUSCH repetition B)}
		- We are ok to combine with repetition type B, though this was discussed and intent to repetition type A.
	+ FG 55-4b: the prerequisite FGs are FG 4-10 (Type 2 HARQ-ACK codebook), one of {FG 5-17 (DG PUSCH repetition A), FG 11-5 (DG PUSCH repetition B)}
	+ FG 55-4c: the prerequisite FGs are FG 10-16 (Type 3 HARQ-ACK codebook), one of {FG 5-17 (DG PUSCH repetition A), FG 11-5 (DG PUSCH repetition B)}
	+ FG 55-4d/e: the prerequisite FGs are one of {FG 55-4a, FG 55-4b, FG 55-4c}
* **Reporting granularity**
	+ The reporting granularity for the UE FGs for type-1, type-2, and type-3 codebooks could be the same as the prerequisite FG, i.e., per UE, per UE and per band, respectively.
	+ Note the reporting granularity of FG 5-17 is per UE.
* FR or TDD/FDD differentiation
	+ Though the targeting scenario is mainly for TDD, we are ok to also apply this to FDD, and no need to do any differentiation.

With above, we have the following proposal. ***Proposal 1: Adopt the following changes on UE FGs for the TEI on HARQ multiplexing on PUSCH.***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 55. TEI18 | 55-4a | Multiplexing Type-1 HARQ-ACK codebook for PDSCH scheduling after UL grant on PUSCH | 1. UE multiplexes Type-1 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where ACK/NACK is generated for the HARQ-ACK codebook including HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmission. ~~FFS dependency between 55-4d/55-4e~~ | ~~4-1,~~ 4-11, one of {5-17, 11-5~~, 11-6~~} | Yes | N/A | UE does not support to multiplex Type-1 HARQ-ACK codebook on non-initial a PUSCH repetition when the Type-1 codebook includes HARQ-ACK information for PDSCH scheduling after a UL grant. | Per ~~Band~~UE | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4b | Multiplexing Type-2 HARQ-ACK codebook for PDSCH scheduling after UL grant on PUSCH | 1. UE multiplexes Type-2 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where the HARQ-ACK codebook includes HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmission. ~~FFS dependency between 55-4d/55-4e~~ | ~~4-1,~~ 4-10, one of {5-17, 11-5~~, 11-6~~} | Yes | N/A | UE does not support to multiplex Type-2 HARQ-ACK codebook on non-initial a PUSCH repetition when the Type-1 codebook includes HARQ-ACK information for PDSCH scheduling after a UL grant. | Per ~~Band~~UE | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4c | Multiplexing Type-3 HARQ-ACK codebook for PDSCH scheduling after UL grant on PUSCH | 1. UE multiplexes Type-3 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where the HARQ-ACK codebook includes HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmission~~FFS dependency between 55-4d/55-4e~~ | 4-1, 10-16, one of {5-17, 11-5~~, 11-6~~} | Yes | N/A | UE does not support to multiplex Type-3 HARQ-ACK codebook on non-initial a PUSCH repetition when the Type-1 codebook includes HARQ-ACK information for PDSCH scheduling after a UL grant. | Per Band | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4d | Determining a different PUCCH resource to transmit HARQ-ACK for PDSCH scheduled after UL grant | 1. Support determining a different PUCCH resource in a slot from the PUCCH resource indicated by the last DCI format before a UL grant in the slot, to include HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling a PUSCH transmission with repetitions and the HARQ-ACK information are multiplexed on a repetition of the PUSCH transmission other than a first repetition in the same slot. | ~~4-1, 4-10~~one of {FG 55-4a, FG 55-4b, FG 55-4c} | Yes | N/A | UE does not support to determine a different PUCCH resource to transmit HARQ-ACK for PDSCH scheduled after UL grant. | Per Band | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4e | Determining different codebook size to transmit HARQ-ACK for PDSCH scheduled after UL grant | 1. Support determining different codebook size in a PUCCH slot from the size determined based on HARQ-ACK information associated with PDSCH reception(s) scheduled before a UL grant, to include HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling a PUSCH transmission with repetitions and the HARQ-ACK information are multiplexed on a repetition of the PUSCH transmission other than a first repetition in the same slot. | ~~4-1, 4-10~~one of {FG 55-4a, FG 55-4b, FG 55-4c} | Yes | N/A | UE does not support to determine different codebook size to transmit HARQ-ACK for PDSCH scheduled after UL grant. | Per Band | N/A | N/A | N/A |  | Optional with capability signaling |

 |
| [6] | Samsung | For the feature group 55-4a, 55-4b and 55-4c, a more accurate description could be “Multiplexing Type-1/2/3 HARQ-ACK codebook in a PUSCH for PDSCHs scheduled after a UL grant”. For “Consequence if the feature is not supported by the UE”, the description of “PDSCH scheduling after a UL grant.” should be changed to “a PDSCH scheduled after the UL grant scheduling the PUSCH.” to be more accurate.**Proposal 2:** Adopt the following update for UE feature 55-4a, 55-4b and 55-4c.

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Feature group** | **Components** | **Consequence if the feature is not supported by the UE** |
| 55-4a | Multiplexing Type-1 HARQ-ACK codebook in a PUSCH for PDSCH ~~scheduling~~ scheduled after UL grant ~~on PUSCH~~ | 1. UE multiplexes Type-1 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where ACK/NACK is generated for the HARQ-ACK codebook including HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmission. FFS dependency between 55-4d/55-4e | UE does not support to multiplex Type-1 HARQ-ACK codebook ~~on non-initial~~ in a PUSCH repetition when the Type-1 codebook includes HARQ-ACK information for a PDSCH ~~scheduling~~ scheduled after ~~a~~ the UL grant scheduling the PUSCH. |
| 55-4b | Multiplexing Type-2 HARQ-ACK codebook in a PUSCH for PDSCH ~~scheduling~~ scheduled after UL grant ~~on PUSCH~~ | 1. UE multiplexes Type-2 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where the HARQ-ACK codebook includes HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmission. FFS dependency between 55-4d/55-4e | UE does not support to multiplex Type-2 HARQ-ACK codebook ~~on non-initial~~ in a PUSCH repetition when the Type-~~1~~ 2 codebook includes HARQ-ACK information for a PDSCH ~~scheduling~~ scheduled after ~~a~~ the UL grant scheduling the PUSCH. |
| 55-4c | Multiplexing Type-3 HARQ-ACK codebook in a PUSCH for PDSCH ~~scheduling~~ scheduled after UL grant ~~on PUSCH~~ | 1. UE multiplexes Type-3 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where the HARQ-ACK codebook includes HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmissionFFS dependency between 55-4d/55-4e | UE does not support to multiplex Type-3 HARQ-ACK codebook ~~on non-initial~~ in a PUSCH repetition when the Type-~~1~~ 3 codebook includes HARQ-ACK information for a PDSCH ~~scheduling~~ scheduled after ~~a~~ the UL grant scheduling the PUSCH. |

For the feature group 55-4d, different UE capabilities should be considered for frequency domain and time domain.When a DL assignment comes after an UL grant for a UE, the UE determines the HARQ-ACK codebook and a PUCCH resource based on the HARQ-ACK codebook size and the PRI indication in the last DCI format for DL assignment before the UL grant. After that, the UE multiplexes the HARQ-ACK in a PUSCH overlapping with the PUCCH, if any. If PUCCH time domain resource is different from the PUCCH that UE determines before the UL grant, UE may multiplex the HARQ-ACK in another PUSCH. As a result, it would take additional time for the UE to re-determine the PUSCH and the REs for both the HARQ-ACK and the data in the PUSCH. An example is given in Figure 1 for illustration. UE first determines to multiplex HARQ-ACK in PUCCH#1 before receiving the UL DCI#1 and UL DCI#2, and then UE determines to multiplex HARQ-ACK in PUSCH#1 after receiving the UL DCI#1 and UL DCI#2. If the UE receives DL DCI 2a, UE needs to re-determine the PUSCH for multiplexing based on the PUCCH resource indicated by DL DCI 2a. On the other hand, if UE receives DL DCI 2b indicating the same PUCCH time domain resource as PUCCH#1, the UE does not need to re-determine the PUSCH for HARQ-ACK multiplexing. The additional timeline is not required for this case. **Figure 1****Proposal 3:** Support separate UE features for UE feature 55-4d and adopt the following update.

|  |  |  |  |
| --- | --- | --- | --- |
| 55-4d-1 | Determining a different PUCCH resource in time domain to transmit HARQ-ACK for PDSCH scheduled after UL grant | 1. Support determining a different PUCCH resource in time domain in a slot from the PUCCH resource indicated by the last DCI format before a UL grant in the slot, to include HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling a PUSCH transmission with repetitions and the HARQ-ACK information are multiplexed on a repetition of the PUSCH transmission other than a first repetition in the same slot. | UE does not support to be indicated a different PUCCH resource in time domain to transmit HARQ-ACK for PDSCH scheduled after UL grant by the DL grant scheduling the PDSCH. |
| 55-4d-2 | Determining a different PUCCH resource in frequency domain to transmit HARQ-ACK for PDSCH scheduled after UL grant | 1. Support determining a different PUCCH resource in frequency domain in a slot from the PUCCH resource indicated by the last DCI format before a UL grant in the slot, to include HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling a PUSCH transmission with repetitions and the HARQ-ACK information are multiplexed on a repetition of the PUSCH transmission other than a first repetition in the same slot. | UE does not support to be indicated a different PUCCH resource in frequency domain to transmit HARQ-ACK for PDSCH scheduled after UL grant by the DL grant scheduling the PDSCH. |

 |

## **Discussion**

### **Proposal 2-1:**

* **The column of “Prerequisite feature groups” in FGs 55-4d and 55-4e is “one of {FG 55-4a, 55-4b, 55-4c}”**
* **Remove “FFS dependency between 55-4d/55-4e” from FGs 55-4a, 55-4b, and 55-4c**

|  |  |
| --- | --- |
| Company | Comment |
| Moderator | Summary of companies view**Dependency between** **FG 55-4a/b/c and 55-4d/e*** Add restriction to FG 55-4a/b/c: QC
	+ UE does not expect to determine a different codebook size in a PUCCH slot from the codebook size determined based on HARQ-ACK information associated with PDSCH reception(s) scheduled before a UL grant that schedules a PUSCH in a slot overlapping with the PUCCH slot.
	+ UE does not expect to determine a different PUCCH resource in a slot from the PUCCH resource determined based on HARQ-ACK information associated with PDSCH reception(s) scheduled before a UL grant that schedules a PUSCH in that slot.
* FG 55-4a/b/c are the prerequisite of FG 55-4d/e: QC, HW/HiSi, ZTE

All companies support FG 55-4a/b/c as prerequisite FGs of FG 55-4d/e.**Companies are also invited to provide view whether the restriction proposed by Qualcomm is necessary for FG 55-4a/b/c in addition to the prerequisite FG** |
|  |  |
|  |  |

### **Proposal 2-2:**

* **FG 55-4d is separated as following FGs**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 55. TEI18 | 55-4d-1 | Determining a different PUCCH resource in time domain to transmit HARQ-ACK for PDSCH scheduled after UL grant | 1. Support determining a different PUCCH resource in a slot from the PUCCH resource in time domain indicated by the last DCI format before a UL grant in the slot, to include HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling a PUSCH transmission with repetitions and the HARQ-ACK information are multiplexed on a repetition of the PUSCH transmission other than a first repetition in the same slot. | ~~4-1, 4-10~~ One of {FG 55-4a, 55-4b, 55-4c} | Yes | N/A | UE does not support to ~~determine~~ be indicated a different PUCCH resource in time domain to transmit HARQ-ACK for PDSCH scheduled after UL grant by the DL grant scheduling the PDSCH. | Per Band | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4d-2 | Determining a different PUCCH resource in frequency domain to transmit HARQ-ACK for PDSCH scheduled after UL grant | 1. Support determining a different PUCCH resource in a slot from the PUCCH resource in frequency domain indicated by the last DCI format before a UL grant in the slot, to include HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling a PUSCH transmission with repetitions and the HARQ-ACK information are multiplexed on a repetition of the PUSCH transmission other than a first repetition in the same slot. | One of {FG 55-4a, 55-4b, 55-4c} | Yes | N/A | UE does not support to be indicated a different PUCCH resource in frequency domain to transmit HARQ-ACK for PDSCH scheduled after UL grant by the DL grant scheduling the PDSCH. | Per Band | N/A | N/A | N/A |  | Optional with capability signaling |

|  |  |
| --- | --- |
| Company | Comment |
| Moderator | This is proposed by Samsung. Companies are invited to provide view whether this separation is necessary or not. |
|  |  |
|  |  |

### **Question 2-3:**

* **Companies are encouraged to provide view on the prerequisite FGs of FGs 55-4a, 55-4b, and 55-4c, respectively**

|  |  |
| --- | --- |
| Company | Comment |
| Moderator | Summary of companies view**Prerequisite FGs*** 55-4a
	+ 4-11, at least one of {5-16, 5-17, 11-5, 11-6}: HW/HiSi
	+ 4-11, one of {5-17, 11-5}: ZTE
* 55-4b
	+ 4-10, at least one of {5-16, 5-17, 11-5, 11-6}: HW/HiSi
	+ 4-10, one of {5-17, 11-5}: ZTE
* 55-4c
	+ 10-16, at least one of {5-16, 5-17, 11-5, 11-6}: HW/HiSi
	+ 10-16, one of {5-17, 11-5}: ZTE

**Reference*** FG 4-10: Dynamic HARQ-ACK codebook, per UE, Mandatory with capability signaling which shall be set to '1'
* FG 4-11: Semi-static HARQ-ACK codebook, per UE, Mandatory with capability signaling
* FG 5-16: Type 2 configured PUSCH repetitions over multiple slots, per UE, Optional with capability signalling
* FG 5-17: PUSCH repetitions over multiple slots, per UE, Mandatory with capability signaling
* FG 10-16: One-shot HARQ ACK feedback, per band, Optional with capability signalling
* FG 11-5: PUSCH repetition Type B, per FS, Optional with capability signalling
* FG 11-6: PUSCH repetition Type A, per UE, Optional with capability signalling
 |
|  |  |
|  |  |

### **Question 2-4:**

* **Companies are encouraged to provide view on the reporting type of FGs 55-4a/4b/4c/4d/4e, respectively**

|  |  |
| --- | --- |
| Company | Comment |
| Moderator | Summary of companies view**Reporting type*** 55-4a
	+ Per UE: ZTE
	+ Per band: QC
	+ Per FS: HW/HiSi
* 55-4b
	+ Per UE: ZTE
	+ Per band: QC
	+ Per FS: HW/HiSi
* 55-4c
	+ Per band: QC, ZTE
	+ Per FS: HW/HiSi
* 55-4d
	+ Per band: QC, ZTE
	+ Per FS: HW/HiSi
* 55-4e
	+ Per band: QC, ZTE
	+ Per FS: HW/HiSi

Note that, according to the RAN2 guidance, it should be avoided to have courser reporting type than prerequisite FG |
|  |  |
|  |  |

### **Proposal 2-5:**

* **FGs 55-4a, 55-4b, and 55-4c are updated as follows:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 55. TEI18 | 55-4a | Multiplexing Type-1 HARQ-ACK codebook in a PUSCH for PDSCH ~~scheduling~~ scheduled after UL grant ~~on PUSCH~~ | 1. UE multiplexes Type-1 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where ACK/NACK is generated for the HARQ-ACK codebook including HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmission. FFS dependency between 55-4d/55-4e | 4-1, 4-11, one of {5-17, 11-5, 11-6} | Yes | N/A | UE does not support to multiplex Type-1 HARQ-ACK codebook on non-initial a PUSCH repetition when the Type-1 codebook includes HARQ-ACK information for a PDSCH ~~scheduling~~ scheduled after ~~a~~ the UL grant scheduling the PUSCH. | Per Band | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4b | Multiplexing Type-2 HARQ-ACK codebook in a PUSCH for PDSCH ~~scheduling~~ scheduled after UL grant ~~on PUSCH~~ | 1. UE multiplexes Type-2 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where the HARQ-ACK codebook includes HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmission. FFS dependency between 55-4d/55-4e | 4-1, 4-10, one of {5-17, 11-5, 11-6} | Yes | N/A | UE does not support to multiplex Type-2 HARQ-ACK codebook on non-initial a PUSCH repetition when the Type-~~1~~2 codebook includes HARQ-ACK information for a PDSCH ~~scheduling~~ scheduled after ~~a~~ the UL grant scheduling the PUSCH. | Per Band | N/A | N/A | N/A |  | Optional with capability signaling |
| 55. TEI18 | 55-4c | Multiplexing Type-3 HARQ-ACK codebook in a PUSCH for PDSCH ~~scheduling~~ scheduled after UL grant ~~on PUSCH~~ | 1. UE multiplexes Type-3 HARQ-ACK codebook on a repetition of a PUSCH transmission other than a first repetition, where the HARQ-ACK codebook includes HARQ-ACK information associated with PDSCH reception(s) scheduled after the UL grant scheduling the PUSCH transmissionFFS dependency between 55-4d/55-4e | 4-1, 10-16, one of {5-17, 11-5, 11-6} | Yes | N/A | UE does not support to multiplex Type-3 HARQ-ACK codebook on non-initial a PUSCH repetition when the Type-~~1~~3 codebook includes HARQ-ACK information for a PDSCH ~~scheduling~~ scheduled after ~~a~~ the UL grant scheduling the PUSCH. | Per Band | N/A | N/A | N/A |  | Optional with capability signaling |

|  |  |
| --- | --- |
| Company | Comment |
| Moderator | This is proposed by Samsung. Companies are invited to provide view whether this revision is necessary or not. |
|  |  |
|  |  |

# **FGs for span-based PDCCH monitoring with additional restrictions**

In [1], FGs for span-based PDCCH monitoring with additional restrictions are captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (Sidelink WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 55. TEI18 | 55-6 | (2, 2) span-based PDCCH monitoring with additional restriction(s) | Support of (2, 2) span-based PDCCH monitoring as per FG11-2 with the following additional restriction(s)There is at least one OFDM symbol gap between two PDCCH monitoring occasions |  | Yes  | N/A |  | Per FS | N/A | N/A |  | This capability is signalled for SCS 15 kHz and 30 kHzThis capability is reported for processing capability #1 and for processing capability #2 respectively | Optional with capability signalling |

Following inputs are provided in contributions for the RAN1#114bis meeting.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [2] | Qualcomm Incorporated | At RAN1#114, following agreement was achieved.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Agreement*** Introduce FG 55-6 for (2, 2) span-based PDCCH monitoring with additional restriction(s)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 55. TEI18 | 55-6 | (2, 2) span-based PDCCH monitoring with additional restriction(s) | Support of (2, 2) span-based PDCCH monitoring as per FG11-2 with the following additional restriction(s)* There is at least one OFDM symbol gap between two PDCCH monitoring occasions
 |  | Yes  | N/A |  | Per FS | N/A | N/A |  | This capability is signalled for SCS 15 kHz and 30 kHzThis capability is reported for processing capability #1 and for processing capability #2 respectively | Optional with capability signalling |

 |

The UE indicating support of FG55-6 for a given {band of a band combination, SCS, and processing capability} would not indicate support of FG11-2 for (2, 2) span-based PDCCH monitoring for the same {band of the band combination, SCS, and processing capability}. This implies that the UE indicating support of FG55-6 cannot support of FG11-2a, 11-2b, 11-2c, 11-2d, 11-2e, 11-2f, 11-2g, and 23-2-1e for (2, 2) span-based PDCCH monitoring.A straightforward approach is to define new FGs that prerequisite FG11-2 for (4, 3) and (7, 3) span-based PDCCH monitoring and FG55-6 for (2, 2) span-based PDCCH monitoring. The other approach is to add descriptions in legacy FG11-2a, 11-2b, 11-2c, 11-2d, 11-2e, 11-2f, 11-2g, and 23-2-1e that these FGs prerequisite FG11-2 for (4, 3) and (7, 3) span-based PDCCH monitoring and either {FG11-2, or FG55-6} for (2, 2) span-based PDCCH monitoring. Since the second approach is non-backward compatible, we propose to take the first approach; i.e., define the corresponding FGs.**Proposal 2:*** *Introduce following Rel-18 FGs that indicates support of UE features defined in FG11-2a, 11-2b, 11-2c, 11-2d, 11-2e, 11-2f, 11-2g, and 23-2-1e for a UE supporting FG55-6 for (2, 2) span-based PDCCH monitoring*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 55. TEI18 | 55-6a | Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span when configured with DL CA with Rel-16 PDCCH monitoring capability on all the serving cells | 1.Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span when configured with DL CA with Rel-16 PDCCH monitoring capability on all the serving cells- Candidate value for the component: {2, 3, …, 16)2.Supported span arrangement for CA-Candidate value for the component: {aligned spans only, aligned spans and non-aligned spans} | FG11-2 for (7, 3) or (4, 3) span based PDCCH monitoring;FG55-6 for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |
|  | 55-6b | Mix of Rel-16 PDCCH monitoring capability and Rel. 15 PDCCH monitoring capability on different carriers | Support Rel-15 monitoring capability and Rel-16 PDCCH monitoring capability on different serving cells | FG11-2 for (7, 3) or (4, 3) span based PDCCH monitoring;FG55-6 for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |
|  | 55-6c | Number of carriers for CCE/BD scaling with DL CA with mix of Rel. 16 and Rel. 15 PDCCH monitoring capabilities on different carriers | 1.Supported combination(s) of (pdcch-BlindDetectionCA-R15, pdcch-BlindDetectionCA-R16)- Candidate values for pdcch-BlindDetectionCA-R15 is 1 to 15- Candidate values for pdcch-BlindDetectionCA-R16 is 1 to 152. Supported span arrangement for CA- Candidate value for the component: {aligned spans only, aligned spans and non-aligned spans} | FG11-2b for (7, 3) or (4, 3) span based PDCCH monitoring;FG55-6b for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |
|  | 55-6d | Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span for MCG and for SCG when configured for NR-DC operation with Rel-16 PDCCH monitoring on all the serving cells | Supported combination of (pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16) | FG11-2 for (7, 3) or (4, 3) span based PDCCH monitoring;FG55-6 for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |
|  | 55-6e | Number of carriers for CCE/BD scaling for MCG and for SCG when configured for NR-DC operation with mix of Rel. 16 and Rel. 15 PDCCH monitoring capabilities on different carriers | Supported combination(s) of (pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16) | FG11-2b for (7, 3) or (4, 3) span based PDCCH monitoring;FG55-6b for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |
|  | 55-6f | Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span when configured with DL CA with Rel-16 PDCCH monitoring capability on all the serving cells with restriction for non-aligned span case | 1.Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span when configured with DL CA with Rel-16 PDCCH monitoring capability on all the serving cells-Candidate value for the component: {2, 3, …, 16}2.UE supports aligned span and non-aligned spanIn case of non-aligned span when the configured number of cells with Rel-16 PDCCH monitoring is larger than the UE reported value, PDCCH monitoring occasion(s) should be configured only on same symbol(s) every slot | FG11-2 for (7, 3) or (4, 3) span based PDCCH monitoring;FG55-6 for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |
|  | 55-6g | Number of carriers for CCE/BD scaling with DL CA with mix of Rel. 16 and Rel. 15 PDCCH monitoring capabilities on different carriers with restriction for non-aligned span case | 1.Supported combination(s) of (pdcch-BlindDetectionCA-R15, pdcch-BlindDetectionCA-R16)-Candidate values for pdcch-BlindDetectionCA-R15 is 1 to 15-Candidate values for pdcch-BlindDetectionCA-R16 is 1 to 152.UE supports aligned span and non-aligned spanIn case of non-aligned span when the configured number of cells with Rel-16 PDCCH monitoring is larger than the UE reported value, PDCCH monitoring occasion(s) should be configured only on same symbol(s) every slot | FG11-2b for (7, 3) or (4, 4) span based PDCCH monitoring;FG55-6b for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |
|  | 55-6h | PDCCH repetition for Rel-16 PDCCH monitoring | 1. Support of PDCCH repetition with Rel-16 PDCCH monitoring capability as defined in FG 11-2 family.2. Supported mode of PDCCH repetition3. X per CC4. X across all CCs | FG23-2-1, and;FG11-2 for (7, 3) or (4, 4) span based PDCCH monitoring;FG55-6 for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |

 |

## **Discussion**

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

* **Introduce following Rel-18 FGs that indicate support of UE features defined in FG11-2a, 11-2b, 11-2c, 11-2d, 11-2e, 11-2f, 11-2g, and 23-2-1e for a UE supporting FG 55-6 for (2, 2) span-based PDCCH monitoring**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 55. TEI18 | 55-6a | Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span when configured with DL CA with Rel-16 PDCCH monitoring capability on all the serving cells | 1.Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span when configured with DL CA with Rel-16 PDCCH monitoring capability on all the serving cells- Candidate value for the component: {2, 3, …, 16)2.Supported span arrangement for CA-Candidate value for the component: {aligned spans only, aligned spans and non-aligned spans} | FG11-2 for (7, 3) or (4, 3) span based PDCCH monitoring;FG55-6 for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |
| 55. TEI18 | 55-6b | Mix of Rel-16 PDCCH monitoring capability and Rel. 15 PDCCH monitoring capability on different carriers | Support Rel-15 monitoring capability and Rel-16 PDCCH monitoring capability on different serving cells | FG11-2 for (7, 3) or (4, 3) span based PDCCH monitoring;FG55-6 for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |
| 55. TEI18 | 55-6c | Number of carriers for CCE/BD scaling with DL CA with mix of Rel. 16 and Rel. 15 PDCCH monitoring capabilities on different carriers | 1.Supported combination(s) of (pdcch-BlindDetectionCA-R15, pdcch-BlindDetectionCA-R16)- Candidate values for pdcch-BlindDetectionCA-R15 is 1 to 15- Candidate values for pdcch-BlindDetectionCA-R16 is 1 to 152. Supported span arrangement for CA- Candidate value for the component: {aligned spans only, aligned spans and non-aligned spans} | FG11-2b for (7, 3) or (4, 3) span based PDCCH monitoring;FG55-6b for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |
| 55. TEI18 | 55-6d | Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span for MCG and for SCG when configured for NR-DC operation with Rel-16 PDCCH monitoring on all the serving cells | Supported combination of (pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16) | FG11-2 for (7, 3) or (4, 3) span based PDCCH monitoring;FG55-6 for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |
| 55. TEI18 | 55-6e | Number of carriers for CCE/BD scaling for MCG and for SCG when configured for NR-DC operation with mix of Rel. 16 and Rel. 15 PDCCH monitoring capabilities on different carriers | Supported combination(s) of (pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16) | FG11-2b for (7, 3) or (4, 3) span based PDCCH monitoring;FG55-6b for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |
| 55. TEI18 | 55-6f | Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span when configured with DL CA with Rel-16 PDCCH monitoring capability on all the serving cells with restriction for non-aligned span case | 1.Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span when configured with DL CA with Rel-16 PDCCH monitoring capability on all the serving cells-Candidate value for the component: {2, 3, …, 16}2.UE supports aligned span and non-aligned spanIn case of non-aligned span when the configured number of cells with Rel-16 PDCCH monitoring is larger than the UE reported value, PDCCH monitoring occasion(s) should be configured only on same symbol(s) every slot | FG11-2 for (7, 3) or (4, 3) span based PDCCH monitoring;FG55-6 for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |
| 55. TEI18 | 55-6g | Number of carriers for CCE/BD scaling with DL CA with mix of Rel. 16 and Rel. 15 PDCCH monitoring capabilities on different carriers with restriction for non-aligned span case | 1.Supported combination(s) of (pdcch-BlindDetectionCA-R15, pdcch-BlindDetectionCA-R16)-Candidate values for pdcch-BlindDetectionCA-R15 is 1 to 15-Candidate values for pdcch-BlindDetectionCA-R16 is 1 to 152.UE supports aligned span and non-aligned spanIn case of non-aligned span when the configured number of cells with Rel-16 PDCCH monitoring is larger than the UE reported value, PDCCH monitoring occasion(s) should be configured only on same symbol(s) every slot | FG11-2b for (7, 3) or (4, 4) span based PDCCH monitoring;FG55-6b for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |
| 55. TEI18 | 55-6h | PDCCH repetition for Rel-16 PDCCH monitoring | 1. Support of PDCCH repetition with Rel-16 PDCCH monitoring capability as defined in FG 11-2 family.2. Supported mode of PDCCH repetition3. X per CC4. X across all CCs | FG23-2-1, and;FG11-2 for (7, 3) or (4, 4) span based PDCCH monitoring;FG55-6 for (2, 2) span based PDCCH monitoring with additional restriction(s) | Yes  | N/A |  | Per FS | N/A | N/A |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comment |
|  |  |
|  |  |
|  |  |

# **FGs for multi-DCI based multi-TRP**

In [2], FGs for multi-DCI based multi-TRP are captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (Sidelink WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 55. TEI18 | 55-7 | Two QCL TypeD for CORESET monitoring in multi-DCI based multi-TRP | Support of determining two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band CA associated with coresetPoolIndex value 0 and 1 | 16-2a | Yes  | N/A |  | Per band | N/A | N/A | FR2 only |  | Optional with capability signalling |

*Proponent (Qualcomm): we propose to introduce a new FG similar to Rel-17 FG23-2-2 (for monitoring two QCL TypeD for Rel-17 PDCCH repetition) or FG23-6-6 (for monitoring two QCL TypeD for Rel-17 SFN PDCCH)*

Following inputs are provided in contributions for the RAN1#114bis meeting.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [3] | Nokia, Nokia Shanghai Bell | **Proposal 1: To facilitate the RAN1#114 TEI18 agreement to introduce a new UE capability for Enhanced PDCCH reception for multiDCI based mTRP operation, introduce the following FG:**

|  |  |  |  |
| --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups |
| 55-7 | Enhanced PDCCH reception for multiDCI based multi-TRP operation | Support for per coresetPoolIndex application of the QCL-TypeD prioritization rules  | 16-2a |

 |
| [6] | Samsung | In Rel-17 FeMIMO, for PDCCH repetition and SFNed PDCCH, QCL prioritization rule was enhanced separately, and corresponding UE capabilities supporting have been defined as FG 23-2-2 for PDCCH repetition and FG 23-6-6 for SFNed PDCCH, respectively.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups | Type | Note |
| 23-2-2 | Two QCL TypeD for CORESET monitoring in PDCCH repetition | Support of determining two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band CA when UE is configured with PDCCH repetition | 23-2-1 | Per band |  |
| 23-6-6 | QCL-TypeD collision handling with CORESET with 2 TCI states | Support of identifying two QCL-TypeD properties for multiple overlapping CORESETs when a CORESET is activated with two TCI states which overlaps with another CORESET. |  | Per band |  |

Similar with the above UE capabilities, the UE capability supporting up to two QCL-TypeD determination under multi-DCI based multi-TRP case can be defined as follows.* + - * + For pre-requisite, since the feature is to support an additional functionality for multi-DCI based multi-TRP, FG 16-2a (Multi-DCI based multi-TRP) is needed as a pre-requisite.
				+ For Type, based on RAN2’s guidance, it is recommended to avoid defining capabilities with re-requisite on a finer granularity [2]. Since FG 16-2a is per FSPC, it is better to follow per FSPC for this new FG as well.
				+ For Note, it is clarified for the case when if a UE is not configured with two coresetPoolIndexes at least in a CC in a certain band, since QCL prioritization rule considers time domain overlapping for intra-band CA case as well. If so, the UE can consider that all CORESETs in the CC are associated with coresetPoolIndex 0.

**Proposal 1:** Support FG 55-7 for endorsed Rel-18 TEI on QCL prioritization rule for multi-DCI based multi-TRP.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups | Type | Note |
| 55-7 | Performing QCL prioritization rule per coresetPoolIndex | Support to identify 1 QCL-TypeD property per coresetPoolIndex for determining up to two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band when UE is configured with two different coresetPoolIndexes in the same CC or at least one CC in the band. | 16-2a | Per FSPC | Note: In case of intra-band CA, if a UE is not configured with two different coresetPoolIndexes in a certain CC, then all CORESETs in the CC are considered as being associated with coresetPoolindex 0. |

 |

## **Discussion**

### **Proposal 4-1:**

* + **Introduce following FG**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 55. TEI18 | 55-7 | Two QCL TypeD for CORESET monitoring in multi-DCI based multi-TRP | Support of determining two QCL-TypeD for time-domain overlapping CORESETs in the same CC or for intra-band CA associated with coresetPoolIndex value 0 and 1 | 16-2a | Yes  | N/A |  | Per FSPC | N/A | FR2 only | N/A | In case of intra-band CA, if a UE is not configured with two different coresetPoolIndexes in a certain CC, then all CORESETs in the CC are considered as being associated with coresetPoolindex 0 | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comment |
|  | Summary of companies view* Prerequisite
	+ 16-2a: QC, Nokia/NSB, Samsung
* Reporting type
	+ Per band: QC
	+ Per FSPC: Samsung

*Moderator’s note: According to the RAN2 guidance, it should be avoided to have courser reporting type than prerequisite FG. For this FG, companies seem fine to include FG 16-2a (per FSPC) as the prerequisite FG, and hence, per FSPC needs to be selected.** Note
	+ Samsung: In case of intra-band CA, if a UE is not configured with two different coresetPoolIndexes in a certain CC, then all CORESETs in the CC are considered as being associated with coresetPoolindex 0.
 |
|  |  |
|  |  |

# **Conclusions**

To be updated

# **References**

[1] R1-2308521 Updated RAN1 UE features list for Rel-18 NR after RAN1#114 Moderators (AT&T, NTT DOCOMO, INC.)

[2] R1-2310181 Other UE features including TEI and span-based PDCCH monitoring with additional restrictions Qualcomm Incorporated

[3] R1-2308861 On UE features for TEI18 Nokia, Nokia Shanghai Bell

[4] R1-2308888 UE features for endorsed Rel-18 TEI on HARQ multiplexing on PUSCH Huawei, HiSilicon

[5] R1-2309142 Discussion on UE feature for Rel-18 TEI ZTE

[6] R1-2309415 UE features for endorsed Rel-18 TEI Samsung