**3GPP TSG RAN WG1 #108-e R1-22xxxxx**

**e-Meeting, February 21st – March 3rd, 2022**

**Agenda item:** 8.16.8

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

**Title:** [draft] Summary on UE features for NR coverage enhancement

**Document for:** Discussion and Decision

# **Introduction**

This document summarizes contributions submitted to AI 8.16.8 regarding UE features for NR coverage enhancement and captures the following email discussion.

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| [108-e-R17-UE-features-CovEnh-01] Email discussion on UE features for NR coverage enhancement – Shinya (DOCOMO) * 1st check point: February 25
* Final check point: March 3
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In the updated RAN1 UE features list for Rel-17 NR after RAN1 #107bis-e [1], there are following feature groups for NR coverage enhancement.

* 30-1 Increased maximum number of dynamic grant PUSCH Type A repetitions
* 30-1a Increased maximum number of Type 2 configured grant PUSCH Type A repetitions
* 30-2 Dynamic grant PUSCH Type A repetitions based on available slots
* 30-2a Configured grant PUSCH Type A repetitions based on available slots
* 30-3 TB processing over multi-slot PUSCH
* 30-3a Repetition of TB processing over multi-slot PUSCH
* 30-4 [The maximum duration for DM-RS bundling]
* 30-4a DM-RS bundling for PUSCH repetition type A
* 30-4b DM-RS bundling for PUSCH repetition type B
* 30-4c DM-RS bundling for TB processing over multi-slot PUSCH
* 30-4d DMRS bunding for PUCCH repetitions
* 30-4e Enhanced inter-slot frequency hopping with inter-slot bundling for PUSCH
* 30-4f Enhanced inter-slot frequency hopping for PUCCH repetitions with DMRS bundling
* 30-4g Restart DM-RS bundling after the events that violate power consistency and phase continuity
* 30-4h DM-RS bundling for non-back-to-back transmission
* 30-5 Slot based dynamic PUCCH repetition indication
* 30-6 Repetition of PUSCH transmission scheduled by RAR UL grant and DCI format 0\_0 with CRC scrambled by TC-RNTI

The issues to be discussed are tagged and colour coded with High priority, Medium priority, or Low priority, considering RAN2 impact especially for capability signaling design.

In this round of the discussion, companies are requested to provide comments on the proposals and questions tagged FL1.

# **30-1 to 30-2a: Enhancements for PUSCH Type A repetitions**

In [1], FGs 30-1 to 30-2a are captured as below.

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| 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 |
|  30. NR\_cov\_enh | 30-1 | Increased maximum number of dynamic grant PUSCH Type A repetitions | K = 1, 2, 3, 4, 7, 8, 12, 16, 20, 24, 28, 32 times repetitions.The number of repetitions is indicated in a TDRA list. A row index of the TDRA list is indicated by a DCI. | [5-17] | Yes | N/A | UE does not support more than 16 repetitions for dynamic grant PUSCH. | [Per UE] | No | No | N/A |  | Optional with capability signalling |
|  30. NR\_cov\_enh | 30-1a | Increased maximum number of Type 2 configurecd grant PUSCH Type A repetitions | K = 1, 2, 3, 4, 7, 8, 12, 16, 20, 24, 28, 32 times repetitions.The number of repetitions is indicated in a TDRA list. A row index of the TDRA list is indicated by a Type 2 configured grant configuration.FFS whether to merge with FG 30-1FFS whether to have a separate FG for CG (including both Type 1 and Type 2) with repK-r17 | [5-16], [30-1] | Yes | N/A | UE does not support more than 16 repetitions for Type 2configurecd grant PUSCH. | [Per UE] | No | No | N/A |  | Optional with capability signalling |
|  30. NR\_cov\_enh | 30-2 | Dynamic grant PUSCH Type A repetitions based on available slots | Transmission occasions for K repetitions are determined on the basis of available slots. | [5-17] | Yes | N/A | UE does not support dynamic grant PUSCH repetitions counted on the basis of available slots. | [Per UE] | FFS | No | N/A |  | Optional with capability signalling |
| 30. NR\_cov\_enh | 30-2a | Configurecd grant PUSCH Type A repetitions based on available slots | Transmission occasions for K repetitions for configured grant PUSCH are determined on the basis of available slots. FFS whether to merge with FG 30-2 | [5-14 or 5-16], [30-2] | Yes | N/A | UE does not support configured grant PUSCH repetitions counted on the basis of available slots. | [Per UE] | FFS | No | N/A |  | Optional with capability signalling |

Following feedbacks are provided in contributions for the RAN1#108-e meeting.

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| [2] | Huawei, HiSilicon | For enhanced PUSCH repetition type A and TBoMS, only one FG for both CG and DG is sufficient, because there is no difference for UE capability to support that for CG and DG. It should be noted that we do not feel that the granularities should be tied to the structure of FGs, because a finer granularity, e.g. per band, cannot solve any potential IoDT concern. Therefore, the granularities are supposed to be discussed separately. ***Proposal 1:*** *For the features about enhanced PUSCH repetition type A and TBoMS,** *Only one FG for both CG and DG is sufficient.*
* *The granularities should be discussed separately.*
 |
| [3] | vivo | In RAN1#107bis-e meeting, for increased maximum number of dynamic grant based Type A PUSCH repetitions, whether FGs are separated for CG PUSCH and DG PUSCH are discussed. Since in Rel-15, CG-PUSCH and DG-PUSCH are separate capabilities, FG 30-1 and 30-1a should also be separated capabilities. Similarly, current structure of FG 30-2 and 30-2a should be kept, i.e. FG 30-2 for DG, 30-2a for type 1 and 2 CG.**Proposal 1:** **For increased maximum number of Type A PUSCH repetitions, current FG structure should be kept, i.e. FG 30-1 for DG, 30-1a for type 1 and 2 CG.** **Proposal 2: Current structure of FG 30-2 and 30-2a should be kept, i.e. FG 30-2 for DG, 30-2a for type 1 and 2 CG.** |
| [4] | ZTE | For UE feature groups FG 30-1 and 30-1a, whether/how to separate/merge the two FGs were discussed with the following two options on the table. * + Option 1: Keep current structure, i.e. FG 30-1 for DG, 30-1a for type 1 and 2 CG
	+ Option 3: Merge FGs 30-1 and 30-1a into an FG

In our view, there is no need two separate UE FGs as there is no complexity difference to support increased maximum number of repetitions between DG and CG PUSCH. * For DG PUSCH repetition, a UE can support determination of increased maximum number of repetition either dynamically (if included in the TDRA table) or semi-statically (otherwise). Thus, it a UE can support increased maximum repetition number for DG, it would be also able to support for CG including both type 1 and type 2.
* This is similar as Rel-16 URLLC FG 11-5/11-6, where only one FG is introduced for dynamic PUSCH repetition indication for both DG and CG PUSCH.

Based on above, we propose to merge FG 30-1 and FG 30-1a. There Regarding the interpretation of the prerequisite FGs (i.e., FG 5-14, 5-16, 5-17), our understanding is a UE doesn’t need to report all the prerequisite FGs to support the merged FG. In other words, if a UE only support FG 5-17 (i.e., DG PUSCH aggregation) and reports the merged FG, it means the UE can only support increased maximum number of repetition for DG PUSCH. Using merged FG could save signaling overhead. The potential IODT issue is a UE may support at least two prerequisite FGs (e.g., DG and type 2 CG), while the UE may only want to support the new feature for DG PUSCH. However, it is not a typical case in our view. It was discussed to compromise to merge the FGs with per band reporting. However, it would cause more unnecessary signaling overhead without solving the IODT issue. Therefore, even a compromise is to be made, it should be still be based on per UE reporting. ***Proposal 1:*** *Merge FG 30-1 and FG 30-1a into an FG, i.e., Option 3 is adopted.* * *Per UE reporting is supported.*

Similarly, we have the following proposals for other related FGs. ***Proposal 2:*** *Merge FGs 30-2 and 30-2a into an FG, i.e., Option 3 is adopted.* * *Per UE reporting is supported.*

***Proposal 3:*** *Keep current structure for FG 30-3, i.e., Option 1 is adopted.* *Per UE reporting is supported.*  |
| [5] | OPPO | For FG30-1 and 30-1a, we prefer to merge FGs 30-1 and 30-1a into an FG. Increased maximum number of DG and CG PUSCH type A repetition can be supported together. Separate FGs are not necessary. Option 3 is proposed.***Proposal 1：Merge FGs 30-1 and 30-1a into an FG.*** For FG30-2 and 30-2a, we prefer to merge FGs 30-2 and 30-2a into an FG. DG and CG PUSCH type A repetition based on available slots can be supported together as a whole feature. Option 3 is proposed.***Proposal 2：Merge FGs 30-2 and 30-2a into an FG.***  |
| [6] | CATT | We are fine to merge FG 30-1 and 30-1a into a FG for as a unified UE capability. It may also be OK to make it ‘per band’ granularity, since for K>1 in non-shared spectrum, the UE capabilities generally have ‘per band’ level in Rel-15/16 [2]. Similar merging can be applied to FG 30-2 and FG 30-2a. Concretely, we do not see strong need to differentiate TDD and FDD bands for the merged FG 30-2, since available slot counting can be applied to both TDD and FDD bands.In addition, in RAN1#107-e, RAN1 make the following agreements for Type 1 CG-PUSCH and Type 2 CG-PUSCH using *repK-r17* [3].

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| Agreement  For *repK-r17*,  The value range of *repK-17* is {1, 2, 4, 8, 12, 16, 24, 32}.  *repK-r17* is included in *ConfiguredGrantConfig*.  When *repK-r17* is provided, the legacy *repK* is not provided. |

Hence, the repetition number K that configured by *repK-r17*, is different from that enabled by *numberOfRepetitions-r17* in TDRA table for DG-PUSCH or Type 2 CG-PUSCH, as agreed in RAN1#105-e [4].

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| Agreement:In addition to {1, 2, 3, 4, 7, 8, 12, 16} and {32}, the following additional value set for repetition factor is supported in Rel-17.* {20, 24, 28}
 |

However, the current FG 30-1a only captures the value of K from *numberOfRepetitions-r17* for DG-PUSCH and Type 2 CG-PUSCH. We suggest to add the supported value K from *repK-r17* for Type 1 CG-PUSCH and Type 2 CG-PUSCH in the new merged FG 30-1. **Proposal 1: Merge FG 30-1 and FG 30-1a into an FG for DG, Type 1 and Type 2 CG PUSCH with per band granularity. The merged FG 30-1 is updated as follows:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 30-1 | Increased maximum number of dynamic grant, Type 1 configured grant, and Type 2 configured grant PUSCH Type A repetitions | K = 1, 2, 3, 4, 7, 8, 12, 16, 20, 24, 28, 32 times repetitions, if the number of repetitions is indicated in a TDRA list. A row index of the TDRA list is indicated by a DCI.K = 1, 2, 4, 8, 12, 16, 24, 32 times repetitions, if the number of repetition is RRC configured by *repK-r17*. | 5-14, 5-16 or ~~[~~5-17~~]~~,  | Yes | N/A | UE does not support more than 16 repetitions for dynamic grant PUSCH, Type 1 configured grant PUSCH nor Type 2 configured grant PUSCH. | ~~[Per UE]~~Per band | No | No | N/A |  |
| ~~30-1a~~ | ~~Increased maximum number of Type 2 configurecd grant PUSCH Type A repetitions~~ | ~~K = 1, 2, 3, 4, 7, 8, 12, 16, 20, 24, 28, 32 times repetitions.~~~~The number of repetitions is indicated in a TDRA list. A row index of the TDRA list is indicated by a Type 2 configured grant configuration.~~~~FFS whether to merge with FG 30-1~~~~FFS whether to have a separate FG for CG (including both Type 1 and Type 2) with repK-r17~~ | ~~[5-16], [30-1]~~ | ~~Yes~~ | ~~N/A~~ | ~~UE does not support more than 16 repetitions for Type 2configurecd grant PUSCH.~~ | ~~[Per UE]~~ | ~~No~~ | ~~No~~ | ~~N/A~~ |  |

**Proposal 2: Merge FG 30-2 and FG 30-2a into an FG for DG, Type 1 and Type 2 CG PUSCH with per band granularity. The merged FG 30-2 is updated as follows:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 30-2 | Dynamic grant and configured grant PUSCH Type A repetitions based on available slots | Transmission occasions for K repetitions for dynamic grant and configured grant PUSCH are determined on the basis of available slots. | 5-14, 5-16 or ~~[~~5-17~~]~~ | Yes | N/A | UE does not support dynamic grant or configured grant PUSCH repetitions counted on the basis of available slots. | ~~[Per UE]~~ Per band | ~~FFS~~ No | No | N/A |  |
| ~~30-2a~~ | ~~Configurecd grant PUSCH Type A repetitions based on available slots~~ | ~~Transmission occasions for K repetitions for configured grant PUSCH are determined on the basis of available slots.~~ ~~FFS whether to merge with FG 30-2~~ | ~~[5-14 or 5-16], [30-2]~~ | ~~Yes~~ | ~~N/A~~ | ~~UE does not support configured grant PUSCH repetitions counted on the basis of available slots.~~ | ~~[Per UE]~~ | ~~FFS~~ | ~~No~~ | ~~N/A~~ |  |

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| [7] | Nokia | * **30-1:**
	+ Move candidate values to notes column and add a proper description of the feature. No need to list the legacy values, hence only list values for K>16.
	+ Add FG11-6 (PUSCH repetition Type A) as pre-requisite
	+ Per UE
* **30-1a:**
	+ Similarly to FG30-1, move values to notes column and restrict range to K>16, with proper description of the FG itself.
	+ Per UE
* **30-2:**
	+ Confirm FG description
	+ Add 30-1 as pre-requisite
	+ Per UE
* **30-2a:**
	+ Confirm FG description
	+ Replace pre-requisite FG5-16 with FG30-1a
	+ Do not merge with 30-2
	+ Per UE
 |
| [8] | China Telecom | It was discussed whether a single FG or separate FGs should be defined for DG-PUSCH and CG-PUSCH. We don’t see much difference for DG-PUSCH and CG-PUSCH to support more than 16 repetitions as well as counting based on available slots. Therefore, FGs 30-1 and 30-1a should be merged into a single FG including DG-PUSCH, type 1 CG-PUSCH and type 2 CG-PUSCH. Likewise, FGs 30-2 and 30-2a should be merged into a single FG including DG-PUSCH, type 1 CG-PUSCH and type 2 CG-PUSCH. In RAN1#107b-e, a compromised way was proposed, i.e., one FG for both DG-PUSCH and CG-PUSCH with per band granularity. However, we don’t see the necessity for per band granularity. For merged FG 30-1, it seems not necessary to differentiate FDD/TDD. As for unpaired spectrum, available slot are determined based on *tdd-UL-DL-ConfigurationCommon*, *tdd-UL-DL-ConfigurationDedicated* and *ssb-PositionsInBurst*, while for paired spectrum and SUL except HD-FDD, all slots are considered as available slots and for HD-FDD, and available slot are determined based on *ssb-PositionsInBurst*, FDD/TDD differentiation for merged FG 30-2 needs further study.**Proposal 1: FGs for PUSCH repetition type A enhancements.**

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| **Features** | Index | Feature group | Components | Prerequisite feature groups | **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 |
|  30. NR\_cov\_enh | 30-1 | Increased maximum number of ~~dynamic grant~~ PUSCH Type A repetitions | K = 1, 2, 3, 4, 7, 8, 12, 16, 20, 24, 28, 32 times repetitions.The number of repetitions is indicated in a TDRA list. A row index of the TDRA list is indicated by a DCI or a configured grant configuration. | [5-14] or [5-16], or [5-17] | UE does not support more than 16 repetitions for ~~dynamic grant~~ PUSCH repetition type A. | ~~[~~Per UE~~]~~ | No | No | N/A |
|  ~~30. NR\_cov\_enh~~ | ~~30-1a~~ | ~~Increased maximum number of Type 2 configurecd grant PUSCH Type A repetitions~~ | ~~K = 1, 2, 3, 4, 7, 8, 12, 16, 20, 24, 28, 32 times repetitions.~~~~The number of repetitions is indicated in a TDRA list. A row index of the TDRA list is indicated by a Type 2 configured grant configuration.~~~~FFS whether to merge with FG 30-1~~~~FFS whether to have a separate FG for CG (including both Type 1 and Type 2) with repK-r17~~ | ~~[5-16], [30-1]~~ | ~~UE does not support more than 16 repetitions for Type 2configurecd grant PUSCH.~~ | ~~[Per UE]~~ | ~~No~~ | ~~No~~ | ~~N/A~~ |
|  30. NR\_cov\_enh | 30-2 | ~~Dynamic gra~~nt PUSCH Type A repetitions based on available slots | Transmission occasions for K repetitions are determined on the basis of available slots. | [5-14] or [5-16], or [5-17] | UE does not support ~~dynamic grant~~ PUSCH repetitions counted on the basis of available slots. | ~~[~~Per UE~~]~~ | FFS | No | N/A |
| ~~30. NR\_cov\_enh~~ | ~~30-2a~~ | ~~Configurecd grant PUSCH Type A repetitions based on available slots~~ | ~~Transmission occasions for K repetitions for configured grant PUSCH are determined on the basis of available slots.~~ ~~FFS whether to merge with FG 30-2~~ | ~~[5-14 or 5-16], [30-2]~~ | ~~UE does not support configured grant PUSCH repetitions counted on the basis of available slots.~~ | ~~[Per UE]~~ | ~~FFS~~ | ~~No~~ | ~~N/A~~ |

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| [9] | NTT DOCOMO | At the RAN1#107bis-e meeting, the structure of FGs 30-1 to 30-3a was discussed. The main discussion points are whether/how to separate/merge FG for DG and FG for CG, and the granularity, e.g. per UE or per band. Although they are basically different discussion points, considering the stuck situation in the last RAN1 meeting, following options can be considered. Opt.1 Merged DG/CG structure with per UE granularityOpt.2 Merged DG/CG structure with per band granularityOpt.3 Separated DG/CG structure with per UE granularityOpt.4 Separated DG/CG structure with per band granularityOur preference is Opt.1 since RRC parameter is/can be common for DG and CG, and the features are not band specific features. On the other hands, we also understand the IODT aspect for early release of the functions to the market, we can live with Option 3 for progress of the discussion. Regarding the granularity, if per UE granularity brings concerns for IODT for specific scenarios/features e.g. NTN or unlicensed bands, the granularity can be considered per scenarios/features, not per band. **Proposal 1: For FGs 30-1 to 30-3a, either of the following FG structures is adopted*** **Separated DG/CG structure with per UE granularity**
* **Merged DG/CG structure with per UE granularity.**
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| [10] | Spreadtrum Communication | * Separate FGs and Type
	+ Separate DG and CG-PUSCH FGs for FG 30-1 and FG 30-1a, FG 30-2 and FG 30-2a, FG 30-3, and FG 30-3a.
		- FG 30-1 and FG 30-1a should be separate, just to keep consistent with DG-PUSCH repetition and CG-PUSCH repetition with separate UE features in Rel-15. FGs 30-2a and 30-2, FGs 30-3a, and 30-3 are in the same situation, those two features should be separately reported.
	+ Type: Per band.
		- First of all, the uplink coverage enhancements features can be applied to different bands. Clearly, different band may have different requirement and sub-group features.
* For compromise, for the proposal from the FL in RAN1 107b-e, we can live with the compromised proposal.

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| *High priority compromised proposal 2-1’/2-2’/3-1’/3-5’:** *Merge FGs 30-1 and 30-1a into an FG for DG, type 1 and 2 CG. Merged FG 30-1 has per band granularity*
* *Merge FGs 30-2 and 30-2a into an FG for DG, type 1 and 2 CG. Merged FG 30-2 has per band granularity*
* *FG 30-3 is not split into 2 separate FGs: 1st one for DG, 2nd one for CG. FG 30-3 has per band granularity*
* *FG 30-3a is not separated to multiple FGs. FG 30-3a has per band granularity*
 |

* Prerequisite
	+ FG 30-1: FG 5-17
	+ FG 30-1a: FG 5-16.
		- Do not include 30-1, CG-PUSCH and DG-PUSCH are two separate FG. DG-PUSCH is not the prerequisite FG for CG-PUSCH.
	+ FG 30-2: FG 5-17
	+ FG 30-2a: FG 5-14 or 5-16.
		- Do not need 30-2, CG-PUSCH and DG-PUSCH are two separate FG. DG-PUSCH is not the prerequisite FG for CG-PUSCH.
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| [11] | Intel Corporation | At the RAN1#107b-e meeting, it was agreed to further discuss whether/how to separate/merge FGs 30-1 and 30-1a, FGs 30-2 and 30-2a for PUSCH reception type A enhancement, respectively [1]. In our view, it is more appropriate to divide the UE feature group into DG-PUSCH and CG-PUSCH for both increased maximum number of repetitions and PUSCH repetition type A with counting based on available slots. In this regard, current structure needs to be kept and merging FG 30-1a with FG 30-1, and FG 30-2a with FG 30-2 is not necessary. At the RAN1#107-e meeting, it was agreed that increased maximum number of repetitions is supported for Type 1 and Type 2 CG-PUSCH. In particular, *repK* in *ConfiguredGrantConfig* supports up to 32 repetitions [1]. Based on this agreement, Type 1 CG-PUSCH needs to be included as part of FG30-1a. Based on the discussions above, Table 1 illustrates suggested update for UE feature groups for PUSCH repetition type A enhancement. Table 1. UE feature groups for PUSCH repetition type A enhancement

|  |  |  |
| --- | --- | --- |
| **Index** | **Feature group** | **Components** |
| 30-1 | Increased maximum number of dynamic grant PUSCH Type A repetitions | K = 1, 2, 3, 4, 7, 8, 12, 16, 20, 24, 28, 32 times repetitions.The number of repetitions is ~~jointly coded with SLIV~~ indicated in a TDRA list. A row index of the TDRA list is indicated by a DCI. |
| 30-1a | Increased maximum number of ~~Type 2~~ configured grant PUSCH Type A repetitions | K = 1, 2, 3, 4, 7, 8, 12, 16, 20, 24, 28, 32 times repetitions.The number of repetitions is ~~jointly coded with SLIV~~ indicated in a TDRA list and by repK-r17. A row index of the TDRA list is indicated by a Type 1 and Type ~~1~~2 configured grant configuration. |
| 30-2 | Dynamic grant PUSCH Type A repetitions based on available slots | Transmission occasions for K repetitions are determined on the basis of available slots. ~~RV is cycled across transmission occasions.~~ |
| 30-2a | Configured grant PUSCH Type A repetitions based on available slots | Transmission occasions for K repetitions for Type 1 and Type 2 configured grant PUSCH are determined on the basis of available slots. ~~RV is cycled across transmission occasions.~~ |

**Proposal 1*** For UE feature groups of PUSCH repetition type A enhancement,
	+ Option 1 is adopted, i.e., keep current structure with FG 30-1 and FG 30-2 for DG, 30-1a and 30-2a for type 1 and 2 CG.
	+ UE features for PUSCH repetition type A enhancement are defined per UE.
	+ FDD/TDD differentiation is not necessary.
	+ Consider Table 1 for UE feature groups of PUSCH repetition type A enhancement.
 |
| [12] | Apple | In RAN1#107-e meeting, it was agreed that type 1 CG PUSCH supports 32 repetitions via the parameter *RepK-r17*, and this parameter is also applied to type 2 CG PUSCH as well. Accordingly, the FG30-1a can be updated to support type 1 configured grant PUSCH type A repetitions, one additional component can be added that repetition can be indicated via *RepK-r17*. Regarding FG30-2a, Similar as 30-1a, different parameter, i.e., *RepK-r17,* is used to indicate the repetition number which is different from FG30-2, it should be an independent FG. In addition, the implementation preference for dynamic grant and configured grant are different. To facilitate the coverage enhancement feature deployment in market, it’s better to define separated FG for the dynamic grant and configured grant to avoid without IODT test. **Proposal 1: Keeping FG30-1a and FG30-2a as independent FG group.** **Proposal 2: The component of 30-1a is updated to support Type 1 configured grant PUSCH. Adding FG5-14 as Prerequisite feature group for FG 30-1a** **K = 1, 2, 3, 4, 7, 8, 12, 16, 20, 24, 28, 32 times repetitions.**1. **The number of repetitions is indicated in a TDRA list. A row index of the TDRA list is indicated by a Type 2 configured grant configuration.**
2. **The number of repetitions is indicated in *RepK-r17* for both Type 1 and Type 2 configured grant PUSCH.**
 |
| [13] | CMCC | **Proposal 1:*** **Merge FGs 30-1 and 30-1a into an FG for DG, type 1 and 2 CG. Merged FG 30-1 has per UE granularity**
* **Merge FGs 30-2 and 30-2a into an FG for DG, type 1 and 2 CG. Merged FG 30-2 has per UE granularity**
* **FG 30-3 is not split into 2 separate FGs: 1st one for DG, 2nd one for CG. FG 30-3 has per UE granularity**
* **FG 30-3a is not separated to multiple FGs. FG 30-3a has per UE granularity**

**Proposal 2:****CG and DG could be differentiated through the prerequisite features.** **Proposal 3:****It is not necessary to differentiate between TDD and FDD for FG 30-1/1a, 2/2a, 3/3a.** |
| [14] | Xiaomi |

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| **Agreement*** Further discuss whether/how to separate/merge FGs 30-2 and 30-2a from following options
	+ Option 1: Keep current structure, i.e., FGs 30-2 for DG, 30-2a for type 1 and 2 CG
	+ Option 3: Merge FGs 30-2 and 30-2a into an FG
 |

Some companies support FGs 30-1 and 30-1a can be merged into a single FG because they hope DG and CG PUSCH type A repetition based on available slots can be supported together as a whole feature and RRC parameter “*numberOfRepetitions-r17* “ is introduced in TDRA table, this parameter is common for DG-PUSCH and Type 2 CG-PUSCH. While other companies argue that features for repetition for DG-PUSCH and Type2 CG-PUSCH are independent with each other and from the implementation point of view, this semi-static configuration method is quite different from DCI indicated the repetition number. From the point of us, if separate FGs are adopted, it will provide convenience for IODT and benefit for UE implementation when some use cases may only support DG or CG PUSCH. Thus, keep consistent with DG-PUSCH repetition and CG-PUSCH repetition with separate UE features in Rel-15 is acceptable.**Proposal 1: Option 1 is acceptable.**It was also discussed that the FGs are supported per UE or per band. Although merged FGs 30-1 and 30-2 are both related to the PUSCH Type A repetitions and the uplink coverage enhancements features can be applied to different bands. But considering different bands may have different requirements and sub-group features, especially for licensed band, un-licensed band and NTN band, it is better to support FGs 30-1 and FGs 30-2 per band.**Proposal 2： FGs 30-1 and FGs 30-2 can be supported per band.**  |
| [15] | Ericsson | The following agreement on the support for an increased maximum number of PUSCH Type A repetitions was reached in RAN1#107bis-e. There was no consensus on separate FGs for DG-PUSCH and CG-PUSCH or a merged FG for increased maximum number of repetitions.

|  |
| --- |
| **Agreement*** Further discuss whether/how to separate/merge FGs 30-1 and 30-1a from following options
	+ Option 1: Keep current structure, i.e. FG 30-1 for DG, 30-1a for type 1 and 2 CG
	+ Option 3: Merge FGs 30-1 and 30-1a into an FG
 |

In Rel-16, PUSCH repetition Type A was enhanced with the support of dynamic repetition factor. [11-6] is the only FG for it, and its prerequisite FG is one of {5-16, 5-17}. In Rel-16, there was no separate FGs for DG-PUSCH and CG-PUSCH regarding the dynamic repetition factor. The prerequisite FG, one of {5-16, 5-17}, indicates [11-6] doesn’t force UE to support of both DG-PUSCH [5-17] and Type 2 CG-PUSCH [5-16]. Instead, if a UE doesn’t support [5-16] but indicates its support of [11-6] and [5-17], it means it supports DG-PUSCH with dynamic repetition factor. Similarly, for the merged Rel-17 FG of increased maximum number of PUSCH Type A repetitions, the prerequisite FGs can be [5-17 or 5-16 or 5-14]. A UE doesn’t have to support all of {5-16, 5-17, 5-14} to indicate support for the merged FG.1.
* Merge FGs 30-1 and 30-1a into one FG. Its prerequisite FGs can be [5-17 or 5-16 or 5-14].

Similar rationale can be applied to PUSCH Type A repetitions based on available slots, based on the following agreement.

|  |
| --- |
| **Agreement*** Further discuss whether/how to separate/merge FGs 30-2 and 30-2a from following options
	+ Option 1: Keep current structure, i.e., FGs 30-2 for DG, 30-2a for type 1 and 2 CG
	+ Option 3: Merge FGs 30-2 and 30-2a into an FG
 |

1.
* Merge FGs 30-2 and 30-2a into one FG. Its prerequisite FGs can be [5-17 or 5-16 or 5-14].

Per-UE capability is preferred for the merged FGs, because the feature is mainly about baseband. We can discuss per-band capability if needed, for example to solve the concern of IoDT test.1.
* Per-UE capability is preferred for the merged FG of 30-1 and 30-1a and the merged FG of 30-2 and 30-2a.

For Type A PUSCH repetition, a set of UE features discussed so far are summarized and updated in Table 1. Table 1: Capabilities for PUSCH Repetition Type A Enhancement

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups | Comments |
| 30-1 | Increased maximum number of ~~dynamic grant~~ PUSCH Type A repetitions with dynamic grant or Type 2 configured grant or Type 1 configured grant | K = 1, 2, 3, 4, 7, 8, 12, 16, 20, 24, 28, 32 times repetitions, where t~~T~~he number of repetitions is indicated in a TDRA list. A row index of the TDRA list is indicated by a DCI or a Type 2 configured grant configuration.K = 1, 2, 4, 8, 12, 16, 24, 32 times repetitions, where the number of repetitions is configured in RRC parameter for Type 1 and Type 2 configured grant configuration. | [5-17] or [5-16] or [5-14] |  |
| ~~30-1a~~ | ~~Increased maximum number of Type 2 configurecd grant PUSCH Type A repetitions~~ | ~~K = 1, 2, 3, 4, 7, 8, 12, 16, 20, 24, 28, 32 times repetitions~~~~The number of repetitions is indicated in a TDRA list. A row index of the TDRA list is indicated by a Type 2 configured grant configuration.~~~~FFS whether to merge with FG 30-1~~~~FFS whether to have a separate FG for CG (including both Type 1 and Type 2) with repK-r17~~ | ~~[5-16], [30-1]~~ |  |
| 30-2 | Dynamic grant or configured grant PUSCH Type A repetitions based on available slots | Transmission occasions for K repetitions are determined on the basis of available slots.  | [5-17] or [5-16] or [5-14] |  |
| ~~30-2a~~ | ~~Configured grant PUSCH Type A repetitions based on available slots~~ | ~~Transmission occasions for K repetitions for configured grant PUSCH are determined on the basis of available slots.~~ ~~FFS whether to merge with FG 30-2~~ | ~~[5-14 or 5-16], [30-2]~~ |  |

1. UE features for PUSCH Repetition Type A Enhancement are defined according to Table 1.
 |
| [16] | Samsung | So far, the major discussion point of FG for coverage enhancement was whether to split/merge the corresponding FGs. During the discussion, it was pointed out that RAN2 guidelines [2] had provided to avoid defining functionality that has no RRC configuration but is dependent on capability bits (copied below for the reference). Unless otherwise justified, it is still valid for Rel-17 UE capability discussion:

|  |
| --- |
| *RAN2 guidelines for UE capability definitions [2]**…***5 Avoid defining functionality that has no RRC configuration but is dependent on capability bits.**The specification should not be written so that the network determines what configuration it can use for a UE implicitly by the reported UE capabilities. Instead, the gNB should always configure the UE explicitly by DL RRC signalling, respecting the reported capabilities. A problematic case in Rel-15 was the UL/DL MIMO layers, which resulted in a late-stage introduction of explicit MIMO signalling support by RAN2 (maxLayersMIMO-Indication).  |

In previous meetings, RAN1 has kept debating whether to split the FGs 30-1/1a, 30-2/2a, and 30-3 according to DG and CG.In case of PUSCH repetition Type A enhancements, RAN1 has agreed the introduction of *repK-r17* applicable to Type 1 CG-PUSCH and Type 2 CG-PUSCH while *numberOfRepetitions-r17* is not applicable to Type 1 CG-PUSCH repetition Type A. This seems to resolve the raised concern during RAN1#107-e with respect to above RAN2 guidelines.In this regard, we are fine to keep current FG structure for FG 30-1/1a/2/2a for the sake of progress. Further, we suggest to remove FFSs in FG 30-1a/2a.**Proposal 1: Keep current FG structure for FG 30-1/1a/2/2a and remove FFSs.** |
| [17] | MediaTek Inc. | Considering the test cost and the applicability/support of the band (e.g., licensed band and unlicensed band), per band support is more preferred for all features.Proposal 1: All features are per band.All features of coverage enhancements are to improve performance rather than the basic features to build a new function. All features should be optional with capability signalling.Proposal 2: All UE features are optional with capability signallingFor the agreement below, we support Option 1.**Agreement*** Further discuss whether/how to separate/merge FGs 30-1 and 30-1a from following options
	+ Option 1: Keep current structure, i.e. FG 30-1 for DG, 30-1a for type 1 and 2 CG
	+ Option 3: Merge FGs 30-1 and 30-1a into an FG

Proposal 3: Support Option 1.For the agreement below, we support Option 1.**Agreement*** Further discuss whether/how to separate/merge FGs 30-2 and 30-2a from following options
	+ Option 1: Keep current structure, i.e., FGs 30-2 for DG, 30-2a for type 1 and 2 CG
	+ Option 3: Merge FGs 30-2 and 30-2a into an FG

Proposal 4: Support Option 1. |
| [18] | Qualcomm | **General remark applicable to all features for NR coverage enhancement****Proposal 1:** Unless otherwise stated, the type for a UE feature should be at least per band (if not with finer granularity type), given the potential UE testing differentiation among licensed, unlicensed, and NTN band.**On PUSCH Type A repetition enhancements**On the question of UE supporting PUSCH Type A repetition enhancements based on CG or DG, we support the compromise proposal discussed in the last meeting, where it was proposed to have a single capability for both CG and DG but indicated at a per band granularity. **Proposal 2:** UE capabilities for enhanced PUSCH Type A repetitions are defined as follows:* Merge FGs 30-1 and 30-1a into an FG for DG, type 1 and 2 CG. Merged FG 30-1 has per band granularity
* Merge FGs 30-2 and 30-2a into an FG for DG, type 1 and 2 CG. Merged FG 30-2 has per band granularity
 |
| [19] | Sharp | In RAN1#107bis-e, it was actively discussed whether to merge/separate FGs for DG-PUSCH and CG-PUSCH. Similar discussions were held for PUSCH repetition Type A with the increased maximum number of repetitions, PUSCH repetition Type A with the available slot counting and TBoMS. Companies had different views, and any consensus was made between them. After several rounds of discussions, the moderator provided the following set of proposals. However, still no consensus on it was achieved.

|  |
| --- |
| **High priority compromised proposal** **2-1’/2-2’/3-1’/3-5’:*** Merge FGs 30-1 and 30-1a into an FG for DG, type 1 and 2 CG. Merged FG 30-1 has per band granularity
* Merge FGs 30-2 and 30-2a into an FG for DG, type 1 and 2 CG. Merged FG 30-2 has per band granularity
* FG 30-3 is not split into 2 separate FGs: 1st one for DG, 2nd one for CG. FG 30-3 has per band granularity
* FG 30-3a is not separated to multiple FGs. FG 30-3a has per band granularity
 |

In principle, our view is that too much segmentation of FGs should be avoided. UEs with a variety of CovEnh capabilities would lead to less motivation to implement each of CovEnh functions for the network due to less gain. From this perspective, it is desirable to merge FGs for DG and CG.For Rel-16, on one hand, the UE capability parameter *pusch-RepetitionTypeA-r16* is reported with per-UE basis. On the other hand, *type1-PUSCH-RepetitionMultiSlots-v1650* and *type2-PUSCH-RepetitionMultiSlots-v1650* are per-band UE capability parameters, though there is the restriction that the capability value should be set consistently for all FDD-FR1 bands, all TDD-FR1 bands and all TDD-FR2 bands respectively.Considering the above, the compromised proposal 2-1’/2-2’/3-1’/3-5’, i.e., merging FGs for CG and CG with keeping the same per-band configurability as in Rel-16 CG, can be considered as reasonable.**Proposal 1:**Take the moderator’s compromised proposal 2-1’/2-2’/3-1’/3-5’:* Merge FGs 30-1 and 30-1a into an FG for DG, type 1 and 2 CG. Merged FG 30-1 has per band granularity
* Merge FGs 30-2 and 30-2a into an FG for DG, type 1 and 2 CG. Merged FG 30-2 has per band granularity
* FG 30-3 is not split into 2 separate FGs: 1st one for DG, 2nd one for CG. FG 30-3 has per band granularity
* FG 30-3a is not separated to multiple FGs. FG 30-3a has per band granularity
 |

## **Discussion**

**[FL1] High priority question 2-1:**

* **Companies are encouraged to provide views on whether/how to separate/merge FGs 30-1 and 30-1a, e.g.,**
	+ Option 1: Keep current structure, i.e. FG 30-1 for DG, 30-1a for type 1 and 2 CG
		- vivo, NOKIA, DOCOMO, Spreadtrum (1st preference), Intel, Apple, Xiaomi, Samsung, MediaTek
		- *No strong reason to further split*
	+ Option 3: Merge FGs 30-1 and 30-1a into an FG
		- Huawei, HiSilicon, ZTE, OPPO, CATT, China Telecom, DOCOMO, Spreadtrum (2nd preference), CMCC, Ericsson
		- With per band granularity : Qualcomm, Sharp
		- *RRC parameter “numberOfRepetitions-r17” is introduced in TDRA table and the parameter is common for DG-PUSCH and Type 2 CG-PUSCH.*
* **Companies are encouraged to provide views on the granularity of FGs 30-1 and 30-1a, e.g.,**
	+ **Per UE**
		- ZTE, NOKIA, China Telecom, DOCOMO, Intel, CMCC, Ericsson
	+ **Per band**
		- CATT, Spreadtrum, Xiaomi,MediaTek, Qualcomm, Sharp

|  |  |
| --- | --- |
| Company | Comment |
| Moderator | This issue was discussed in the last RAN1 meeting but no consensus was achieved. Companies are strongly encouraged to provide view which options you can live with. |
| NTT DOCOMO | We prefer Option 3. However, we can compromise Option 1 if the FGs are per UE. If IODT for the specific scenarios, e.g. NTN or unlicensed band, are concerned, we are fine with introducing the FG per scenario. |
| Samsung | It is time to conclude the repeated discussion. We can live with either option. |
| Intel | Option 1 with Per UE.  |
| Panasonic | Our first preference is to Option 1, but we also understand the need of the compromise to Option 3. Per UE with NTN and unlicensed are separation is our preference for the test effort difference and minimize the signaling compared with per band. |

**[FL1] High priority question 2-2:**

* **Companies are encouraged to provide views on whether/how to separate/merge FGs 30-2 and 30-2a, e.g.,**
	+ Option 1: Keep current structure, i.e. FG 30-1 for DG, 30-1a for type 1 and 2 CG
		- vivo, NOKIA, DOCOMO, Spreadtrum (1st preference), Intel, Apple, Xiaomi, Samsung, MediaTek
		- *No strong reason to further split*
	+ Option 3: Merge FGs 30-1 and 30-1a into an FG
		- Huawei, HiSilicon, ZTE, OPPO, CATT, China Telecom, DOCOMO, Spreadtrum (2nd preference), CMCC, Ericsson
		- With per band granularity : Qualcomm, Sharp
		- *RRC parameter “numberOfRepetitions-r17” is introduced in TDRA table and the parameter is common for DG-PUSCH and Type 2 CG-PUSCH.*
* **Companies are encouraged to provide views on the granularity of FGs 30-2 and 30-2a, e.g.,**
	+ **Per UE**
		- ZTE, NOKIA, China Telecom, DOCOMO, Intel, CMCC, Ericsson
			* *not band specific feature*
	+ **Per band**
		- CATT, Spreadtrum, Xiaomi,MediaTek, Qualcomm, Sharp
			* *different band may have different requirement and sub-group features*
			* *potential UE testing differentiation among licensed, unlicensed, and NTN band*

|  |  |
| --- | --- |
| Company | Comment |
| Moderator | This issue was discussed in the last RAN1 meeting but no consensus was achieved. Especially for FG 30-2/2a, this conclusion affects corresponding RRC parameters, which should be concluded asap. Companies are strongly encouraged to provide view which options you can live with. |
| NTT DOCOMO | We prefer Option 3. However, we can compromise Option 1 if the FGs are per UE. If IODT for the specific scenarios, e.g. NTN or unlicensed band, are concerned, we are fine with introducing the FG per scenario. |
| Samsung | (same comment as above) It is time to conclude the repeated discussion. For the sake of progress, we can live with either option.BTW, we understand above options 1 and 2 are for FG 30-2/2a not 30-1/1a. |
| Intel | Same comment as above. Option 1 with Per UE |
| Panasonic | Our first preference is to Option 1, but we also understand the need of the compromise to Option 3. Per UE with NTN and unlicensed are separation is our preference for the test effort difference and minimize the signaling compared with per band. |

**Low priority question 2-3:**

* **Companies are encouraged to provide views on whether/how to revise the prerequisite feature groups for FGs 30-1 to 30-2a**

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

**Low priority question 2-4:**

* **Companies are encouraged to provide views on whether/how to revise any other contents in FGs 30-1 to 30-2a which do not have capability signaling impacts**

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

# **30-3 to 30-3a: TB processing over multi-slot PUSCH**

In [1], FGs 30-3 to 30-3a 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 |
| 30. NR\_cov\_enh | 30-3 | TB processing over multi-slot PUSCH | Support of TB processing over multi-slot PUSCH for DG and CG in RRC connected mode.FFS whether to split FG 30-3 into at least 2 separate FGs: 1st one for DG, 2nd one for CG | [11-6] | Yes | N/A | UE does not support TB processing over multi-slot PUSCH. | [Per UE] | FFS | No | N/A |  | Optional with capability signalling |
| 30. NR\_cov\_enh | 30-3a | Repetition of TB processing over multi-slot PUSCH | Support repetition of TB processing over multi-slot PUSCH in RRC connected mode. | TBD | Yes | N/A |  | [Per UE] | FFS | No | N/A |  | Optional with capability signalling |

Following feedbacks are provided in contributions for the RAN1#108-e meeting.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [2] | Huawei, HiSilicon | ***Proposal 1:*** *For the features about enhanced PUSCH repetition type A and TBoMS,** *Only one FG for both CG and DG is sufficient.*

*The granularities should be discussed separately.*For FG 30-3/3a, considering that TBoMS is applicable to services not larger than 1 CB, e.g. VoIP, scheduling across multiple bands is not necessary. We prefer per band.For other features except for FG 30-4/4a/4b/4c/4d/4e/4f/4g and FG 30-3/3a, there is no particular reason to apply other granularities. Per UE is sufficient.***Proposal 5:*** *For the type of the granularity,* * *Per band for FG 30-3/3a*

|  |  |  |  |
| --- | --- | --- | --- |
| 30. NR\_cov\_enh | 30-3 | TB processing over multi-slot PUSCH | ~~[11-6]~~ |
| 30. NR\_cov\_enh | 30-3a | Repetition of TB processing over multi-slot PUSCH | ~~TBD~~30-3 |

 |
| [3] | vivo | feature 30-2, i.e., type-A PUSCH repetitions counted on available slots, should be considered as prerequisite feature for feature 30-3.**Proposal 3: For TBoMS, feature 30-2 should be included as prerequisite feature for feature 30-3.** **Besides, FG 30-2 is split to 2 separate FGs, i.e. one for CG and one for DG. Similarly, FG 30-3 should be split into 2 FGs for CG and DG respectively.****Proposal 4: For TBoMS, split FG 30-3 into 2 FGs for DG and CG respectively.** |
| [4] | ZTE | ***Proposal 3:*** *Keep current structure for FG 30-3, i.e., Option 1 is adopted.* * *Per UE reporting is supported.*
 |
| [5] | OPPO | In our view, TBoMS capability for DG and CG can be merged in the same FG, as shown in current structure. TBoMS for DG and CG are supported as a whole feature. Option 1 is proposed.***Proposal 3：Keep current structure of FG30-3.***  |
| [6] | CATT | Similar to FG 30-1 and FG 30-2, we are fine with not to split them into separate FGs, with a granularity of ‘per band’ level.Specifically, we do not see strong need to differentiate TDD and FDD bands, as available slot counting can be applied to both TDD and FDD bands. Regarding to the prerequisite of FG 30-3, we do not think there is strong correlation with FG 11-6, so no prerequisite is preferred. For FG 30-3a, the prerequisite can be FG 30-3.**Proposal 3: FG 30-3 and FG 30-3a are updated with ‘per band’ granularity as follows.**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 30-3 | TB processing over multi-slot PUSCH | Support of TB processing over multi-slot PUSCH for DG and CG in RRC connected mode.~~FFS whether to split FG 30-3 into at least 2 separate FGs: 1st one for DG, 2nd one for CG~~ | ~~[11-6]~~ | Yes | N/A | UE does not support TB processing over multi-slot PUSCH. | ~~[Per UE]~~ Per band | ~~FFS~~ No | No | N/A |  |
| 30-3a | Repetition of TB processing over multi-slot PUSCH | Support repetition of TB processing over multi-slot PUSCH in RRC connected mode. | ~~TBD~~ 30-3 | Yes | N/A |  | ~~[Per UE]~~ Per band | ~~FFS~~ No | No | N/A |  |

 |
| [7] | Nokia | * **30-3:**
	+ Confirm FG description
	+ OK to split in 2 FGs for DG ad CG, for consistency with other FGs for coverage enhancements
	+ Per UE
 |
| [8] | China Telecom | Similar with PUSCH repetition type A, we don’t see much difference for DG-PUSCH and CG-PUSCH to support TBoMS, so separate FGs for DG-PUSCH and CG-PUSCH are not needed. Regarding the granularity, we think per UE is sufficient. It seems not necessary to differentiate FDD/TDD.**Proposal 2: FGs for TB processing over multi-slots.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | Index | Feature group | Components | Prerequisite feature groups | **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 |
| 30. NR\_cov\_enh | 30-3 | TB processing over multi-slot PUSCH | Support of TB processing over multi-slot PUSCH for DG and CG in RRC connected mode.~~FFS whether to split FG 30-3 into at least 2 separate FGs: 1st one for DG, 2nd one for CG~~ | ~~[11-6]~~ | UE does not support TB processing over multi-slot PUSCH. | ~~[~~Per UE~~]~~ | ~~FFS~~No | No | N/A |
| 30. NR\_cov\_enh | 30-3a | Repetition of TB processing over multi-slot PUSCH | Support repetition of TB processing over multi-slot PUSCH in RRC connected mode. | ~~TBD~~30-3 | UE does not support repetition of TB processing over multi-slot PUSCH. | ~~[~~Per UE~~]~~ | ~~FFS~~No | No | N/A |

 |
| [9] | NTT DOCOMO | **Proposal 1: For FGs 30-1 to 30-3a, either of the following FG structures is adopted*** **Separated DG/CG structure with per UE granularity**
* **Merged DG/CG structure with per UE granularity.**

**Proposal 2: There is no prerequisite FG of FG 30-3.****Proposal 3: The prerequisite FGs of FG 30-3a should be FGs 11-6, FG 30-3, and merged FGs 30-2 and 30-2a.** |
| [10] | Spreadtrum Communication | In principle, our view is that too much segmentation of FGs should be avoided. UEs with a variety of CovEnh capabilities would lead to less motivation to implement each of CovEnh functions for the network due to less gain. From this perspective, it is desirable to merge FGs for DG and CG.For Rel-16, on one hand, the UE capability parameter *pusch-RepetitionTypeA-r16* is reported with per-UE basis. On the other hand, *type1-PUSCH-RepetitionMultiSlots-v1650* and *type2-PUSCH-RepetitionMultiSlots-v1650* are per-band UE capability parameters, though there is the restriction that the capability value should be set consistently for all FDD-FR1 bands, all TDD-FR1 bands and all TDD-FR2 bands respectively.Considering the above, the compromised proposal 2-1’/2-2’/3-1’/3-5’, i.e., merging FGs for CG and CG with keeping the same per-band configurability as in Rel-16 CG, can be considered as reasonable.**Proposal 1:**Take the moderator’s compromised proposal 2-1’/2-2’/3-1’/3-5’:* Merge FGs 30-1 and 30-1a into an FG for DG, type 1 and 2 CG. Merged FG 30-1 has per band granularity
* Merge FGs 30-2 and 30-2a into an FG for DG, type 1 and 2 CG. Merged FG 30-2 has per band granularity
* FG 30-3 is not split into 2 separate FGs: 1st one for DG, 2nd one for CG. FG 30-3 has per band granularity
* FG 30-3a is not separated to multiple FGs. FG 30-3a has per band granularity
 |
| [11] | Intel Corporation | Table 2. UE feature groups for TBoMS

|  |  |  |
| --- | --- | --- |
| **Index** | **Feature group** | **Components** |
| 30-3 | TB processing over multi-slot PUSCH for DG-PUSCH | Support of TB processing over multi-slot PUSCH in RRC connected mode for DG-PUSCH. |
| 30-3a | TB processing over multi-slot PUSCH for CG-PUSCH | Support of TB processing over multi-slot PUSCH in RRC connected mode for CG-PUSCH. |

**Proposal 2*** For UE feature groups of TBoMS,
	+ Option 3 is adopted, i.e., split 30-3 into 2 separate FGs: 1st one for DG, 2nd one for CG.
	+ UE features for TBoMS are defined per UE.
	+ FDD/TDD differentiation is not necessary.
	+ Consider Table 2 for UE feature groups of TBoMS.
 |
| [12] | Apple | For FG30-3, the FG of dynamic grant scheduled TBoMS and configured grant based TBoMS can be separated defined, as the implementation and specification impacts are different, especially how to support type 1 configured grant for TBoMS is not clearly defined yet.**Proposal 3: FG30-3 is split into two separated FGs for dynamic grant based TBoMS and configured grant based TBoMS respectively.** |
| [13] | CMCC | **Proposal 1:*** **Merge FGs 30-1 and 30-1a into an FG for DG, type 1 and 2 CG. Merged FG 30-1 has per UE granularity**
* **Merge FGs 30-2 and 30-2a into an FG for DG, type 1 and 2 CG. Merged FG 30-2 has per UE granularity**
* **FG 30-3 is not split into 2 separate FGs: 1st one for DG, 2nd one for CG. FG 30-3 has per UE granularity**
* **FG 30-3a is not separated to multiple FGs. FG 30-3a has per UE granularity**
 |
| [14] | Xiaomi | As some companies mentioned in the last meeting, there are different implementation and specification impacts between DG and CG, and it is not clearly yet how to support type 1 configured grant for TBoMS. Also, it is more beneficial for IODT and the implementation of different use cases e.g., some network may only support DG or CG if separate FGs are adopted. So, it is better to split CG and DG into 2 separate FGs.**Proposal 3: Support splitting 30-3 into 2 separate FGs: 1st one for DG, 2nd one for CG.**For the prerequisite FG, although FG 30-3 utilize the similar time domain resource allocation mechanism with FG 11-6 which is the enhanced PUSCH repetition type A in Rel-16, there are still many differences between these two features, such as TBS calculation, RV determination for each allocated slot and so on. Therefore, it is difficult to say that the FG 11-6 is the prerequisite feature group for FG 30-3. Besides, several companies proposed that FG 30-2 is the prerequisite feature group for FG 30-3 since available slots determination for TBoMS just follows the same design of enhanced PUSCH repetition type A in Rel-17. However, considering that FG 30-2 still works based on the feature of PUSCH repetition type A in Rel-15, we can’t agree with this proposal.**Proposal 4: Don’t support taking FG 11-6 and FG 30-2 as the prerequisite feature groups for FG 30-3.**In addition, whether the currently mechanism of TBoMS PUSCH can work well in some bands without any additional enhancements, such as unlicensed bands or NTN bands, may need to be further discussed. And if any enhancement is needed, this feature may not be supported in these bands in Rel-17. Thus, to be conservative, the type of FG 30-3 could be supported per band.**Proposal 5: The type of FG 30-3 is per band.****Proposal 6: No need to differentiate between FDD and TDD bands, and between FR1 and FR2 bands for FG 30-3.**And, as for time domain resource allocation, TBS calculation, RV determination and etc. within one repetition of TBoMS, it follows the same rule as single TBoMS PUSCH. Therefore, we can take the repetition of TBoMS as the combination of a single TBoMS PUSCH and PUSCH repetition type A with available slot determination. And, FG 11-6 in Rel-16, FG 30-2, FG30-2a and FG 30-3 should be the prerequisite FGs for FG 30-3.**Proposal 7: FG 11-6, FG 30-2, FG 30-2a and FG 30-3 should be the prerequisite FGs for FG 30-3a.** |
| [15] | Ericsson | Table 2: Capabilities for Transport Block over Multi-slot PUSCH

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups | Comments |
| 30-3 | TB processing over multi-slot PUSCH | Support of TB processing over multi-slot PUSCH for DG ~~and~~ or CG without repetition in RRC connected mode.~~FFS whether to split FG 30-3 into at least 2 separate FGs: 1st one for DG, 2nd one for CG~~ | ~~[11-6]~~ |  |
| 30-3a | Repetition of TB processing over multi-slot PUSCH | Support Repetition of TB processing over multi-slot PUSCH in RRC connected mode. | ~~TBD~~[30-3], [11-6] |  |

1. UE features for transport block over multi-slot PUSCH are defined according to Table 2.
 |
| [16] | Samsung | For FG 30-3, we still do not see the need to split current FG. It was argued that FG associated with DG and CG were split in Rel-15 (e.g., FG 5-16/5-17). On the contrary, in Rel-16, a single capability (FG 11-5) consists of DG and CG. Moreover, NO SPLIT would be compliant with above RAN2 guidelines [2].**Proposal 2: Keep current FG structure for FG 30-3 and remove FFS.** |
| [17] | MediaTek Inc. | Proposal 5: Support Option 3. |
| [18] | Qualcomm | On the question of UE TBOMS based on CG or DG, we support the compromise proposal discussed in the last meeting, where it was proposed to have a single capability for both CG and DG, but indicated at a per band granularity. **Proposal 5:** UE capabilities for TBOMS are defined as follows:* FG 30-3 is retained and covers both CG and DG. FG 30-3 has per band granularity.
* FG 30-3a is retained and covers both CG and DG. FG 30-3a has per band granularity.

Since support for interlacing of TBOMS transmissions is not yet concluded, we suggest an additional capability in the following proposal:**Proposal 6:** Consider the following additional feature for TBOMS:* Maximum concurrent TBOMS transmissions supported by a UE within a carrier and across all carriers when operating in UL-CA.
 |
| [19] | Sharp | **Proposal 1:**Take the moderator’s compromised proposal 2-1’/2-2’/3-1’/3-5’:* Merge FGs 30-1 and 30-1a into an FG for DG, type 1 and 2 CG. Merged FG 30-1 has per band granularity
* Merge FGs 30-2 and 30-2a into an FG for DG, type 1 and 2 CG. Merged FG 30-2 has per band granularity
* FG 30-3 is not split into 2 separate FGs: 1st one for DG, 2nd one for CG. FG 30-3 has per band granularity
* FG 30-3a is not separated to multiple FGs. FG 30-3a has per band granularity
 |

## **Discussion**

**[FL1] High priority question 3-1:**

* **Companies are encouraged to provide views on whether/how to separate FG 30-3, e.g.,**
	+ Option 1: Keep current structure
		- Huawei, HiSilicon, CATT, CT, DCM, Spreadtrum Communication, CMCC, Ericsson, Samsung, Qualcomm, Sharp
		- *As Rel-16*
	+ Option 2: Split 30-3 into 2 separate FGs: 1st one for DG, 2nd one for CG
		- vivo, Nokia, Intel, Xiaomi, MTK
		- *implementation and specification impacts are different*
		- *how to support type 1 configured grant for TBoMS is not clearly defined yet*

|  |  |
| --- | --- |
| Company | Comment |
| Moderator | This issue was discussed in the last RAN1 meeting but no consensus was achieved. Companies are strongly encouraged to provide view which options you can live with. |
| NTT DOCOMO | We prefer Option 1. However, we can compromise Option 2 if the FGs are per UE. If IODT for the specific scenarios, e.g. NTN or unlicensed band, are concerned, we are fine with introducing the FG per scenario. |
| Samsung | Option 1 |
| Intel | Prefer a unified principle for PUSCH repetition type A and TBoMS.  |
| Panasonic | Our first preference is to Option 2, but we also understand the need of the compromise to Option 1. Per UE with NTN and unlicensed are separation is our preference for the test effort difference and minimize the signaling compared with per band. |

**[FL1] High priority question 3-2:**

* **Companies are encouraged to provide views on whether to add an FG for the maximum concurrent TBoMS transmissions supported by a UE across all carriers when operating in UL-CA**
	+ Support: Qualcomm

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | We should defer this discussion until some progress is made in AI 8.8.1.2. |
| Samsung | Same comment as previous meeting. Unless it is concluded in AI 8.8.1.2, it is pointless to discuss in UE feature session.  |
| Intel | Share similar view as other companies that we can wait for the progress in TBoMS AI.  |
| Panasonic | We should wait the discussion. |

**[FL1] High priority question 3-3:**

* **Companies are encouraged to provide views on whether/how to separate FG 30-3a for DG, type1 CG and type2 CG e.g.,**
	+ Keep current structure: Huawei, HiSilicon, CATT, CT, DCM, Spreadtrum Communication, CMCC, Ericsson, Qualcomm, Sharp

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | Keep the current structure, i.e. do not split. |
| NTT DOCOMO | We prefer to keep the current structure. |
| Samsung | Keep current structure |
| Intel | Keep current structure |

**Medium priority question 3-4:**

* **Companies are encouraged to provide views on whether the type of FG 30-3 should be per UE or per band**
	+ Per UE: Nokia, CT, DCM, Intel, CMCC
		- FDD/TDD differentiation
			* Not necessary: CT, Intel, CMCC, Xiaomi
		- FR1/FR2 differentiation
			* Not necessary: Xiaomi
	+ Per band: Huawei, HiSilicon, CATT, Spreadtrum Communication, Xiaomi, Qualcomm, Sharp

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | We prefer per UE. However, we can compromise per band, if the merged FG for DG/CG is agreed.  |
| Panasonic | Per UE with NTN, unlicensed, FR1/2 are separation is our preference for the test effort difference and minimize the signaling compared with per band. |
|  |  |

**Medium priority question 3-5:**

* **Companies are encouraged to provide views on whether the type of FG 30-3a should be per UE or per band**
	+ Per UE: CT, DCM, CMCC
		- FDD/TDD differentiation
			* Not necessary: CT, DCM, CMCC
	+ Per band: Huawei, HiSilicon, CATT, Spreadtrum Communication, Qualcomm, Sharp

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | We prefer per UE. However, we can compromise per band, if the merged FG for DG/CG is agreed.  |
| Panasonic | Per UE should be enough as repetition of TB would not be so band or FDD/TDD specific difference. |
|  |  |

**Low priority question 3-6:**

* **Companies are encouraged to provide views on whether/how to revise the prerequisite feature groups for FG 30-3**
	+ No prerequisite FG: Huawei, HiSilicon, CATT, DCM, Xiaomi, Ericsson
	+ FG 30-2: vivo

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

**Low priority question 3-7:**

* **Companies are encouraged to provide views on whether/how to revise the prerequisite feature groups for FG 30-3a**
	+ FG 30-3: Huawei, HiSilicon, CATT, CMCC
	+ FG 11-6 and 30-3: Ericsson,
	+ FG 11-6, 30-2, 30-2a, 30-3: DCM, Xiaomi

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

**Low priority question 3-8:**

* **Companies are encouraged to provide views on whether/how to revise any other contents in FGs 30-3 to 30-3a which do not have capability signaling impacts**

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

# **30-4 to 30-4g: DM-RS bundling**

In [1], FGs 30-4 to 30-4g 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 |
| 30. NR\_cov\_enh | 30-4 | [The maximum duration for DM-RS bundling] | The maximum duration during which UE is able to maintain power consisitency and phase continuity to support DM-RS bundling for PUSCH/PUCCHFFS dependence on modulation orderFFS dependence on back-to-back vs. non-back-to-back repetitions |  | Yes | N/A | UE does not support DM-RS bundling for PUSCH/PUCCH | [Per UE] | FFS | No | N/A |  | Optional with capability signalling |
|  30. NR\_cov\_enh | 30-4a | DM-RS bundling for PUSCH repetition type A | Support DM-RS bundling for PUSCH repetition type A | [30-4], [30-1] or [30-2] | Yes | N/A | UE does not Support DM-RS bundling for PUSCH repetition type A | [Per UE] | FFS | No | N/A |  | Optional with capability signalling |
|  30. NR\_cov\_enh | 30-4b | DM-RS bundling for PUSCH repetition type B | Support DM-RS bundling for PUSCH repetition type B | [30-4], [11-5] [30-1] | Yes | N/A | UE does not Support DM-RS bundling for PUSCH repetition type B | [Per UE] | FFS | No | N/A |  | Optional with capability signalling |
|  30. NR\_cov\_enh | 30-4c | DM-RS bundling for TB processing over multi-slot PUSCH | Support DM-RS bundling for TB processing over multi-slot PUSCH | [30-4], [30-3] | Yes | N/A | UE does not Support DM-RS bundling for TB processing over multi-slot PUSCH | [Per UE] | FFS | No | N/A | FFS whether to Add a note in FG 30-4c: “Note: If a UE reports support of FG [30-4a], 30-4c, [30-3] and/or 30-3a, the UE supports DMRS bundling for the repetitions of TBoMS” | Optional with capability signalling |
| 30. NR\_cov\_enh | 30-4d | DMRS bunding for PUCCH repetitions | Support DM-RS bundling for PUCCH repetitions for PUCCH formats 1/3/4 | [30-4], [4-23] | Yes | N/A | UE does not support DMRS bunding for PUCCH repetitions | [Per UE] | FFS | No | N/A |  | Optional with capability signalling |
| 30. NR\_cov\_enh | 30-4e | Enhanced inter-slot frequency hopping with inter-slot bundling for PUSCH | Support enhanced inter-slot frequency hopping with inter-slot bundling for PUSCH | [30-4a] or [30-4b] or [30-4c] | Yes | N/A | UE does not support enhanced inter-slot frequency hopping with inter-slot bundling for PUSCH | [Per UE] | FFS | No | N/A |  | Optional with capability signalling |
| 30. NR\_cov\_enh | 30-4f | Enhanced inter-slot frequency hopping for PUCCH repetitions with DMRS bundling | Enhanced inter-slot frequency hopping for PUCCH repetitions with DMRS bundling | [30-4d] | Yes | N/A | UE does not support Enhanced inter-slot frequency hopping for PUCCH repetitions with DMRS bundling | [Per UE] | FFS | No | N/A |  | Optional with capability signalling |
| 30. NR\_cov\_enh | 30-4g | Restart DM-RS bundling after the events that violate power consistency and phase continuity | Support restarting DM-RS bundling after the events that violate power consistency and phase continuity | [30-4] | Yes | N/A | UE does not support restarting DM-RS bundling after the events that violate power consistency and phase continuity | [Per UE] | FFS | No | N/A |  | Optional with capability signalling |
| 30. NR\_cov\_enh | 30-4h | DM-RS bundling for non-back-to-back transmission | Support DM-RS bundling for non-back-to-back transmission for consecutive slots for PUSCH and PUCCH only for corresponding supported back-to-back transmission FGs (30-4a, 30-4b, 30-4c, or 30-4d) | 30-4a, 30-4b, 30-4c, or 30-4d | Yes | N/A | UE does not Support DM-RS bundling for non-back-to-back transmission | [Per UE] | FFS | No | N/A |  | Optional with capability signalling |

Following feedbacks are provided in contributions for the RAN1#108-e meeting.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [2] | Huawei, HiSilicon | For the back-to-back transmissions and non-back-to-back transmissions, although a single value of maximum duration may be sufficient, it is safer to wait for RAN4’s input.***Proposal 2:*** *For FG 30-4, whether and how to report different value of the maximum duration for DMRS bundling for (a) different modulation orders (b)* *back-to-back and non-back-to-back, is up to RAN4.****Proposal 3:*** *FG 30-4b should be kept as a single FG.*FG 30-3 and FG 30-4a are unnecessary in the note, because 30-3 should be a prerequisite for FG 30-3a, and 30-4a is the feature of DMRS bundling for PUSCH repetition type A, not for TBoMS.***Proposal 4:*** *Add a note in FG 30-4c: “Note: If a UE reports support of FG 30-4c, 30-3a, the UE supports DMRS bundling for the repetitions of TBoMS”.*For FG 30-3/3a, considering that TBoMS is applicable to services not larger than 1 CB, e.g. VoIP, scheduling across multiple bands is not necessary. We prefer per band.For other features except for FG 30-4/4a/4b/4c/4d/4e/4f/4g and FG 30-3/3a, there is no particular reason to apply other granularities. Per UE is sufficient.***Proposal 5:*** *For the type of the granularity,* * *Per band for FG 30-4/4a/4b/4c/4d/4e/4f/4g*
* *Per band for FG 30-3/3a*
* *Per UE for other FGs.*

***Proposal 6:*** *For FG 30-1 to FG 30-6, FDD/TDD differentiation is not necessary.*

|  |  |  |  |
| --- | --- | --- | --- |
| 30. NR\_cov\_enh | 30-4 | ~~[~~The maximum duration for DM-RS bundling~~]~~ |  |
|  30. NR\_cov\_enh | 30-4a | DM-RS bundling for PUSCH repetition type A | ~~[~~30-4~~]~~, ~~[30-1] or [30-2]~~ 5-14 or 5-16 or 5-17 or 30-1 |
|  30. NR\_cov\_enh | 30-4b | DM-RS bundling for PUSCH repetition type B | ~~[~~30-4~~]~~, ~~[~~11-5~~]~~ ~~[30-1]~~  |
|  30. NR\_cov\_enh | 30-4c | DM-RS bundling for TB processing over multi-slot PUSCH | ~~[~~30-4~~]~~, ~~[~~30-3~~]~~ or 30-3a |
| 30. NR\_cov\_enh | 30-4d | DMRS bunding for PUCCH repetitions | ~~[~~30-4~~]~~, ~~[~~4-23~~]~~ |
| 30. NR\_cov\_enh | 30-4e | Enhanced Inter-slot frequency hopping with inter-slot bundling for PUSCH | ~~[~~30-4a~~]~~ or ~~[~~30-4b~~]~~ or ~~[~~30-4c~~]~~ |
| 30. NR\_cov\_enh | 30-4f | Enhanced inter-slot frequency hopping for PUCCH repetitions with DMRS bundling | ~~[~~30-4d~~]~~ |
| 30. NR\_cov\_enh | 30-4g | Restart DM-RS bundling after the events that violate power consistency and phase continuity | ~~[~~30-4~~]~~ |
| 30. NR\_cov\_enh | 30-4h | DM-RS bundling for non-back-to-back transmission | 30-4a, 30-4b, 30-4c or 30-4d |

 |
| [3] | vivo | For DMRS bundling related features, UEs may have different capabilities on maintaining phase continuity and power consistency on different bands, according to RAN4 LS R4-2202368 [2]. Hence, DMRS bundling related features should be per band.**Proposal 5: DMRS bundling related FGs should be per band.** |
| [4] | ZTE | Though we don’t see much necessity for such not, we are ok to add one note for better clarity if there is different understanding on this point. In our view, FG 30-4a, which is related to DMRS bundling of PUSCH repetition type A, has no impact on support of FG 30-4c, and FG 30-3 is not needed as it is clear a UE can support it if a UE reports FG 30-3a. Therefore, we have the following proposal. ***Proposal 5:*** *Add a note in FG 30-4c: “Note: If a UE reports support of FG 30-4c and 30-3a, the UE supports DMRS bundling for the repetitions of TBoMS.*  |
| [5] | OPPO | For the FG for non-back-to-back transmission, we prefer one FG for all FG30-4x for non-back-to-back transmission.***Proposal 4：Introduce one FG for all FG30-4x for non-back-to-back transmission.*****Agreement*** FGs 30-4 to 30-4d are not merged
	+ FFS: whether to Add a note in FG 30-4c: “Note: If a UE reports support of FG [30-4a], 30-4c, [30-3] and/or 30-3a, the UE supports DMRS bundling for the repetitions of TBoMS”

For the FFS on the note, we are fine to add the note to make it clearer.  |
| [6] | CATT | Regarding to the granularity of FGs for JCE (joint channel estimation), it is reasonable to make them as ‘per band’ level, since they are highly related to RF implementation, which should be sensitive to the working band. **Proposal 4: FGs for JCE (FG 30-4/4a/4b/4c/4d/4f/4g/4h) are updated with ‘per band’ granularity.** |
| [7] | Nokia | * **30-4/a/b/c/d:**
	+ Per band
* **30-4g:**
	+ Description of "Feature group" should be (changes are highlighted in red):
		- "Restart DM-RS bundling after the dynamic events that violate power consistency and phase continuity"
	+ Description of "Components" should be (changes are highlighted in red):
		- "Support restarting DM-RS bundling after the events triggered by DCI or MAC-CE that violate power consistency and phase continuity, except events which are triggered by DCI or MAC CE but regarded as semi-static events"
	+ Description of "Consequence if the feature is not supported by the UE" should be (changes are highlighted in red):
		- "UE does not support restarting DM-RS bundling after the dynamic events that violate power consistency and phase continuity"
* **30-4h:**
	+ It is not consistent if 30-4h is the only place where it is indicated that 30-4a/b/c/d are limited to back-to-back cases. The simpler solution seems to be to update the description of 30-4/a/b/c/d to indicate this restriction explicitly, in which case the yellow highlighted text in 30-4h can be confirmed as is.
 |
| [8] | China Telecom | **Proposal 3: FGs for DMRS bundling for PUSCH/PUCCH.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | Index | Feature group | Components | Prerequisite feature groups | **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 |
| 30. NR\_cov\_enh | 30-4 | ~~[~~The maximum duration for DM-RS bundling~~]~~ | The maximum duration during which UE is able to maintain power consistency and phase continuity to support DM-RS bundling for PUSCH/PUCCH.Note: Support modulation order not higher than QPSK.~~FFS dependence on modulation order~~~~FFS dependence on back-to-back vs. non-back-to-back repetitions~~ |  | UE does not support DM-RS bundling for PUSCH/PUCCH | ~~[Per UE]~~Per band | FFS | No | N/A |
|  30. NR\_cov\_enh | 30-4a | DM-RS bundling for PUSCH repetition type A | Support DM-RS bundling for PUSCH repetition type A | [30-4], [30-1] or [30-2] | UE does not Support DM-RS bundling for PUSCH repetition type A | ~~[Per UE]~~Per band | FFS | No | N/A |
|  30. NR\_cov\_enh | 30-4b | DM-RS bundling for PUSCH repetition type B | Support DM-RS bundling for PUSCH repetition type B | [30-4], [11-5] ~~[30-1]~~ | UE does not Support DM-RS bundling for PUSCH repetition type B | ~~[Per UE]~~Per band | FFS | No | N/A |
|  30. NR\_cov\_enh | 30-4c | DM-RS bundling for TB processing over multi-slot PUSCH | Support DM-RS bundling for TB processing over multi-slot PUSCH | [30-4], [30-3] | UE does not Support DM-RS bundling for TB processing over multi-slot PUSCH | ~~[Per UE]~~Per band | FFS | No | N/A |
| 30. NR\_cov\_enh | 30-4d | DMRS bundling for PUCCH repetitions | Support DM-RS bundling for PUCCH repetitions for PUCCH formats 1/3/4 | [30-4], [4-23] | UE does not support DMRS bundling for PUCCH repetitions | ~~[Per UE]~~Per band | FFS | No | N/A |
| 30. NR\_cov\_enh | 30-4e | Enhanced inter-slot frequency hopping with inter-slot bundling for PUSCH | Support enhanced inter-slot frequency hopping with inter-slot bundling for PUSCH | [30-4a] or [30-4b] or [30-4c] | UE does not support enhanced inter-slot frequency hopping with inter-slot bundling for PUSCH | ~~[Per UE]~~Per band | FFS | No | N/A |
| 30. NR\_cov\_enh | 30-4f | Enhanced inter-slot frequency hopping for PUCCH repetitions with DMRS bundling | Enhanced inter-slot frequency hopping for PUCCH repetitions with DMRS bundling | [30-4d] | UE does not support Enhanced inter-slot frequency hopping for PUCCH repetitions with DMRS bundling | ~~[Per UE]~~Per band | FFS | No | N/A |
| 30. NR\_cov\_enh | 30-4g | Restart DM-RS bundling after the events that violate power consistency and phase continuity | Support restarting DM-RS bundling after the events triggered by DCI or MAC-CE that violate power consistency and phase continuity.Note: Events which are triggered by DCI or MAC CE, but regarded as semi-static events, e.g. frequency hopping, UL beam switching for multi-TRP operation, or other if defined, are excluded. | [30-4] | UE does not support restarting DM-RS bundling after the events that violate power consistency and phase continuity | ~~[Per UE]~~Per band | FFS | No | N/A |
| 30. NR\_cov\_enh | 30-4h | DM-RS bundling for non-back-to-back transmission | Support DM-RS bundling for non-back-to-back transmission for consecutive slots for PUSCH and PUCCH only for corresponding supported back-to-back transmission FGs (30-4a, 30-4b, 30-4c, or 30-4d) | 30-4a, 30-4b, 30-4c, or 30-4d | UE does not Support DM-RS bundling for non-back-to-back transmission | ~~[Per UE]~~Per band | FFS | No | N/A |

 |
| [9] | NTT DOCOMO | **Proposal 4: No need to support the different values of maximum duration for DMRS bundling for different modulation orders.****Proposal 5: The prerequisite FGs for 30-4a, 30-4b, 30-4c, 30-4d, 30-4e, 30-4f, 30-4g, and 30-4h can be {FG 30-4 and FGs 5-14 or 5-16 or 5-17}, {FGs 30-4 and 11-5}, {FGs 30-4 and 30-3}, {FGs 30-4 and 4-23}, {FGs 30-4a or 30-4b or 30-4c}, {FG 30-4d}, {FG 30-4}, and {FGs 30-4a or 30-4b or 30-4c or 30-4d}, respectively.**Regarding the FFS part in the note column in FG 30-4c, we think FGs 30-4a, 30-4c and 30-3a are sufficient to indicate the support of DMRS bundling over the repetitions of TBoMS. Since FG30-3 should be the prerequisite FG for FG 30-3a, it is not necessary to include FG30-3 in addition to FG 30-3a.**Proposal 6: Add a Note: If a UE reports support of FG 30-4a, 30-4c, and 30-3a, the UE supports DMRS bundling for the repetitions of TBoMS.**  |
| [11] | Intel Corporation | Based on this, Table 3 illustrates suggested update for UE feature groups for DMRS bundling. Table 3. UE feature groups for DMRS bundling

|  |  |  |  |
| --- | --- | --- | --- |
| 30-4g | Restart DM-RS bundling after ~~the~~ event(s) triggered by DCI or MAC-CE that violate power consistency and phase continuity | Support restarting DM-RS bundling after ~~the~~ event(s) triggered by DCI or MAC-CE that violate power consistency and phase continuityNote: Events which are triggered by DCI or MAC CE, but regarded as semi-static events, e.g., frequency hopping, UL beam switching for multi-TRP operation, or other if defined, are excluded. | ~~[30-4]~~30-4a, 30-4b, 30-4c, or 30-4d |
| 30-4h | DM-RS bundling for non-back-to-back transmission | Support DM-RS bundling for non-back-to-back transmission for consecutive slots for PUSCH and PUCCH only for corresponding supported back-to-back transmission FGs (30-4a, 30-4b, 30-4c, or 30-4d), respectively, | 30-4a, 30-4b, 30-4c, or 30-4d |

**Proposal 3*** Consider Table 3 for UE feature groups of DMRS bundling.
 |
| [13] | CMCC | **Proposal 7:****Single maximum duration for all modulations is used.****Proposal 8:** **The 30-4a should be supported for supporting DMRS bundling for the repetition of TBOMS.****Proposal 8:** **The 30-4a should be supported for supporting DMRS bundling for the repetition of TBOMS.****Proposal 9:****The note should be included in FG 30-4c for clarification and keep gNB and UE aligned.****Proposal 10:** **FGs 30-4 to 30-h could be per UE, per band or per FR.** **Proposal 11:****No need to differentiation between TDD and FDD.** |
| [14] | Xiaomi | At the RAN1#107bis-e meeting, whether UE can report different values of maximum duration for DMRS bundling for different modulation orders was discussed. There is no conclusion that the maximum duration depends on the modulation order. Accordingly, UE does not need to report different values of maximum duration for DMRS bundling for different modulation orders. **Proposal 8: No need to support the different values of maximum duration for DMRS bundling for different modulation orders.**For FG30-4g, it has been agreed in last RAN1 meeting that UE is mandatory to support restarting DM-RS bundling due to semi-static events. Therefore, UE capability of restarting DMRS bundling is applied only to dynamic events. FG30-4g component need to update accordingly.**Proposal 9: Updating the FG30-4g to apply to dynamic events only.** |
| [15] | Ericsson | Table 3: Capabilities for PUSCH and PUCCH Joint Channel Estimation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups | Comments |
| 30-4 | [The maximum duration for DM-RS bundling] | The maximum duration during which UE is able to maintain power ~~consisitency~~ consistency and phase continuity to support DM-RS bundling for PUSCH/PUCCHFFS dependence on modulation order~~FFS dependence on back-to-back vs. non-back-to-back repetitions~~ |  | May not be needed if only one value of maximum duration is defined. |
| 30-4a | DM-RS bundling for PUSCH repetition type A | Support DM-RS bundling for PUSCH repetition type A over consecutive symbols | [30-4], ~~[30-1] or [30-2]~~[5-14, 5-16, or 5-17] |  |
| 30-4b | DM-RS bundling for PUSCH repetition type B | Support DM-RS bundling when configured for PUSCH repetition type B over consecutive symbols | [30-4], [11-5] ~~[30-1]~~ |  |
| 30-4c | DM-RS bundling for TB processing over multi-slot PUSCH | Support DM-RS bundling when configured for TB processing over multi-slot PUSCH over consecutive symbols | [30-4], [30-3] |  |
| 30-4d | DMRS bunding for PUCCH repetitions | Support DM-RS bundling for PUCCH repetitions over consecutive symbols for PUCCH formats 1/3/4 | [30-4], [4-23] |  |
| 30-4e | Enhanced Inter-slot frequency hopping ~~with inter-slot bundling~~ for PUSCH and PUCCH | Support enhanced inter-slot frequency hopping pattern ~~with inter-slot bundling~~ for PUSCH  | ~~[30-4a] or [30-4b] or [30-4c]~~[2-16] |  |
| 30-4f | Enhanced inter-slot frequency hopping for PUCCH repetitions with DMRS bundling | Enhanced inter-slot frequency hopping for PUCCH repetitions with DMRS bundling | [30-4d], [4-23] |  |
| 30-4g | Restart DM-RS bundling after the events that violate power consistency and phase continuity | ~~Support restarting DM-RS bundling after the events that violate power consistency and phase continuity~~ Support bundling PUSCH and PUCCH DM-RS remaining in a bundling nominal time domain window after dynamic event(s) that violate power consistency and phase continuity requirements | [30-4] |  |
| 30-4h | DM-RS bundling for non-back-to-back transmission | Support DM-RS bundling for non-back-to-back transmission for consecutive slots for PUSCH and PUCCH only for corresponding supported back-to-back transmission FGs (30-4a, 30-4b, 30-4c, or 30-4d) | 30-4a, 30-4b, 30-4c, or 30-4d |  |

1. UE features for PUSCH and PUCCH joint channel estimation are defined according to Table 3
 |
| [16] | Samsung | In RAN1#107bis-e, it was raised that FG 30-4g did not capture the relevant RAN1 agreement, i.e., UE capability of restarting DMRS bundling is applied only to dynamic events. RAN1 discussed the similar point for corresponding RRC parameter, *PUSCH-Window-Restart*,and ended up with the following agreement [4]:

|  |
| --- |
| ***PUSCH-Window-Restart:***UE bundles PUSCH DM-RS remaining in a nominal time domain window after event(s) triggered by DCI or MAC-CE that violate power consistency and phase continuity requirements.Note: Events which are triggered by DCI or MAC CE, but regarded as semi-static events, e.g. frequency hopping, UL beam switching for multi-TRP operation, or other if defined, are excluded. |

Therefore, we propose to take the same approach for FG 30-4g.**Proposal 3: Update 30-4g as following in alignment with the corresponding RRC parameter description.** |
| [17] | MediaTek Inc. | During DMRS bundling discussion, the within-slot B2B and across-slot B2B were agreed separated as the different solutions. So it is preferred to have the split for 30-4b to support within-slot B2B and across-slot B2B separately. Proposal 6: For DMRS bundling with 30-4b, split FG into two FGs: one for within-slot B2B and the other for across-slot B2B. Considering the potential different UE implementation for support of DMRS bundling in FR1 and FR2, it is suggested to have at least FR1/FR2 differentiation for FG 30-4 to 30-4f.**Proposal 7: For DMRS bundling with 30-4 to 30-4f, at least FR1/FR2 differentiation is supported.** |
| [18] | Qualcomm | We have the following proposals on UE capability reporting for PUSCH/PUCCH DMRS bundling.**Proposal 3:** On UE features 30-4 to 30-4g: all features on DMRS Bundling (PUSCH and PUCCH) to be indicated at the per FS granularity. **Proposal 4**: On UE feature 30-4 for maximum duration for DMRS bundling, since a UE may report different values for different modulation orders, choose from the following two options:1. restrict applicability of 30-4 to QPSK or lower modulation order, or
2. introduce new FGs to cover the remaining modulation orders.
 |

## **Discussion**

**[FL1] High priority question 4-1:**

* **Companies are encouraged to provide views on whether UE can report different values of maximum duration for DMRS bundling for**
	+ **(a) different modulation orders**
		- Yes, or restrict 30-4 to QPSK or lower modulation order: Qualcomm
		- No: CT, DCM, CMCC
		- Wait for RAN4 progress: Huawei, HiSilicon
	+ **(b) back-to-back and non-back-to-back transmissions**
		- No: CT
		- Wait for RAN4 progress: Huawei, HiSilicon

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | There is no clear RAN1 reason for such different reporting or limitation to lower modulation orders. Hence do not support it unless there is clear indication from RAN4. |
| Samsung  | No for both (a) and (b). As per recent RAN4 LS in R1-2200908/R4-2202368 (copied below), RAN4 has considered single value per band, i.e., no differentiation per modulation order and (non) back-to-back transmission. Hence, we suggest to remove the entire FFSs in FG30-4 for now:

|  |
| --- |
| In an earlier LS RAN4 indicated that up to 32 slots was being discussed. RAN4 will further discuss the feasible value(s) for maximum duration and has considered the following:UE reports the single value per band from a set of up to 4 values, and RAN4 does not consider the value more than 32 slots for the capability for maximum duration. Values RAN4 being considered are 5, 8, 16 or 32 slots. |

 |
| Intel | Wait for RAN4 progress. |
| Panasonic | Up to RAN4 is sufficient. |

**[FL1] High priority question 4-2:**

* **Companies are encouraged to provide views on whether to separate FG 30-4b for within a slot and over slots**
	+ Yes: MTK
	+ No: Huawei
		- *Based on the RAN1 agreement, the window length of 1 is not supported.*

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | Do not support separating. |
| NTT DOCOMO | More clarification on the motivation is needed. |
| Samsung | No separatation |
| Intel | Not sure the motivation.  |
| Panasonic | Support |

**[FL1] High priority question 4-3:**

* **Companies are encouraged to provide views on whether to add a note about the prerequisite FGs for TBoMS with repetition in FG30-4c**
	+ Add a note: Huawei, HiSilicon, ZTE, OPPO, DCM, CMCC
		- FG 30-3a and FG 30-4c: Huawei, HiSilicon, ZTE
		- FG 30-3a, FG 30-4a and FG 30-4c: DCM, CMCC

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | We prefer to add the note that FG 30-3a, FG 30-4a and FG 30-4c are the prerequisite FGs for TBoMS with repetition, because repetition of TBoMS can be viewed as the combined feature of repetition and TBoMS. If the majority prefers not to include FG 30-4a as the prerequisite feature, we are fine with not including it. |
| Intel | We are fine to add the note.  |
| Panasonic | Either is ok to us.  |

**Medium priority question 4-4:**

* **Companies are encouraged to provide views on whether the type of FGs 30-4 and 30-4a to 30-4g should be per UE, per band, or per FS**
	+ Per UE:
		- TDD/FDD differentiation
			* Necessary: MTK
			* Not necessary: CMCC
		- FR1/FR2 differentiation
			* Not necessary:
	+ Per band: Huawei, HiSilicon, vivo, CATT, Nokia, CT
		- *CFOs of different operating frequency are different*
	+ Per FS: Qualcomm

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | We are fine with per band to align them with the maximum duration. |
| Panasonic | Our initial thinking is per FS as how to realized/use RF components can be different among per band combinations. We'd like to see more views. |
|  |  |

**Medium priority question 4-5:**

* **Companies are encouraged to provide views on whether the type of FGs 30-4h should be per UE, per band, or per FS**
	+ Per UE: Huawei, HiSilicon
		- TDD/FDD differentiation
			* Not necessary: Huawei, HiSilicon, CMCC
		- FR1/FR2 differentiation
			* Not necessary: Huawei, HiSilicon
	+ Per band: vivo, CATT, CT

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | We are fine with either granularity.  |
| Panasonic | Per UE should be sufficient in our view. |
|  |  |

**Low priority question 4-6:**

* **Companies are encouraged to provide views on whether/how to revise the prerequisite feature groups for FGs 30-4 and 30-4x**
	+ FG 30-4
		- No prerequisite: Huawei, HiSilicon, Ericsson
	+ FG 30-4a
		- FG 30-4 and FG 5-14 or 5-16 or 5-17 or 30-1: Huawei, HiSilicon
		- FG 30-4 and FG 5-14 or 5-16 or 5-17: DCM, Ericsson
		- FG 30-4 and FG 30-1 or 30-2: CT
	+ FG 30-4b
		- FG 30-4 and FG 11-5: Huawei, HiSilicon, CT, DCM, Ericsson
	+ FG 30-4c
		- FG 30-4 and FG 30-3 or 30-3a: Huawei, HiSilicon, CT
		- FG 30-4 and FG 30-3: CT, DCM, Ericsson
	+ FG 30-4d
		- FG 30-4 and FG 4-23: Huawei, HiSilicon, CT, DCM, Ericsson
	+ FG 30-4e
		- FG 30-4a or 30-4b or 30-4c: Huawei, HiSilicon, CT, DCM
		- FG 2-16: Ericsson
			* *To support enhanced frequency hopping without DMRS bundling*
	+ FG 30-4f
		- FG 30-4d: Huawei, HiSilicon, CT, DCM
		- FG 30-4d, 4-23: Ericsson
	+ FG 30-4g
		- FG 30-4: Huawei, HiSilicon, CT, DCM, Ericsson
		- FG 30-4a or 30-4b or 30-4c or 30-4d: Intel
	+ FG 30-4h
		- FG 30-4a or 30-4b or 30-4c or 30-4d: Huawei, HiSilicon, DCM, Ericsson

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

**Low priority question 4-7:**

* **Companies are encouraged to provide views on the description of FG 30-4a to 30-4d,**
	+ Specify FGs for back-to-back repetition: Nokia, Ericsson

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

**Low priority question 4-8:**

* **Companies are encouraged to provide views on the description of FG 30-4g**
	+ Description of “Feature group”
		- Add “dynamic” before “event(s)”: Nokia
		- Add “triggered by DCI or MAC CE” after “event(s)” Intel
	+ Description of “Components”
		- Make it aligned with RRC parameter description: Nokia, CT, Intel, Samsung
		- Add “dynamic event(s)” in the description: Ericsson
	+ Description of “Consequence if the feature is not supported by the UE”
		- Add “dynamic” before “events”: Nokia

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

**Low priority question 4-9:**

* **Companies are encouraged to provide views on whether/how to revise any other contents in FGs 30-4 and 30-4x which do not have capability signaling impacts**

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

# **30-5: Slot based dynamic PUCCH repetition indication**

In [1], FG 30-5 is 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 |
| 30. NR\_cov\_enh | 30-5 | Slot based dynamic PUCCH repetition indication | Support slot based dynamic PUCCH repetition indication for PUCCH formats 0/1/2/3/4support slot based dynamic PUCCH repetition for PUCCH formats 0/1/2/3/4FFS whether to split FG 30-5 into 2 FGs; one for PUCCH formats 0/2 and the other for PUCCH formats 1/3/4 | 4-23 and/or 25-2 | Yes | N/A | UE does not support Dynamic PUCCH repetition indication | [Per UE] | FFS | No | N/A |  | Optional with capability signalling |

Following feedbacks are provided in contributions for the RAN1#108-e meeting.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| [2] | Huawei, HiSilicon |

|  |  |  |  |
| --- | --- | --- | --- |
| 30. NR\_cov\_enh | 30-5 | Slot based dynamic PUCCH repetition indication for PUCCH formats 0/1/2/3/4 | 4-23and/or25-2 |

 |
| [3] | vivo |  |
| [4] | ZTE | We think that one single FG is sufficient for all PUCCH formats. Different PUCCH formats may target different use cases, while there is no difference among different PUCCH formats from implementation complexity point of view. Therefore, we have the following proposal. ***Proposal 6:*** *FG 30-5 is not separated to multiple FG.* |
| [6] | CATT | There is an FFS on whether to split FG 30-5 into 2 FGs for different PUCCH formats. Unlike joint channel estimation, the mechanism of dynamic PUCCH repetition does not need to differentiate the PUCCH format. For all PUCCH formats, dynamic indication is enabled by DCI indication and *PUCCH-nrofSlots-r17* newly added in the corresponding PUCCH resource configuration. Thus we think there is no need to differentiate PUCCH formats in FG 30-5. Concretely, FG 25-2 is about the capability for repetition of PUCCH format 0/2, whose prerequisite is FG 4-23 [1]. Hence, for FG 30-5, its prerequisite should be FG 4-23 or FG 25-2. If only FG 4-23 and FG 30-5 are reported, the UE supports dynamic indication of repetition only for PUCCH format 1/3/4. On the other hand, if FG 25-2 and FG 30-5 are reported, the UE supports dynamic indication of repetition for all PUCCH format 0/1/2/3/4.**Proposal 5: No need to split FG 30-5 into 2 FGs for different PUCCH formats. FG 30-5 is updated as follows:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 30-5 | Slot based dynamic PUCCH repetition indication | Support slot based dynamic PUCCH repetition indication for PUCCH formats only for corresponding supported PUCCH repetition FGs (4-23 or 25-2) ~~0/1/2/3/4~~~~support slot based dynamic PUCCH repetition for PUCCH formats 0/1/2/3/4~~~~FFS whether to split FG 30-5 into 2 FGs; one for PUCCH formats 0/2 and the other for PUCCH formats 1/3/4~~ | 4-23 ~~and/~~or 25-2 | Yes | N/A | UE does not support Dynamic PUCCH repetition indication | [Per UE] | FFS | No | N/A |  |

 |
| [7] | Nokia | * **30-5:**
	+ Confirm FG description
	+ Per UE
 |
| [8] | China Telecom | For dynamic PUCCH repetition indication, we think the granularity of per UE is sufficient. We don’t think there is a need to differentiate for FDD/TDD and FR1/FR2. We prefer a single FG, and don’t support to split FG 30-5 into 2 FGs for different formats. Moreover, we think the description “Support slot based dynamic PUCCH repetition indication for PUCCH formats 0/1/2/3/4” already implicitly indicates that slot based dynamic PUCCH repetition for PUCCH formats 0/1/2/3/4 is supported.**Proposal 4: FGs for dynamic PUCCH repetition indication.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | Index | Feature group | Components | Prerequisite feature groups | **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 |
| 30. NR\_cov\_enh | 30-5 | Slot based dynamic PUCCH repetition indication | Support slot based dynamic PUCCH repetition indication for PUCCH formats 0/1/2/3/4~~support slot based dynamic PUCCH repetition for PUCCH formats 0/1/2/3/4~~~~FFS whether to split FG 30-5 into 2 FGs; one for PUCCH formats 0/2 and the other for PUCCH formats 1/3/4~~ | 4-23 and/or 25-2 | UE does not support Dynamic PUCCH repetition indication | ~~[~~Per UE~~]~~ | ~~FFS.~~No | No | N/A |

 |
| [9] | NTT DOCOMO | At the RAN1#107bis-e meeting, whether to split the FG into two FGs was discussed (e.g., one for PUCCH formats 1/3/4 and another for PUCCH formats 0/2). Since single FG is introduced for the sub-slot based dynamic PUCCH repetition indication as in FG 25-3a, single FG should be used for all PUCCH formats for the slot based dynamic PUCCH repetition indication, and supporting long/short PUCCH formats can be identified by the prerequisite feature groups, e.g. one of {4-23, 25-2}. |
| [11] | Intel Corporation | Based on this and considering that slot based PUCCH repetition is mainly targeted for coverage enhancement, Table 4 illustrates suggested update for UE feature groups for dynamic PUCCH repetition factor indication. Table 4. UE feature groups for dynamic PUCCH repetition factor indication

|  |  |  |  |
| --- | --- | --- | --- |
| 30-5 | Slot based dynamic PUCCH repetition indication | Support slot based dynamic PUCCH repetition indication for PUCCH formats 0/1/2/3/4~~support slot based dynamic PUCCH repetition for PUCCH formats 0/1/2/3/4~~~~FFS whether to split FG 30-5 into 2 FGs; one for PUCCH formats 0/2 and the other for PUCCH formats 1/3/4~~ | 4-23 and/or 25-2 |

**Proposal 4*** For UE feature groups of dynamic PUCCH repetition factor indication
	+ FG 30-5 is not separated to multiple FG
	+ UE features for dynamic PUCCH repetition factor indication are defined per UE.
	+ FDD/TDD differentiation is not necessary.
	+ Consider Table 4 for UE feature groups of dynamic PUCCH repetition factor indication.
 |
| [13] | CMCC | **Proposal 12****Confirm the high priority proposal 5-1*** **FG 30-5 is not separated to multiple FG**

**Proposal 13:****The FG 30-5 should be reported per UE and should not be differentiated between TDD/FDD.** |
| [14] | Xiaomi | Considering single FG is introduced for the sub-slot based dynamic PUCCH repetition indication as in FG 25-3a, single FG should be used for all PUCCH formats for the slot based dynamic PUCCH repetition indication. Thus, we don’t support to split FG 30-5 into 2 FGs for different formats. Moreover, we think the description “Support slot based dynamic PUCCH repetition indication for PUCCH formats 0/1/2/3/4” already implicitly indicates that slot based dynamic PUCCH repetition for PUCCH formats 0/1/2/3/4 is supported, which is not needed.Table 3 UE feature list for dynamic PUCCH repetition indication

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | Index | Feature group | Components | Prerequisite feature groups | **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 |
| 30. NR\_cov\_enh | 30-5 | Slot based dynamic PUCCH repetition indication | Support slot based dynamic PUCCH repetition indication for PUCCH formats 0/1/2/3/4~~support slot based dynamic PUCCH repetition for PUCCH formats 0/1/2/3/4~~~~FFS whether to split FG 30-5 into 2 FGs; one for PUCCH formats 0/2 and the other for PUCCH formats 1/3/4~~ | 4-23 and/or 25-2 | UE does not support Dynamic PUCCH repetition indication | ~~[~~Per UE~~]~~ | ~~FFS~~ No | No | N/A |

**Proposal 10: FG 30-5 should be used for all PUCCH formats to align with FG 25-3a for sub-slot based dynamic PUCCH repetition indication.** |
| [15] | Ericsson | In RAN1#107, the following was agreed:**Agreement*** **Revised the component in FG 30-5 as “Support slot based dynamic PUCCH repetition indication for PUCCH formats 0/1/2/3/4”**
* **Add a component in FG 30-5 for support slot based dynamic PUCCH repetition for PUCCH formats 0/1/2/3/4**
* **FG 4-23 and/or FG 25-2 are the prerequisite feature groups for FG 30-5**
* **Add FFS whether to split FG 30-5 into 2 FGs; one for PUCCH formats 0/2 and the other for PUCCH formats 1/3/4**

The FFS to split the PUCCH formats 0/2 from 1/3/4 does not seem motivated. Dynamic repetition and dynamic repetition indication do not seem to be much different, since the repetition is limited to slot based repetition, and since the indication mechanism is the same (using PRI to indicate a PUCCH resource configured with a repetition factor). Therefore, we suggest to drop the FFS.Table 4: Capabilities for PUCCH Repetition Enhancement

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups | Comments |
| 30-5 | Slot based dynamic PUCCH repetition indication | Support slot based dynamic PUCCH repetition indication for PUCCH formats 0/1/2/3/4support slot based dynamic PUCCH repetition for PUCCH formats 0/1/2/3/4~~FFS whether to split FG 30-5 into 2 FGs; one for PUCCH formats 0/2 and the other for PUCCH formats 1/3/4~~ | 4-23 and/or 25-2 |  |

1. UE features for PUCCH repetition enhancement are defined according to Table 4
 |
| [17] | MediaTek Inc. | From UE implementation, PUCCH formats 0/2 repetition for URLLC and PUCCH format 1/3/4 for CovEnh are different features targeting the different use cases and device types. Moreover, PUCCH Format 1/3/4 dynamic repetition and PUCCH format 0/2 repetition also have the different prerequisite features. Merging them as one feature will also cause the additional testing cost and implementation complexity for the UE which is targeting to support only one of the features or device types.Whether to have the separated features is dependent on whether they have the different use cases/scenarios. This is about essential on how to define FGs. At least, FG should be defined according to the use case/scenarios, i.e., whether the device needs to support the different use cases simultaneously. Clearly, CovEnh and URLLC are quite different use cases and scenarios. There is no need for the device to support them simultaneously. Otherwise, it will increase the unnecessary implementation complexity and the testing cost. We should split them considering the use cases/scenarios, unnecessary UE complexity/cost.The main argument from opponents is sub-slot repetitions defined for all formats in 25-3a which was actually agreed in URLLC session including slot-level repetition for PUCCH format 0/2. To be noted, there is neither coverage problem for PUCCH format 0/2 according to SI nor the agreement in CovEnh for slot-level repetition of PUCCH format 0/2.Moreover, the sub-slot dynamic repetition FG 25-3 is likely to have prerequisite FG 30-5, which implies unnecessary coupling between sub-slot and slot repetitions.So we suggest to have the following proposals for consideration by considering FG 25-3a and FG 30-5 jointly as below:1. Moving “slot-level PUCCH format 0/2 repetition” to FG 25-3 with prerequisite FG 30-5 (all agreed in URLLC sessions for URLLC use case)2. FG 30-5 is limited for dynamic indication of DCI for both slot and sub-slot repetitions.3. FG 30-5a is added for PUCCH format 1/3/4 with prerequisite FG 30-5 and FG 4-23 (all agreed in CovEnh sessions)Proposal 8: For 30-5, the following changes are provided:- 1. Moving “slot-level PUCCH format 0/2 repetition” to FG 25-3 with prerequisite FG 30-5 (all of them agreed in URLLC sessions for URLLC use case) or leave it for FFS (up to discussion of URLLC session).- 2. FG 30-5 is restricted for dynamic indication of DCI support for both slot and sub-slot repetitions.- 3. FG 30-5a is added for PUCCH format 1/3/4 with prerequisite FG 30-5 and FG 4-23 (all agreed in CovEnh sessions) |
| [18] | Qualcomm | **Proposal 7:** Ensure UE capabilities for dynamic indication of PUCCH repetition separately indicated at least per frequency band. |

## **Discussion**

**[FL1] High priority question 5-1:**

* **Companies are encouraged to provide views on whether to separate FG 30-5 or not, e.g.,**
	+ Option 1: Keep current structure, i.e., FG 30-5 for PUCCH formats 0/1/2/3/4
		- Huawei, HiSilicon, vivo, ZTE, CATT, Nokia, ChinaTelecom, DOCOMO, Intel, CMCC, Xiaomi, Ericsson,
		- *As sub-slot based dynamic PUCCH repetition indication*
	+ Option 2: Split 30-5 into 2 separate FGs: 1st one for PUCCH formats 1/3/4, 2nd one for PUCCH formats 0/2
		- MediaTek
		- *slot based PUCCH repetition of PUCCH format 0/2 only introduced in Rel-17*
		- *CovEnh and URLLC are quite different use cases and scenarios*

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| Company | Comment |
| Nokia, NSB | Keep the current structure |
| NTT DOCOMO | We support Option1 and supporting long/short PUCCH formats can be identified by the prerequisite feature groups, e.g. one of {4-23, 25-2} |
| Samsung | Option 1 |
| Intel | Option 1 |
| Panasonic | We support Option 1. |

**Medium priority question 5-2:**

* **Companies are encouraged to provide views on whether the type of FG 30-5 should be per UE or per band**
	+ Per UE: Nokia,
		- FDD/TDD differentiation is not necessary: Huawei, HiSilicon,
	+ Per band: Qualcomm,

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| Company | Comment |
| NTT DOCOMO | We think the feature is common for bands, so that we support per UE. |
| Panasonic | Per UE with NTN, unlicensed, FR1/2 are separation is our preference. |
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**Low priority question 5-3:**

* **Companies are encouraged to provide views on whether/how to revise the prerequisite feature groups for FG 30-5**

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**Low priority question 5-4:**

* **Companies are encouraged to provide views on whether/how to revise any other contents in FG 30-5 which do not have capability signaling impacts**

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# **30-6: Repetition of PUSCH transmission scheduled by RAR UL grant and DCI format 0\_0 with CRC scrambled by TC-RNTI**

In [1], FG 30-6 is captured as below.

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| 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 |
| 30. NR\_cov\_enh | 30-6 | Repetition of PUSCH transmission scheduled by RAR UL grant and DCI format 0\_0 with CRC scrambled by TC-RNTI | Support of repetition of PUSCH transmission scheduled by RAR UL grant and DCI format 0\_0 with CRC scrambled by TC-RNTI  |  | Yes | N/A | UE does not support repetition of PUSCH transmission scheduled by RAR UL grant and DCI format 0\_0 with CRC scrambled by TC-RNTI. | [Per UE] | No | No | N/A  |  | [Optional with capability signalling] |

Following feedbacks are provided in contributions for the RAN1#108-e meeting.

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| [2] | Huawei, HiSilicon | It is necessary for UE to report Msg3 repetition capability after RRC is established during initial access, so that NW is able to configure repetitions for CFRA PUSCH. Thus, FG 30-6 should be optional with capability signaling.***Proposal 8:*** *FG 30-6* *should be optional with capability signaling.* |
| [4] | ZTE | In RAN1#107-e, it was agreed to introduce FG 30-6 for Msg3 PUSCH repetition. Regarding the reporting type, we think per UE reporting is sufficient. As for the ‘Need of FDD/TDD differentiation’, we don’t see much difference from UE complexity point of view. ***Proposal 7:*** *For FG 30-6, support per UE reporting and no need of FDD/TDD differentiation.* |
| [6] | CATT | During RAN1#107-e, introducing the capability for PUSCH scheduled by RAR UL grant and DCI format 0\_0 with CRC scrambled by TC-RNTI was agreed [3]. Thus FG 30-6 should be optional with capability signaling. We are open to make it with ‘per UE’ or ‘per band’ granularity.**Proposal 6: FG 30-6 should be optional with capability signaling.** |
| [7] | Nokia | * **30-6:**
	+ Confirm FG description
	+ Per UE
 |
|  |  | For Msg.3 repetition, we think the granularity of per UE is sufficient. We are fine with other parts. **Proposal 5: FGs Msg.3 repetition.**

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| **Features** | Index | Feature group | Components | Prerequisite feature groups | **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 |
| 30. NR\_cov\_enh | 30-6 | Repetition of PUSCH transmission scheduled by RAR UL grant and DCI format 0\_0 with CRC scrambled by TC-RNTI | Support of repetition of PUSCH transmission scheduled by RAR UL grant and DCI format 0\_0 with CRC scrambled by TC-RNTI  |  | UE does not support repetition of PUSCH transmission scheduled by RAR UL grant and DCI format 0\_0 with CRC scrambled by TC-RNTI. | ~~[~~Per UE~~]~~ | No | No | N/A  |

 |
| [9] | NTT DOCOMO | **Proposal 8: FG 30-6 should be optional with capability signalling so that gNB can trigger handover with information of the UE capability about PUSCH repetition scheduled by RAR UL grant.** It was discussed that the FG is supported per UE or per band. Since Msg3 repetition is not the band specific feature, the FG can be per UE. Also, the differentiation between TDD and FDD is not necessary, following FGs of repetition type A.**Proposal 9: FG 30-6 can be supported per UE with no differentiation between TDD and FDD.** |
| [12] | Apple | **Msg3 PUSCH repetition**

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported |
| 30. NR\_cov\_enh | 30-6 | Repetition of PUSCH transmission scheduled by RAR UL grant and DCI format 0\_0 with CRC scrambled by TC-RNTI | Support of repetition of PUSCH transmission scheduled by RAR UL grant and DCI format 0\_0 with CRC scrambled by TC-RNTI  |  | Yes |

According to the agreements, Msg3 PUSCH repetitions only support inter-slot hopping for initial and re-transmission. There is no consensus to support intra-slot hopping. Thus, it’s better to introduce a component in FG20-6 to make it clear.**Proposal 4: Adding a component to FG30-6: Support inter-slot frequency hopping for repetition of Msg3 initial and re-transmission.** |
| [13] | CMCC | **Proposal 14:****It is proposed that FG 30-6 should be optional with capability signaling.****Proposal 15:****FG 30-6 should be reported as per UE level not per band. And it is not necessary to differentiate between TDD and FDD.** |
| [14] | Xiaomi | Considering that for some bands, such as for NTN bands in case of the long communication distances, or for unlicensed bands in case of worse interference from other coexisting systems, 16 repetitions for msg.3 may be not enough, and further enhancements may be needed. Thus, we think the type of FG 30-6 can be supported per band.Other aspects related to spectrum bands, including the differentiation between FR1 and FR2 bands, and the differentiation between FDD and TDD bands, can share the same design as FG 30-3 discussed in Section 2.2.**Proposal 11: FG 30-6 is an optional feature with signalling.****Proposal 12: The type of FG 30-6 is per band.** |
| [16] | Samsung | Like other FGs for Rel-17 Coverage Enhancement, FG 30-6 should be “Optional with capability signaling”. **Proposal 4: Set “Optional with capability signaling” for FG 30-6.** |

## **Discussion**

**Medium priority question 6-1:**

* **Companies are encouraged to provide views on** **whether capability signaling is necessary for FG 30-6, i.e., whether to support as optional with capability signaling or optional without capability signaling**
	+ Optional with capability signaling: Huawei, HiSilicon, CATT, DCM, CMCC, Xiaomi, Samsung
		- *gNB can trigger handover with information of the UE capability about PUSCH repetition scheduled by RAR UL grant*
	+ Optional without capability signaling:
	+ Up to RAN2:

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| Company | Comment |
| NTT DOCOMO | Optional with capability signaling. |
| Panasonic | Up to RAN2 is our preference as the argument of handover is RAN2 expertise. |
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**Medium priority question 6-2:**

* **Companies are encouraged to provide views on whether the type of FG 30-6 should be per UE or per band**
	+ Per UE: Huawei, HiSilicon, ZTE, Nokia, CT, DCM, CMCC
		- FDD/TDD differentiation
			* Not necessary: Huawei, HiSilicon, ZTE, CT, DCM, CMCC
	+ Per band: Xiaomi

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| Company | Comment |
| NTT DOCOMO | We prefer per UE, since this feature is the same regardless of frequency.  |
| Panasonic | If it is indicated, per UE with NTN, unlicensed, FR1/2 are separation is our preference |
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**Low priority question 6-3:**

* **Companies are encouraged to provide views on whether to add component for inter-slot frequency hopping for Msg3 repetitions in FG 30-6**
	+ Support: Apple

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**Low priority question 6-4:**

* **Companies are encouraged to provide views on whether/how to revise any other contents in FG 30-6 which do not have capability signaling impacts**

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| Company | Comment |
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# **Conclusions**

TBD

# **References**

[1] R1-2200780 Updated RAN1 UE features list for Rel-17 NR after RAN1 #107bis-e Moderators (AT&T, NTT DOCOMO, INC.)

[2] R1-2200971 Rel-17 UE features for NR coverage enhancement Huawei, HiSilicon

[3] R1-2201126 Discussion on UE features for NR coverage enhancement vivo

[4] R1-2201177 Discussion on UE features for NR coverage enhancement ZTE

[5] R1-2201289 Rel-17 Coverage Enhancement UE features OPPO

[6] R1-2201350 Discussion on Rel-17 UE features for NR coverage enhancement CATT

[7] R1-2201415 On UE features for NR coverage enhancement Nokia, Nokia Shanghai Bell

[8] R1-2201448 UE features for Rel-17 NR coverage enhancements China Telecom

[9] R1-2201508 Discussion on Rel.17 UE features for NR coverage enhancement NTT DOCOMO, INC.

[10] R1-2201561 UE features for NR coverage enhancement Spreadtrum Communications

[11] R1-2201733 Discussion on UE features for NR coverage enhancement Intel Corporation

[12] R1-2201798 Views on Rel-17 Coverage Enhancement UE Features Apple

[13] R1-2201886 Discussion on Rel.17 UE features for NR coverage enhancement CMCC

[14] R1-2201911 UE features for NR coverage enhancement Xiaomi

[15] R1-2201967 UE Features for NR Coverage Enhancement Ericsson

[16] R1-2202045 UE features for NR coverage enhancement Samsung

[17] R1-2202087 Discussion on UE features for NR Coverage Enhancement MediaTek Inc.

[18] R1-2202172 UE Features for Coverage Enhancements Qualcomm Incorporated

[19] R1-2202203 UE feature for Rel-17 coverage enhancement Sharp