**3GPP TSG RAN WG1 #102e R1-200xxxx**

**e-Meeting, August 17th – 28th, 2020**

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

**Title:** **Summary on [102-e-NR-UEFeatures-Others-01]**

**Agenda Item:** **7.2.11**

**Document for:** **Discussion and Decision**

1. Introduction

This contribution summarizes the following email discussion/approval in AI 7.2.11.

[102-e-NR-UEFeatures-Others-01] Email discussion/approval on new FGs that are not dedicated to a specific Rel-16 work item/TEI (17th – 20th August), Hiroki (DCM)

* Whether/how to define new FGs related to PUCCH group based on proposals in R1-2006482 and potentially following points
	+ A UE should not be mandated to support the case where cells from different NR PUCCH groups are in the same TAG, but there is no such capability signalling in Rel.15.
	+ A UE should not be mandated to support the case where cells from two NR PUCCH groups are in the same band, but there is no such capability signalling in Rel.15
* Whether/how to define new FG for supporting offset between the end of PDCCH triggering A-SRS and the SRS transmission for CB PUSCH and antenna switching for UEs supporting PDCCH capabilities besides FG 3-1
* Whether/how to define new FG for supporting partial cancellation of configured PUCCH/PUSCH/PRACH due to dynamic SFI, dynamically granted PDSCH and CSI-RS, and UE behavior for UE not supporting the FG
1. New FGs related to PUCCH group

In [2], following proposals are made.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| * 1. Issue with current PUCCH group

From the previous discussion, 3 band FR1 + FR1 + FR2 NR BC is newly introduced in Rel-16 in RAN4, and more importantly, it is attracting commercial deployment interest. In this subsection, we discuss the inadequacy of the current PUCCH group capability reporting in terms of supporting FR1 + FR1 + FR2 deployment * UE is not allowed to support 3 different numerologies in the same PUCCH group
	+ For FR1 + FR1 + FR2 NR-CA deployment, this forces UE and NW to use two PUCCH groups since, currently, UE can only support two different numerologies in the same PUCCH group
	+ Compared to supporting two PUCCH group, a single PUCCH group with 3 different numerologies may offer UE more implementation flexibility and better system performance as well
* UE cannot indicate the preferred PUCCH group configuration
	+ Rel-15 UE capability reporting is unclear, our understanding is that, it allows both PUCCH groups configurations
		- (FR1 + FR1) + FR2
		- (FR1) + (FR1 + FR2)
	+ UE either has to support both or support neither based on the current capability reporting
* UE does not have full flexibility to indicate the location of PUCCH in the PUCCH group. Below are the details
	+ For (FR1 15kHz + FR1 30kHz), UE may want to support both PUCCH on 15kHz and on 30kHz, so UE can report to support both FG6-9 and FG6-9a
	+ For (FR1 15kHz + FR2 120kHz), UE may want to support PUCCH on 15kHz only, so UE has to support that it does not support FG6-9a
	+ The above two conflict each other

To resolve the above issues, we propose the following new PUCCH group related FGs in order to better support the emerging FR1 + FR1 + FR2 deployment* 1. Proposed new FGs

We propose the following new FGs with some explanation of the purpose * FG22-5a, this is to indicate whether UE supports 3 different numerologies in the same PUCCH group and the restrictions on PUCCH configuration
* FG22-5b, this is to indicate whether UE supports FR1 + (FR1 + FR2) PUCCH group configuration
* FG22-5c, this is to indicate, for FR1 + (FR1 + FR2) PUCCH group configuration, whether PUCCH can be configured on FR2 on the secondary PUCCH group, or SCG.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 (V2X WI only)”.** | **Consequence if the feature is not supported by the UE** | **Type** | **Need of FDD/TDD differentiation** | **Need of FR1/FR2 differentiation** | **Capability interpretation for mixture of FDD/TDD and/or FR1/FR2** | **Note** | **Mandatory/Optional** |
| 22. NR Others | 22-5a | Support of three different numerologies in the same PUCCH group for EN-DC, NGEN-DC, NE-DC, NR-DC and NR-CA | For EN-DC, NGEN-DC, NE-DC, NR-DC and NR-CA, support three different numerologies in the same PUCCH group1. Which SCS can be configured to transmit NR PUCCH
 |  | Yes | N/A |  | Per BC | N/A | N/A  | N/A | Candidate value for component 1, 3 bit bitmap {smallest SCS, second smallest SCS, largest SCS} | Optional with capability signallingComponent 1: {smallest SCS, second smallest SCS, largest SCS} |
| 22. NR Others | 22-5b | Not supporting more than one NR PUCCH group per frequency range for both NR-DC and NR-CA | For both NR-DC and NR-CA, UE does not support more than one NR PUCCH group per frequency range |  | Yes | N/A |  | Per BC | N/A | N/A  | N/A |  | Optional with capability signalling |
| 22. NR Others | 22-5c | Not supporting of NR PUCCH-SCell on FR2 in the NR PUCCH group with both FR1 and FR2  | UE does not support NR PUCCH-SCell being sent on the carrier in FR2 when NR PUCCH group is configured with carriers in both FR1 and FR2 |  | Yes | N/A |  | Per BC | N/A | N/A  | N/A |  | Optional with capability signalling |

 |

Based on the above contribution, it is agreed to discuss following point in the email discussion [4].

**Discussion point #1**

* **Whether/how to define new FGs related to PUCCH group to better support the FR1 + FR1 + FR2 deployment**

During the preparation phase email discussion, following comments were provided [4].

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | For the first topic, we suggest adding two more issues related to the current UE capability signalling for two NR PUCCH groups:* + A UE should not be mandated to support the case where cells from different NR PUCCH groups are in the same TAG, but there is no such capability signalling in Rel.15.
	+ A UE should not be mandated to support the case where cells from two NR PUCCH groups are in the same band, but there is no such capability signalling in Rel.15.
 |
| Intel | On the discussion point #1:Discussion point #1Ÿ Whether/how to define new FGs related to PUCCH group to better support the FR1 + FR1 + FR2 deploymentSo far, we only support up to two different numerologies within the same PUCCH group. We think we need to firstly check if three numerologies within the same PUCCH group can be already supported as per the current specification. It will be weird if three numerologies within the same PUCCH group have been already supported as per the current spec since it means the absence of the corresponding UE capability means it is mandatory feature without capability signaling already.In that sense, I think we can discuss the issue under TEI, not UE feature. The outcome of the discussion can of course result in the UE capability. |
| Huawei, HiSilicon | Discussion for issues 2.1 and 2.2 is fine while more justification is expected, and we assume these are for Rel-16 only.  |

## 2.1 Proposal and discussion

Based on the contributions and above inputs in the preparation phase, following proposal is made.

### **FL proposal 1:**

* **A new FG to indicate whether UE supports 3 different numerologies in the same PUCCH group and the restrictions on PUCCH configuration is introduced.**
* **A new FG to indicate whether UE supports FR1 + (FR1 + FR2) PUCCH group configuration is introduced.**
* **A new FG to indicate, for FR1 + (FR1 + FR2) PUCCH group configuration, whether PUCCH can be configured on FR2 on the secondary PUCCH group, or SCG is introduced.**
* **A new FG to indicate whether UE supports cells from different NR PUCCH groups in the same TAG is introduced.**
* **A new FG to indicate whether UE supports cells from different NR PUCCH groups in the same band is introduced.**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposals:

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

1. New FG for supporting offset between the end of PDCCH triggering A-SRS and the SRS transmission for CB PUSCH and antenna switching

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2-58 | For SRS for CB PUSCH and antenna switching on FR1, zero slot offset for aperiodic SRS transmission | For SRS for CB PUSCH and antenna switching on FR1, support of zero slot offset between aperiodic SRS triggering and transmission | 2-53 | *zeroSlotOffsetAperiodicSRS* | *FeatureSetUplink-v1540* | n/a | n/a |  | Optional with capability signalling |

In [3], following proposal is made.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| If a UE does not support FG 2-58, a UE expects a gap between the last symbol of PDCCH carrying SRS triggering and the earliest SRS symbol to be offset by at least 1 slot, i.e., SRS triggering and resource for transmission cannot be in the same slot. This gap helps the UEs supporting only PDCCH based on FG 3-1. In particular, assuming a 3-symbol PDCCH at the beginning of slot n, the earliest time for SRS transmission is over the last 6 symbols of slot n+1, i.e., the gap between the end of PDCCH triggering SRS and the first potential symbol for SRS transmission is 19 symbols. However, the same gap cannot be maintained for UEs supporting any other PDCCH capability, e.g., 3-2, 3-5/a/b or the new Rel. 16 PDCCH. To address the issue for the UEs supporting PDCCH monitoring capabilities besides FG 3-1, we propose to adopt the following FG:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2-58a | For SRS for CB PUSCH and antenna switching on FR1 with symbol level offset for aperiodic SRS transmission  | For UEs supporting a PDCCH monitoring capability in addition to FG 3-1:1. For SRS for CB PUSCH and antenna switching on FR1, support d symbols offset between aperiodic SRS triggering and transmission
 | 2-53 | Yes | N/A |  | FS | n/a | n/a | n/a |  | Optional with capability signallingThe value range for component 1 = {0, 19} |

**Proposal: Add an FG for supporting offset between the end of PDCCH triggering A-SRS and the SRS transmission for CB PUSCH and antenna switching for UEs supporting PDCCH capabilities besides FG 3-1.** |

Based on the above contribution, it is agreed to discuss following point in the email discussion [4].

**Discussion point #2**

* **Whether/how to define new FG for supporting offset between the end of PDCCH triggering A-SRS and the SRS transmission for CB PUSCH and antenna switching for UEs supporting PDCCH capabilities besides FG 3-1**

During the preparation phase email discussion, following comment was provided [4].

|  |  |
| --- | --- |
| Company | Comment |
| Huawei, HiSilicon | Discussion for issues 2.1 and 2.2 is fine while more justification is expected, and we assume these are for Rel-16 only.  |

## 3.1 Proposal and discussion

Based on the contributions and above inputs in the preparation phase, following proposal is made.

### **FL proposal 2:**

* **A new FG for supporting offset between the end of PDCCH triggering A-SRS and the SRS transmission for CB PUSCH and antenna switching for UEs supporting PDCCH capabilities besides FG 3-1 is introduced.**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposals:

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

1. New FG for supporting partial cancellation of configured PUCCH/PUSCH/PRACH due to dynamic SFI, dynamically granted PDSCH and CSI-RS

In [3], following proposal is made.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A partial cancellation according to the following clause from Section 11.1.1 of 38.213 (f90) was included in Rel. 15 specification:*If a UE is configured by higher layers to transmit SRS, or PUCCH, or PUSCH, or PRACH in a set of symbols of a slot and the UE detects a DCI format 2\_0 with a slot format value other than 255 that indicates a slot format with a subset of symbols from the set of symbols as downlink or flexible, or the UE detects a DCI format 1\_0, DCI format 1\_1, or DCI format 0\_1 indicating to the UE to receive CSI-RS or PDSCH in a subset of symbols from the set of symbols, then* *-     the UE does not expect to cancel the transmission in symbols from the set of symbols that occur, relative to a last symbol of a CORESET where the UE detects the DCI format 2\_0 or the DCI format 1\_0 or the DCI format 1\_1 or the DCI format 0\_1, after a number of symbols that is smaller than the PUSCH preparation time  for the corresponding PUSCH processing capability [6, TS 38.214] assuming  and  corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH carrying the DCI format 2\_0, DCI format 1\_0, DCI format 1\_1 or DCI format 0\_1 and the SCS configuration of the SRS, PUCCH, PUSCH or r, where r corresponds to the SCS configuration of the PRACH if it is 15kHz or higher; otherwise r=0**-     the UE cancels the PUCCH, or PUSCH, or PRACH transmission in remaining symbols from the set of symbols and cancels the SRS transmission in remaining symbols from the subset of symbols.* The behavior defined according to the text basically means that the UE should be able to cancel an ongoing configured uplink transmission if it detects a DCI scheduling PDSCH or CSI-RS or SFI. The cancellation could be partial based on the timeline. (A similar text with new DCI formats exists in the Rel. 16 spec.) Based on this text, e.g., a DL DCI scheduling a PDSCH can force a UE to interrupt an ongoing P-CSI transmission. However, the Rel. 15 UEs are not able to ***partially cancel*** an ongoing uplink transmission. Hence, we propose to add the following FG to support the feature:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| XX | XX | Cancellation of PUCCH, PUSCH or PRACH with a DCI scheduling a PDSCH or CSI-RS or a DCI format 2\_0 for SFI | A UE supports the partial cancellation of the SRS or PUCCH or PUSCH or PRACH configured transmission: 1. The UE cancels the configured PUCCH or PUSCH or PRACH in a set of symbols of a slot due to detection of a DCI format 2\_0 with a slot format value other than 255 *255* that indicates a slot format with a subset of symbols from the set of symbols as downlink or flexible
2. The UE cancels the configured PUCCH or PUSCH or PRACH in a set of symbols of a slot due to the detection of a DCI format 1\_0, DCI format 1\_1, DCI format 1\_2 or DCI format 0\_1 and DCI format 0\_2 indicating to the UE to receive CSI-RS or PDSCH in a subset of symbols from the set of symbols.

  |  | Yes | N/A |  | FS | N/A | N/A | N/A | Optional with capability signaling.Component-1 is subjected to FG 3-6 |

If the UE does not support this feature, then cancellation of the configured PUCCH/PUSCH/PRACH is possible if their starting symbol is at least after a number of symbols that is larger or equal to the PUSCH preparation time T\_proc,2 from the last symbol of a CORESET where the UE detects the DCI format 2\_0 or the DCI formats 1\_0, 1\_1, 1\_2 or the DCI format 0\_1/0\_2. In such a case, the entire duration of the configured transmission is cancelled. **Proposed Conclusion: A UE not supporting the proposed FG, including the Rel. 15 UEs, is not expected to cancel a transmission of a configured PUCCH/PUSCH/PRACH over a subset of symbols if the gap between the starting symbol of the PUCCH/PUSCH/PRACH transmissions and the last symbol of a CORESET where the UE detects the DCI format 2\_0 or the DCI format 1\_0 or the DCI format 1\_1or DCI format 1\_2 or the DCI format 0\_1 or DCI format 0\_2, is smaller than the PUSCH preparation time  for the corresponding PUSCH processing capability [6, TS 38.214] assuming  and  corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH carrying the DCI format 2\_0, DCI format 1\_0, DCI format 1\_1, DCI format 1\_2, DCI format 0\_1 or DCI format 0\_2 and the SCS configuration of the SRS, PUCCH, PUSCH or r, where r corresponds to the SCS configuration of the PRACH if it is 15kHz or higher; otherwise r=0.** **Proposal: Add an FG for supporting partial cancellation of configured PUCCH/PUSCH/PRACH due to dynamic SFI, dynamically granted PDSCH and CSI-RS.** |

Based on the above contribution, it is agreed to discuss following point in the email discussion [4].

**Discussion point #3**

* **Whether/how to define new FG for supporting partial cancellation of configured PUCCH/PUSCH/PRACH due to dynamic SFI, dynamically granted PDSCH and CSI-RS, and UE behavior for UE not supporting the FG**

During the preparation phase email discussion, following comments were provided [4].

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | * + We are fine to discuss for issues 2.1 and 2.2, but we think that the discussion is not needed for issue 2.3.
 |
| Qualcomm | For the 3rd topic, clearly the Rel. 15 NR UEs are not designed/are not supposed to perform “partial” cancellation; the Rel. 15 agreement itself was based on the full cancellation, not partial cancellation. Note that no capability even is defined for performing partial cancellation of configured UL transmissions due to PDSCH/CSI-RS/SFI.  |
| Huawei, HiSilicon | As to issue 2.3, it is related on both Rel-15 and Rel-16. We need to clarify the current behavior in Rel-15 first, e.g. based on the current specification, whether “partial cancellation” is supported or not; and if the conclusion is it is supported, it seems the proposal to have a feature group for it is necessary. Based on the conclusion for Rel-15, we can further discuss what to do for Rel-16.     |

## 4.1 Proposal and discussion

Based on the contributions and above inputs in the preparation phase, following proposal is made.

### **FL proposal 3:**

* **A new FG for supporting partial cancellation of configured PUCCH/PUSCH/PRACH due to dynamic SFI, dynamically granted PDSCH and CSI-RS is introduced.**

Companies are encouraged to check above FL proposal and to provide feedback if any in below. If you cannot accept the FL proposals, please put your company name after “Cannot accept the proposals” below and please provide your alternative proposal (in your comment) which could be acceptable to all in your consideration.

 Cannot accept the proposals:

|  |  |
| --- | --- |
| Company | Comment |
| Apple | I think we there are two question we need to first clarify * Do we support partial cancellatin PUCCH/PUSCH/PRACH in the current specification? From our perspective, cancellation due to duplexing direction change can lead to complicated design especially partial cancellatio and then resuming the transmission., since it can be impossible for UE to maintain phase continuity. We would prefer this case not to be supported by the specification.
 |
|  |  |
|  |  |

1. Conclusion

**FL proposal 1:**

* **A new FG to indicate whether UE supports 3 different numerologies in the same PUCCH group and the restrictions on PUCCH configuration is introduced.**
* **A new FG to indicate whether UE supports FR1 + (FR1 + FR2) PUCCH group configuration is introduced.**
* **A new FG to indicate, for FR1 + (FR1 + FR2) PUCCH group configuration, whether PUCCH can be configured on FR2 on the secondary PUCCH group, or SCG is introduced.**
* **A new FG to indicate whether UE supports cells from different NR PUCCH groups in the same TAG is introduced.**
* **A new FG to indicate whether UE supports cells from different NR PUCCH groups in the same band is introduced.**

**FL proposal 2:**

* **A new FG for supporting offset between the end of PDCCH triggering A-SRS and the SRS transmission for CB PUSCH and antenna switching for UEs supporting PDCCH capabilities besides FG 3-1 is introduced.**

**FL proposal 3:**

* **A new FG for supporting partial cancellation of configured PUCCH/PUSCH/PRACH due to dynamic SFI, dynamically granted PDSCH and CSI-RS is introduced.**

Reference

[1] R1-2006462 Updated RAN1 UE features list for Rel-16 NR Moderators (AT&T, NTT DOCOMO, INC.)

[2] R1-2006482 Discussions on NR Rel-16 UE features Apple

[3] R1-2006788 Discussion on NR Rel-16 UE features Qualcomm Incorporated

[4] R1-2006715 Summary on NR UE features for others Moderator (NTT DOCOMO, INC.)

Appendix: UE features list for FGs that are not dedicated to a specific Rel-16 work item/TEI in [1]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 (V2X 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 |
| 22. NR Others | 22-1 | Indicating supported option for UL Tx switching for inter-band UL CA | Indicating supported option for UL Tx switching for inter-band UL CA* Candidate values set is {option1, option2, both option 1 and option 2}
 | 6-6 and RAN4 FG 7-1 (Tx switching period between two uplink carriers) | Yes | N/A |  | Per BC | N/A | N/A (FR1 only) | N/A | It has been agreed in RAN1 that UE can report support of one of the three candidates {option1, option2, both option1 and option2}. It is up to RAN2 to design the corresponding UE capability signalling. | Signaling of this FG is mandatory conditioned on the support of switching time capability for Tx switching between two uplink carriers in inter-band UL CA band combinations in RAN4 FG 7-1 (i.e. Tx switching period between two uplink carriers) |
| 22. NR Others | 22-2 | Indicating supported option for UL Tx switching for EN-DC | Indicating supported option for UL Tx switching for EN-DC* Candidate values set is {option1, option2}
 | EN-DC and RAN4 FG 7-1 (Tx switching period between two uplink carriers) | Yes | N/A |  | Per BC | N/A | N/A (FR1 only) | N/A |  | Signaling of this FG is mandatory conditioned on the support of switching time capability for Tx switching between two uplink carriers in EN-DC in RAN4 FG 7-1 (i.e. Tx switching period between two uplink carriers) |
| 22. NR Others | 22-3a | CBG based transmission for UL with 1 unicast PUSCH per slot per CC with UE processing time Capability 2 | CBG based transmission for UL with 1 unicast PUSCH per slot per CC with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-3b | CBG based transmission for UL with up to 2 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for UL with up to 2 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-3c | CBG based transmission for UL with up to 7 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for UL with up to 7 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-3d | CBG based transmission for UL with up to 4 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for UL with up to 4 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-3e | CBG based transmission for DL with 1 unicast PDSCH per slot per CC with UE processing time Capability 2 | CBG based transmission for DL with 1 unicast PDSCH per slot per CC with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-3f | CBG based transmission for DL with up to 2 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for DL with up to 2 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-3g | CBG based transmission for DL with up to 7 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for DL with up to 7 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-3h | CBG based transmission for DL with up to 4 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for DL with up to 4 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 2 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4a | CBG based transmission for UL with 1 unicast PUSCH per slot per CC with UE processing time Capability 1 | CBG based transmission for UL with 1 unicast PUSCH per slot per CC with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4b | CBG based transmission for UL with up to 2 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 1 | CBG based transmission for UL with up to 2 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4c | CBG based transmission for UL with up to 7 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 1 | CBG based transmission for UL with up to 7 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4d | CBG based transmission for UL with up to 4 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 1 | CBG based transmission for UL with up to 4 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4e | CBG based transmission for DL with 1 unicast PDSCH per slot per CC with UE processing time Capability 1 | CBG based transmission for DL with 1 unicast PDSCH per slot per CC with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4f | CBG based transmission for DL with up to 2 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 1 | CBG based transmission for DL with up to 2 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4g | CBG based transmission for DL with up to 7 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 1 | CBG based transmission for DL with up to 7 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |
| 22. NR Others | 22-4h | CBG based transmission for DL with up to 4 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 1 | CBG based transmission for DL with up to 4 unicast PDSCHs per slot per CC for different TBs with UE processing time Capability 1 |  | Yes | N/A |  | Per FS | N/A | N/A |  | This capability is necessary for each SCS | Optional with capability signalling |