**3GPP TSG RAN WG1 #100bis-e R1-2002874**

e-Meeting, April 20th – 30th, 2020

Source: NTT DOCOMO, INC.

Title: Summary on Email discussion [100b-e-NR-UEFeatures-URLLC/IIoT-07]

Agenda Item: 7.2.11.5

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

# **Introduction**

This contribution summarizes the following email discussion in AI 7.2.11.5 regarding UE features for URLLC/IIoT.

[100b-e-NR-UEFeatures-URLLC/IIoT-07] Email discussion/approval on issues with capability signaling impacts on FGs related to UCI enhancements for URLLC (27th – 29th April) – Hiroki (DCM)

* Discuss followings on 11-3
	+ Confirm to remove component 3) and accordingly the note for component 3)
	+ Whether report type should be per UE or per FSPC or per band
		- If it is per UE,
			* It can be confirmed that FG11-3 does not need “FDD/TDD differentiation” and “FR1/FR2 differentiation”
* Discuss followings on 11-4
	+ Whether or not to include component 6) in FG 11-4
	+ Whether or not report type should be per UE or per FS
		- If it is per UE,
			* Confirm FG11-4 does not need “FDD/TDD differentiation” and “FR1/FR2 differentiation”
* Discuss whether report type of 11-4x should be per UE or per FSPC
	+ If it is per UE,
		- Confirm that FG11-4x does not need “FDD/TDD differentiation” and “FR1/FR2 differentiation”
* Discuss whether FG11-4a needs “FDD/TDD differentiation” and “FR1/FR2 differentiation”
	+ If differentiation is needed for both,
		- Whether/how to clarify capability interpretation for “support mixture of FDD/TDD and/or FR1/FR2”
* Note that discussed FGs in this email discussion are derived by outcome of high priority email discussion in FL proposal 2

In the email discussion [100b-e-NR-UEFeatures-URLLC/IIoT-02], following agreements were made.

**Agreements**:

FG11-3 is kept

**Conclusion:**

Following is discussed in AI 7.2.11.13.

* Whether to introduce separate FGs for the simultaneous use of CBG-based UL transmission and minimum processing capability 2 (e.g., 11-3a/3b/3c/3d/3e)

# **11-3: More than one PUCCH for HARQ-ACK transmission within a slot**

Based on agreements and [1], FG11-3 can be defined 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 (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****( 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 |
| 11. NR\_L1enh\_URLLC | 11-3 | More than one PUCCH for HARQ-ACK transmission within a slot | 1) Supports sub-slot based HARQ-ACK feedback procedure. • A UL slot consists of a number of sub-slots. No more than one transmitted PUCCH carrying HARQ-ACKs starts in a sub-slot.• At least one sub-slot configuration for PUCCH can be UE specifically configured to a UE. • Supports a single configuration for PUCCH resource for all sub-slots in a slot. The starting symbol of a PUCCH resource is defined with respect to the first symbol of sub-slot. Any sub-slot PUCCH resource is not across sub-slot boundaries. 2) Supported sub-slot configuration1. [3) Supported combinations of (A, B), where A is the minimum gap between sub-slots containing actual PUCCH transmissions measured from beginning to beginning of the sub-slots, including across slots, and B is the sub-slot duration, with both A and B in units of symbols]
 | TBD | Yes | N/A |  | [Per UE] | [No] | [No] | [N/A]  | Candidate value set for component 2):{ 7-symbol\*2,2-symbol\*7 and 7-symbol\*2}[Candidate value set for component 3):(A, B) = {(7, 7),(4, 2) and (7, 7),(2, 2) and (7, 7)}]FFS: Whether to keep component 3) and accordingly the above note for component 3)FFS: Any relationship between FG 11-3 and CBG-based PUSCH with minimum processing time capability #2? | Optional with capability signalling |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

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| Company | Comment |
| Qualcomm | We propose:* Include two more subslot patterns, one for 3 HARQ-ACK Tx per slot and one for 4 HARQ-ACK Tx per slot.
* If these are added, then component 3 is needed.
* Type of capability signaling is per FS. The UE does not need to support this feature in every band and every band combination. In addition, the subslot configuration does not need to be the same in every band. Further, the number of TBs per slot is a signaled per FS. Hence, the UE does not need to, e.g., support 7 PUCCH Tx per slot in bands where it only supports a single TB per slot.
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Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

**Based on the feedbacks, at least following points should be discussed for FG11-3.**

* **Whether to remove component 3) and accordingly the note for component 3)**
* **Whether report type should be per UE or per FSPC or per band**
	+ **If it is per UE,**
		- **It can be confirmed that FG11-3 does not need “FDD/TDD differentiation” and “FR1/FR2 differentiation”**

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| [2] | ZTE | * There is no need to report additional pattern to the one supported by component 2 i.e. 2-symbol\*7 and 7-symbol\*2.
	+ Current component 3), 2 back-to-back PUCCHs across two different slots cannot be supported by reporting (4,2) or (7,2) while such case is supported in Rel-15.

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| ***Suggested revision #3 on FG 11-3*** |
| Index | Feature group | Components | **Note** |
| 11-3 | More than one PUCCH for HARQ-ACK transmission within a slot | 1) Supports sub-slot based HARQ-ACK feedback procedure. • A UL slot consists of a number of sub-slots. No more than one transmitted PUCCH carrying HARQ-ACKs starts in a sub-slot.• At least one sub-slot configuration for PUCCH can be UE specifically configured to a UE. • Supports a single configuration for PUCCH resource for all sub-slots in a slot. The starting symbol of a PUCCH resource is defined with respect to the first symbol of sub-slot. Any sub-slot PUCCH resource is not across sub-slot boundaries. 2) Supported sub-slot configuration~~3) Supported combinations of (A, B), where A is the minimum gap between sub-slots containing actual PUCCH transmissions measured from beginning to beginning of the sub-slots, including across slots, and B is the sub-slot duration, with both A and B in units of symbols~~  | Candidate value set for component 2):{ 7-symbol\*2,2-symbol\*7 and 7-symbol\*2}~~[Candidate value set for component 3):~~~~(A, B) =~~ ~~{(7, 7),~~~~(4, 2) and (7, 7),~~~~(2, 2) and (7, 7)}]~~~~FFS: Whether to keep component 3) and accordingly the above note for component 3)~~~~FFS: Any relationship between FG 11-3 and CBG-based PUSCH with minimum processing time capability #2?~~ |

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| [3] | vivo | * For 11-3, to clarify the necessity of following FFS
	+ FFS: Whether to keep component 3) and accordingly the above note for component 3)
	+ FFS: Any relationship between FG 11-3 and CBG-based PUSCH with minimum processing time capability #2?
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| [3] | OPPO | * For 11-3, for component 3), it is deleted due to it is not discussed and agreed in RAN1.
* It is not necessary due to component 2) defines sub-slot configuration clearly.

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| 11-3 | More than one PUCCH for HARQ-ACK transmission within a slot | 1) Supports sub-slot based HARQ-ACK feedback procedure. • A UL slot consists of a number of sub-slots. No more than one transmitted PUCCH carrying HARQ-ACKs starts in a sub-slot.• At least one sub-slot configuration for PUCCH can be UE specifically configured to a UE. • Supports a single configuration for PUCCH resource for all sub-slots in a slot. The starting symbol of a PUCCH resource is defined with respect to the first symbol of sub-slot. Any sub-slot PUCCH resource is not across sub-slot boundaries. 2) Supported sub-slot configuration |

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| [5] | Ericsson | Component 3) of feature group 11-3 should not be included. UE performs the sub-slot based HARQ-ACK transmission according to RRC configuration.  |
| [7] | Media Tek Inc. | For FG11-3, remove the brackets from component 3) “*[3) Supported combinations of (A, B), where A is the minimum gap between sub-slots containing actual PUCCH transmissions measured from beginning to beginning of the sub-slots, including across slots, and B is the sub-slot duration, with both A and B in units of symbols]*”. |
| [8] | LGE | On FG 11-3, suggest to remove the component 3) and the corresponding note.  |
| [9] | Intel | * On component 3), this component is not necessary. Technical reasons below:
	+ We don’t see a similar situation as for PDCCH monitoring cases for PUCCH transmissions. For PDCCH monitoring the associated processing for the PDCCH and any corresponding channels as indicated in the DCI occurs starting from the PDCCH symbols, and may consume additional time beyond the last symbol of the PDCCH. Thus, consideration on minimum gap between two consecutive PDCCH monitoring spans can help how fast the processors in the UE may be freed up for the next monitoring span.
	+ On the other hand, for PUCCH transmission, once the PUCCH ends, the corresponding processing resources at the UE can be freed up. It is not clear exactly how the gap between two PUCCH transmissions makes a difference as long as PUCCHs are limited to respective non-overlapping sub-slots.
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| [10] | CATT | The necessity of component 3) is not clear.

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| 11-3 | More than one PUCCH for HARQ-ACK transmission within a slot | 1) Supports sub-slot based HARQ-ACK feedback procedure. • A UL slot consists of a number of sub-slots. No more than one transmitted PUCCH carrying HARQ-ACKs starts in a sub-slot.• At least one sub-slot configuration for PUCCH can be UE specifically configured to a UE. • Supports a single configuration for PUCCH resource for all sub-slots in a slot. The starting symbol of a PUCCH resource is defined with respect to the first symbol of sub-slot. Any sub-slot PUCCH resource is not across sub-slot boundaries. 2) Supported sub-slot configuration~~[3) Supported combinations of (A, B), where A is the minimum gap between sub-slots containing actual PUCCH transmissions measured from beginning to beginning of the sub-slots, including across slots, and B is the sub-slot duration, with both A and B in units of symbols]~~  |  | Yes | N/A |  | [Per UE] | [No] | [No] | [support mixture of FDD/TDD and/or FR1/FR2]  | Candidate value set for component 2):{ 7-symbol\*2,2-symbol\*7 and 7-symbol\*2}~~[Candidate value set for component 3):~~~~(A, B) =~~ ~~{(7, 7),~~~~(4, 2) and (7, 7),~~~~(2, 2) and (7, 7)}]~~~~FFS: Whether to keep component 3) and accordingly the above note for component 3)~~FFS: Any relationship between FG 11-3 and CBG-based PUSCH with minimum processing time capability #2? | Optional with capability signalling |

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| [11] | Samsung | * No need for component 3
	+ UE should be able to transmit PUCCH at least as often as receive PDSCH/transmit PUSCH. For 120 kHz, it is similar to transmitting PUCCH every 2 symbols for 15 kHz/30 kHz.
* It is preferable to have “Supported maximum number of actual PUCCH transmissions for HARQ-ACK within a slot” instead of component 3).
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| [12] | Apple | * Support to introduce component 3) in FG 11-3 by modifying it to the following: “Supported combinations of (A, B), where A is the minimum gap between sub-slots ~~containing~~ within which the actual PUCCH transmissions start, measured from beginning to beginning of the sub-slots, including across slots, and B is the sub-slot duration, with both A and B in units of symbols”.
	+ It would allow UEs to implement the feature with reduced complexity, similar to the span pattern that has been introduced for PDCCH.
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| [14] | Nokia, NSB | No need for CBG-related restrictions, and hence we are fine with removing component 3.. |
| [15] | Qualcomm | Following updates are proposed.

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| 11-3 | More than one PUCCH for HARQ-ACK transmission within a slot | 1) Supports sub-slot based HARQ-ACK feedback procedure. • A UL slot consists of a number of sub-slots. No more than one transmitted PUCCH carrying HARQ-ACKs starts in a sub-slot.• At least one sub-slot configuration for PUCCH can be UE specifically configured to a UE. • Supports a single configuration for PUCCH resource for all sub-slots in a slot. The starting symbol of a PUCCH resource is defined with respect to the first symbol of sub-slot. Any sub-slot PUCCH resource is not across sub-slot boundaries. 2) Supported sub-slot configuration3) Supported combinations of (A, B), where A is the minimum gap between sub-slots containing actual PUCCH transmissions measured from beginning to beginning of the sub-slots, including across slots, and B is the sub-slot duration, with both A and B in units of symbols  |  | Yes | N/A |  | PerBand | N/A | N/A |  | Candidate value set for component 2):{ 7-symbol\*2,2-symbol\*3 and 7-symbol\*2,7-symbol\*2 and 2-symbol\*3 and 2-symbol\*4, 7-symbol\*2 and 2-symbol\*3 and 2-symbol\*4 and 2-symbol\*7}Candidate value set for component 3):(A, B) = {(7, 7),(4, 2) and (7, 7),(3,2) and (4,2) and (7,7),(2, 2) and (3,2) and (4,2) and (7, 7)} | Optional with capability signalling |

In addition, the proposed FG 11-3a-e would allow for capability signalling for the simultaneous use of CBG-based UL transmission and minimum processing capability 2.

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| 11-3a | CBG based transmission for UL with 1 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for UL with 1 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | 5-5a or 5-5b | Yes | N/A |  | Per UE | No | FR1 only |  | [Modification of Rel-15 capability] | Optional with capability signalling |
| 11-3b | 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 | 5-13 | Yes | N/A |  | Per UE | No | FR1 only |  | [Modification of Rel-15 capability] | Optional with capability signalling |
| 11-3c | 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 | 5-13a | Yes | N/A |  | Per UE | No | FR1 only |  | [Modification of Rel-15 capability] | Optional with capability signalling |
| 11-3d | 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 | 5-13c | Yes | N/A |  | Per UE | No | FR1 only |  | [Modification of Rel-15 capability] | Optional with capability signalling |
| 11-3e | CBG based transmission for UL with up to 3 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | CBG based transmission for UL with up to 3 unicast PUSCHs per slot per CC for different TBs with UE processing time Capability 2 | 5-13d | Yes | N/A |  | Per UE | No | FR1 only |  | [Modification of Rel-15 capability] | Optional with capability signalling |

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| [16] | Huawei, HiSilicon | * It seems Component 3) is necessary for FG 11-3.
	+ Compared to 7-symbol sub-slot configuration, 2-symbol sub-slot configuration will impose much larger implementation complexity to UE. From UE implementation perspective, even the sub-slot duration is 2, some separation between the actual PUCCH transmissions is needed. Configuring 2 symbol sub-slot configuration is to enable fast starting of PUCCH transmission. If due to the requirement of separation between two actual PUCCH transmissions, then only 7 symbol sub-slot configuration can be configured, it is not good from latency perspective.
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# **[11-4: Two HARQ-ACK codebooks [with up to one sub-slot based HARQ-ACK codebook] simultaneously constructed for supporting PDSCH reception with different priorities at a UE]**

Based on [1], FG11-4 can be defined as below although it is still under the discussion in [100b-e-NR-UEFeatures-URLLC/IIoT-02].

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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 (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****( 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 |
| 11. NR\_L1enh\_URLLC | 11-4 | Two HARQ-ACK codebooks [with up to one sub-slot based HARQ-ACK codebook] simultaneously constructed for supporting PDSCH reception with different priorities at a UE | 1) Supports two HARQ-ACK codebooks with different priorities to be simultaneously constructed [with the restriction up to one sub-slot based HARQ-ACK codebook].2) Supports separate PUCCH configuration for different HARQ-ACK codebooks3) Supports 2-level priority of HARQ-ACK for dynamically scheduled PDSCH and SPS PDSCH.[4) Supports a DCI format (from the formats 0\_1/1\_1/0\_2/1\_2) scheduling PDSCH with different HARQ-ACK priorities or PUSCH with different priorities when only DCI format 0\_1/1\_1 is configured or only DCI format 0\_2/1\_2 is configured per BWP] 5) Supports separate configuration of parameters PDSCH-HARQ-ACK-Codebook, UCI-OnPUSCH and ‘codeBlockGroupTransmission” for different HARQ-ACK codebooks. 1. [6) Supported maximum number of actual PUCCH transmissions for HARQ-ACK within a slot]
 | TBD | Yes | N/A |  | [Per UE]FFS: FS | [No] | [No] | [N/A]  | FFS: For component 4), whether to separate DL priority and UL priority, and whether to separate DCI format 0\_1/1\_1 and DCI format 0\_2/1\_2 | Optional with capability signalling |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

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| Company | Comment |
| Qualcomm | * Remove the bracket inside the feature group title and from component 1.
* For component 4, there is no need to include the UL DCI formats.
* We propose to add the following component too:
	+ If both processing time capability 1 CC(s) and processing time capability 2 CC(s) are configured, and both slot-based and sub-slot based PUCCH are configured, then HARQ-ACK feedback for a processing time capability 1 CC can only take place in the slot-based PUCCH and HARQ-ACK feedback for a processing time capability 2 CC can only take place in the sub-slot based PUCCH
* Reporting Type is FS for the same reasons as mentioned in our response to FG 11-3.
* We are fine with keeping component 6 as well.
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Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

**Based on the feedbacks, at least following points should be discussed for FG11-4.**

* **Whether or not to include component 6) in FG 11-4**
* **Whether or not report type should be per UE or per FS**
	+ **If it is per UE,**
		- **Confirm FG11-4 does not need “FDD/TDD differentiation” and “FR1/FR2 differentiation”**
* **It can be confirmed that The description of FG can be modified as “[Two sub-slot based HARQ-ACK codebooks simultaneously constructed for supporting PDSCH reception with different priorities of the corresponding HARQ-ACK feedback at a UE].”.**

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| [2] | ZTE | For FG 11-4/FG 11-4x, it needs to first clarify whether the limitation of one PUCCH transmission in one slot/sub-slot is per HARQ-ACK codebook or not.  |
| [3] | vivo | * Do not merge 11-4 with 12-1
	+ There could be a use case where UE has mixed eMBB and URLLC in DL while only eMBB in UL, in such case UE can only implement 11-4 without 12-1.
* For component 4), make separate features for DL priority and UL priority indication.
* For component 4), do not separate the DCI format x\_1 and x\_2
 |
| [4] | OPPO | * The condition that when only DCI format 0\_1/1\_1 is configured or only DCI format 0\_2/1\_2 is configured in USS per BWP can be deleted due to the same solution is applied. Similarly, for 11-4a, it is not necessary.
* HARQ-ACK codebook is associated with DCI format 1\_1 and 1\_2 only, so DCI format 0\_1 and 0\_2, PUSCH with different priorities need to be deleted in this feature group.

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| 11-4 | Up to two HARQ-ACK codebooks simultaneously constructed for supporting different service types for a UE | 1) Supports up to two HARQ-ACK codebooks with different priorities to be simultaneously constructed.2) Supports separate PUCCH configuration for different HARQ-ACK codebooks3) Supports 2-level priority of HARQ-ACK for dynamically scheduled PDSCH and SPS PDSCH.4) Supports a DCI format (from the formats /1\_1/1\_2) scheduling PDSCH with different HARQ-ACK priorities 5) Supports separate configuration of parameters PDSCH-HARQ-ACK-Codebook, UCI-OnPUSCH and ‘codeBlockGroupTransmission” for different HARQ-ACK codebooks.  |

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| [5] | Ericsson | * For FG 11-4 component 4), there is no need to separate DL priority and UL priority.
* For FG 11-4 component 4), DCI format 0\_1/1\_1 and DCI format 0\_2/1\_2 should be separated, with different dependency of FG 11-1.
* For FG 11-4 component 6) (in bracket), it should not be introduced.
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| [7] | Media Tek Inc. | For FG11-4, the following suggestions are made;* Clarify if FG11-3 is prerequisite for FG11-4 or not.
* Change the capability type to FS.
* Remove the brackets in component 1) “*[with the restriction up to one sub-slot based HARQ-ACK codebook]*”.
* Component 6) “*Supported maximum number of actual PUCCH transmissions for HARQ-ACK within a slot*” can be removed. If the UE is not supporting FG11-3, the maximum number of PUCCHs per slot will be 2. If the UE supports FG11-3 and FG11-4, the maximum number of PUCCH slot will be what is reported in FG11-3 plus 1.
* There is no need to have separate UE capabilities for scheduling PDSCH with different HARQ-ACK priorities or PUSCH with different priorities by DCI format 1\_1/0\_1 and DCI format 1\_2/0\_2. Supporting FG11-4 doesn’t imply the support of DCI format 1\_2/0\_2.
* There is no need to add separate DL priority and UL priority.
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| [8] | LGE | * On FG 11-4, the description of FG needs to be updated as there is no definition on priority of “PDSCH reception”. It can be updated as “Two HARQ-ACK codebooks simultaneously constructed supporting PDSCH reception with different priorities of the corresponding HARQ-ACK feedback at a UE”.
* Regarding the separation of UE capability for different combinations based on slot-based HARQ-ACK codebook and sub-slot based HARQ-ACK codebook, it is preferable to set the following combinations: (1) One is slot-based and one is sub-slot-based, (2) Both are slot-based, and (3) Both are sub-slot-based. However, if the test efforts really need to be considered, it is fine with the compromised option from Rapporteur: (1) At least one is slot-based, and (2) Both are sub-slot-based.
* For the component 4), the bracket needs to be removed.
* For the component 6), considering this FG 11-4 would entail multiple PUCCHs with different priorities in a slot, it would be reasonable to have the component.
* Regarding “FFS: Whether and how to combine FG 11-4 and FG 12-1”, it can be understood that two HARQ-ACK codebook construction is related to intra-UE prioritization. In fact, the component 3) of FG 11-4 may be a part of FG 12-1. However, the other components of FG 11-4 would be just to support two HARQ-ACK codebooks with different priorities itself rather than only intra-UE prioritization. In this context, the benefit and methodology are a bit questionable to merge two FGs into a FG.
* Regarding “FFS: For component 4), whether to separate DL priority and UL priority, and whether to separate DCI format 0\_1/1\_1 and DCI format 0\_2/1\_2”, we think there is no need for separation between DL and UL priorities.
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| [9] | Intel | * There is no notion of PDSCHs with different priorities. In FG description, text should be changed to “… supporting PDSCH reception with different priorities **of the corresponding HARQ-ACK feedback** at a UE”.
* For component 4), the parts related to priorities for PUSCH should be deleted from FGs # 11-4 and 11-4x and moved to FG 12-1.
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| [10] | CATT | * Component 4) should be included in FG 11-4
	+ UE supports FG 11-4 should also support prioritization between UL channels/signals with different PHY priority levels and the prioritization/cancellation timelines as defined in FG 12-1. However, for a UE supporting FG 12-1, FG 11-4 may not be supported.
* FG 11-4 does not need to include PUSCH and its scheduling DCI formats DCI format 0\_1 and DCI format 0\_2.

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| 11-4 | Two HARQ-ACK codebooks [with up to one sub-slot based HARQ-ACK codebook] simultaneously constructed for supporting PDSCH reception with different priorities at a UE | 1) Supports two HARQ-ACK codebooks with different priorities to be simultaneously constructed [with the restriction up to one sub-slot based HARQ-ACK codebook].2) Supports separate PUCCH configuration for different HARQ-ACK codebooks3) Supports 2-level priority of HARQ-ACK for dynamically scheduled PDSCH and SPS PDSCH.[4) Supports a DCI format (from the formats ~~0\_1~~/1\_1/~~0\_2~~/1\_2) scheduling PDSCH with different HARQ-ACK priorities ~~or PUSCH~~ with different priorities when only DCI format 0\_1/1\_1 is configured or only DCI format 0\_2/1\_2 is configured per BWP] 5) Supports separate configuration of parameters *PDSCH-HARQ-ACK-Codebook*, *UCI-OnPUSCH* and ‘*codeBlockGroupTransmission”* for different HARQ-ACK codebooks. [6) Supported maximum number of actual PUCCH transmissions for HARQ-ACK within a slot]7) Prioritization between UL channels/signals with different PHY priority levels8) Additional number of symbols (d1) needed beyond the PUSCH preparation time for cancelling a low priority UL transmission.9) Additional number of symbols (d2) needed beyond the PUSCH preparation time for scheduling a high priority UL transmission that cancels a low priority UL transmission |  | Yes | N/A |  | [Per UE]FFS: FS | [No] | [No] | [support mixture of FDD/TDD and/or FR1/FR2]  | FFS: Whether and how to combine FG 11-4 and FG 12-1~~FFS: For component 4), whether to separate DL priority and UL priority, and whether to separate DCI format 0\_1/1\_1 and DCI format 0\_2/1\_2~~ | Optional with capability signalling |

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| [11] | Samsung | * Component 6) should be removed here and can be moved into 11-3.
* For the first FFS, no need to combine.
* For the second FFS, OK to separate DCI format 0\_1/1\_1 and DCI format 0\_2/1\_2.
 |
| [12] | Apple | * Keep separate UE FGs for the support of two-level HARQ-ACK priority and the support of two-level PUSCH/SR priority. Update FG 11-4 to include the multiplexing/prioritization between UL channels so that it becomes a complete and independent FG.
* Define separate UE FGs for DCI format 0\_1 and DCI format 0\_2 for the support of dynamic PUSCH priority indication.
* Define separate UE FGs for DCI format 1\_1 and DCI format 1\_2 for the support of dynamic HARQ-ACK priority indication.
* Introduce FG 11-4x for two sub-slot-based HARQ-ACK codebooks, and update FG 11-4 to be up to one sub-slot-based HARQ-ACK codebook. Clarify for FG 11-4 that if a UE does not support 11-3 but supports 11-4, it means the UE can only support two slot-based HARQ-ACK codebooks.
* Split FG 11-4a into two FGs, one for HARQ-ACK priority indication in DCI formats 1\_1/1\_2, and another one for PUSCH priority indication in DCI formats 0\_1/0\_2.
 |
| [13] | Panasonic | * Fine to define two UE capabilities, with sub-slot based HARQ-ACK codebook and sub-slot based HARQ-ACK codebook as a separate UE capability.
* There is no need to introduce separate UE capabilities for scheduling PDSCH with different HARQ-ACK priorities or PUSCH with different priorities by DCI format 1\_1/0\_1 and DCI format 1\_2/0\_2.
	+ DCI format 1\_2/0\_2 are applicable to eMBB and URLLC as the superset function of DCI format 1\_1/0\_1.
 |
| [14] | Nokia, NSB | * Merge 11-4 with 12-1
	+ These feature groups are strongly related. One cannot operate 11-4 (having PUSCH & 2 CBs of different HARQ-Ack priorities) without the related multiplexing / prioritization which is part of 12-1.
* For component 4), no need for separate capability here, same applies to the related FFS for 11-4a.
* For 11-4 / 11-4X, no need to have separate capability of slot or sub-slot based CB
	+ Note that for subslot HARQ-ACK we have the independent capability 11-3 already. From our understanding, a UE supporting 11-3 and 11-4 should support slot or subslot based codebook for either of the two codebooks.
* No need identified for separate capability 6.
 |
| [15] | Qualcomm | Following updates are proposed.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11-4 | Two HARQ-ACK codebooks simultaneously constructed for supporting PDSCH reception with different priorities at a UE with restriction | 1) Supports two HARQ-ACK codebooks with different priorities to be simultaneously constructed 2) Supports separate PUCCH configuration for different HARQ-ACK codebooks3) Supports 2-level priority of HARQ-ACK for dynamically scheduled PDSCH and SPS PDSCH.4) Only one of the HARQ-ACK codebooks can have a sub-slot based PUCCH configuration 5) Supports separate configuration of parameters *PDSCH-HARQ-ACK-Codebook*, *UCI-OnPUSCH* and ‘*codeBlockGroupTransmission”* for different HARQ-ACK codebooks. [6) Supported maximum number of actual PUCCH transmissions for HARQ-ACK within a slot]7) If both processing time capability 1 CC(s) and processing time capability 2 CC(s) are configured, and both slot-based and sub-slot based PUCCH are configured, then HARQ-ACK feedback for a processing time capability 1 CC can only take place in the slot-based PUCCH and HARQ-ACK feedback for a processing time capability 2 CC can only take place in the sub-slot based PUCCH | 11-3 | Yes | N/A |  | FS | N/A | N/A |  |  | Optional with capability signalling |

 |
| [16] | Huawei, HiSilicon | * Prefer to set separate UE capability for “slot based + slot based”, “sub-slot based + slot based” and “sub-slot based + sub-slot based” from UE implementation perspective. As a compromise, we are fine to only set separate capability for “sub-slot based + sub-slot based”.
* Prefer to set separate UE capabilities for scheduling PDSCH with different HARQ-ACK priorities or PUSCH with different priorities by DCI format 1\_1/0\_1 and DCI format 1\_2/0\_2
	+ i.e. capability 1 for scheduling PDSCH with different HARQ-ACK priorities or PUSCH with different priorities by DCI format 1\_1/0\_1 and capability 2 for scheduling PDSCH with different HARQ-ACK priorities or PUSCH with different priorities by DCI format 1\_2/0\_2.
* No need to separate DL priority and UL priority. Similar views for FG 11-4a.
* Open to merge FG 11-4 and FG 12-1 into one single UE feature group. Alternatively, we can just put some note in both FG 11-4 and FG 12-1 to show the relationship between these two FGs, e.g. put a note “A UE supporting this feature shall also support FG 12-1” to FG 11-4.
 |

# **[11-4x: Two sub-slot based HARQ-ACK codebooks simultaneously constructed for supporting PDSCH reception with different priorities at a UE]**

Based on [1], FG11-4x can be defined as below although it is still under the discussion in [100b-e-NR-UEFeatures-URLLC/IIoT-02].

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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****( 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 |
| 11. NR\_L1enh\_URLLC | [11-4x] | [Two sub-slot based HARQ-ACK codebooks simultaneously constructed for supporting PDSCH reception with different priorities at a UE]. | 1) Supports two sub-slot based HARQ-ACK codebooks with different priorities to be simultaneously constructed.2) Supports separate PUCCH configuration for different HARQ-ACK codebooks3) Supports 2-level priority of HARQ-ACK for dynamically scheduled PDSCH and SPS PDSCH.4) Supports a DCI format (from the formats 0\_1/1\_1/0\_2/1\_2) scheduling PDSCH with different HARQ-ACK priorities or PUSCH with different priorities when only DCI format 0\_1/1\_1 is configured or only DCI format 0\_2/1\_2 is configured in USS per BWP 1. 5) Supports separate configuration of parameters *PDSCH-HARQ-ACK-Codebook*, *UCI-OnPUSCH* and ‘*codeBlockGroupTransmission”* for different HARQ-ACK codebooks.
 | 11-3 (TBD) | Yes | N/A |  | [Per UE] | [No] | [No] | [N/A] | FFS: whether to add this FG and the contents of this FG | Optional with capability signalling |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | * For component 4, there is no need to include the UL DCI formats.
* Reporting Type is FS for the same reasons as mentioned in our response to FG 11-3.
 |
|  |  |
|  |  |
|  |  |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

**Based on the feedbacks, at least following points should be discussed for FG11-4x.**

* **Whether report type should be per UE or per FSPC**
	+ **If it is per UE,**
		- **Confirmed FG11-4x does not need “FDD/TDD differentiation” and “FR1/FR2 differentiation”**

|  |  |  |
| --- | --- | --- |
| [2] | ZTE | For FG 11-4/FG 11-4x, it needs to first clarify whether the limitation of one PUCCH transmission in one slot/sub-slot is per HARQ-ACK codebook or not.  |
| [5] | Ericsson | FG [11-4x] is not introduced. FG 11-4 is revised to include the support of up to two sub-slot based HARQ-ACK codebooks. |
| [7] | Media Tek Inc. | For FG11-4x, the maximum number of PUCCHs per slot for this feature should be clarified. The feature is acceptable if the understanding is that the maximum number of PUCCHs per slot for this feature is equal to the number reported in FG11-3 (i.e. the supported number of PUCCHs in FG11-3 is divided between the two HARQ codebooks). On the other hand, this feature group can’t be acceptable if the total number of PUCCHs is expected to be double compared to what was reported in FG11-3.1. For FG11-4x, we have the following suggestions:
* Remove the brackets from FG11-4x.
* Change the capability type to FS.
* Add the following component “*Supported maximum number of actual PUCCH transmissions for HARQ-ACK within a slot*”.
 |
| [9] | Intel | For component 4), the parts related to priorities for PUSCH should be deleted from FGs # 11-4 and 11-4x and moved to FG 12-1. |
| [10] | CATT | Following updates are proposed.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [11-4x] | [Two sub-slot based HARQ-ACK codebooks simultaneously constructed for supporting PDSCH reception with different priorities at a UE]. | 1) Supports two sub-slot based HARQ-ACK codebooks with different priorities to be simultaneously constructed.2) Supports separate PUCCH configuration for different HARQ-ACK codebooks3) Supports 2-level priority of HARQ-ACK for dynamically scheduled PDSCH and SPS PDSCH.4) Supports a DCI format (from the formats ~~0\_1~~/1\_1/~~0\_2~~/1\_2) scheduling PDSCH with different HARQ-ACK priorities ~~or PUSCH~~ with different priorities when only DCI format 0\_1/1\_1 is configured or only DCI format 0\_2/1\_2 is configured in USS per BWP 5) Supports separate configuration of parameters *PDSCH-HARQ-ACK-Codebook*, *UCI-OnPUSCH* and ‘*codeBlockGroupTransmission”* for different HARQ-ACK codebooks.6) Prioritization between UL channels/signals with different PHY priority levels7) Additional number of symbols (d1) needed beyond the PUSCH preparation time for cancelling a low priority UL transmission.8) Additional number of symbols (d2) needed beyond the PUSCH preparation time for scheduling a high priority UL transmission that cancels a low priority UL transmission | 11-3 | Yes | N/A |  | [Per UE] | [No] | [No] | [support mixture of FDD/TDD and/or FR1/FR2] | FFS: whether to add this FG and the contents of this FG | Optional with capability signalling |

 |
| [11] | Samsung | It is not necessary to have this feature since the combination of 11-3 and 11-4 can support this operation without introducing additional signaling.  |
| [14] | Nokia, NSB | * For 11-4 / 11-4X, no need to have separate capability of slot or sub-slot based CB
	+ Note that for subslot HARQ-ACK we have the independent capability 11-3 already. From our understanding, a UE supporting 11-3 and 11-4 should support slot or subslot based codebook for either of the two codebooks.
 |
| [15] | Qualcomm | Following updates are proposed.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11-4x | Two HARQ-ACK codebooks simultaneously constructed for supporting PDSCH reception with different priorities at a UE without restriction | 1) Supports two HARQ-ACK codebooks with different priorities to be simultaneously constructed.2) Supports separate PUCCH configuration for different HARQ-ACK codebooks3) Supports 2-level priority of HARQ-ACK for dynamically scheduled PDSCH and SPS PDSCH.5) Supports separate configuration of parameters *PDSCH-HARQ-ACK-Codebook*, *UCI-OnPUSCH* and ‘*codeBlockGroupTransmission”* for different HARQ-ACK codebooks. | 11-3, 11-4 | Yes | N/A |  | FS | N/A | N/A |  |  | Optional with capability signalling |

 |

# **[11-4a: Monitoring a DCI format (from the formats 0\_1/1\_1/0\_2/1\_2) scheduling PDSCH with different HARQ-ACK priorities or PUSCH with different priorities when both DCI format 0\_1/1\_1 and DCI format 0\_2/1\_2 are configured to be monitored per BWP]**

Based on [1], FG11-4a can be defined as below although it is still under the discussion in [100b-e-NR-UEFeatures-URLLC/IIoT-02].

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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****( 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 |
| 11. NR\_L1enh\_URLLC | 11-4a | Monitoring a DCI format (from the formats 0\_1/1\_1/0\_2/1\_2) scheduling PDSCH with different HARQ-ACK priorities or PUSCH with different priorities when both DCI format 0\_1/1\_1 and DCI format 0\_2/1\_2 are configured to be monitored per BWP  |  | 11-1a, 11-4 (TBD) | Yes | N/A | FFS | Per UE | [No] | [No] | [N/A]  | FFS: Whether to split 11-4a into two rows as below:11-4x: DL priority indication in DCI with mixed DCI formats11-4y: UL priority indication in DCI with mixed DCI formats | Optional with capability signalling |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | We propose to separate the FG into two rows: (1) for DL priorities and (2) for UL priorities. The type of signaling for each new FG could be per-UE, but with both FDD/TDD and FR1/FR2 differentiations. Further, the differentiations for both is from the perspective of the scheduling cell. |
|  |  |
|  |  |
|  |  |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

**Based on the feedbacks, at least following points should be discussed for FG11-4a.**

* **Whether FG11-4a needs “FDD/TDD differentiation” and “FR1/FR2 differentiation”**
	+ **If differentiation is needed for both,**
		- **Whether/how to clarify capability interpretation for “support mixture of FDD/TDD and/or FR1/FR2”**

|  |  |  |
| --- | --- | --- |
| [3] | vivo | * FG 11-4a can be removed if there is no new priority indication mechanism agreed for the case when both DCI formats are configured.
	+ if there is no new mechanism agreed for the case when both DCI formats are configured, e.g. priority determination based on DCI format, there seems no need to keep 11-4a.
	+ since 11-4a includes also the priority indication for UL, which has overlap with IIOT UE feature 12-1 component 1 (i..e Configuration of PHY priority level for CG PUSCH and SR, and dynamic indication of priority level for dynamic PUSCH), which needs to be clarified if 11-4a is to be kept.
 |
| [4] | OPPO | For FFS, no need to introduce separate capabilities. |
| [8] | LGE | * On FG 11-4a, this FG can be further separated into two FGs: one for DCI format 0\_1/1\_1 and another for DCI format 0\_2/1\_2.
	+ more flexibility can be ensured such that DCI format 0\_1/1\_1 can schedule two priorities while DCI format 0\_2/1\_2 can schedule only one priority.
* Prerequisite FG of FG 11-4a would be 11-1 and 11-4 rather than 11-1a and 11-4.
* Regarding the FFS on separation between DL and UL (11-4x/11-4y), no essential need for further separation.
 |
| [15] | Qualcomm | Following updates are proposed.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11-4a | DL priority indication in DCI with mixed DCI formats  | When both DCI format 1\_1 and DCI format 1\_2 are configured to be monitored per BWP, only one DCI format (from the formats 1\_1/1\_2) can be used to schedule PDSCH with low priority HARQ-ACK and only one can be used to schedule PDSCH with high priority HARQ-ACK. | 11-1, 11-4 | Yes | N/A |  | Per UE | Yes | Yes | The differentiation is from the perspective of the scheduling cell. |  | Optional with capability signalling |
| 11-4b | UL priority indication in DCI with mixed DCI formats | When both DCI format 0\_1 and DCI format 0\_2 are configured to be monitored per BWP, only one DCI format (from the formats 0\_1/0\_2) can be used to schedule PUSCH with low priority and only one can be used to schedule PUSCH with high priority. | 11-1, 11-4 | Yes | N/A |  | Per UE | Yes | Yes | The differentiation is from the perspective of the scheduling cell. |  | Optional with capability signaling  |

 |

# **Conclusion**

TBD

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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****( 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 |
| 11. NR\_L1enh\_URLLC | 11-3 | More than one PUCCH for HARQ-ACK transmission within a slot | 1) Supports sub-slot based HARQ-ACK feedback procedure. • A UL slot consists of a number of sub-slots. No more than one transmitted PUCCH carrying HARQ-ACKs starts in a sub-slot.• At least one sub-slot configuration for PUCCH can be UE specifically configured to a UE. • Supports a single configuration for PUCCH resource for all sub-slots in a slot. The starting symbol of a PUCCH resource is defined with respect to the first symbol of sub-slot. Any sub-slot PUCCH resource is not across sub-slot boundaries. 2) Supported sub-slot configuration1. [3) Supported combinations of (A, B), where A is the minimum gap between sub-slots containing actual PUCCH transmissions measured from beginning to beginning of the sub-slots, including across slots, and B is the sub-slot duration, with both A and B in units of symbols]
 | TBD | Yes | N/A |  | [Per UE] | [No] | [No] | [N/A]  | Candidate value set for component 2):{ 7-symbol\*2,2-symbol\*7 and 7-symbol\*2}[Candidate value set for component 3):(A, B) = {(7, 7),(4, 2) and (7, 7),(2, 2) and (7, 7)}]FFS: Whether to keep component 3) and accordingly the above note for component 3)FFS: Any relationship between FG 11-3 and CBG-based PUSCH with minimum processing time capability #2? | Optional with capability signalling |

# **References**

[1] R1-2001484 RAN1 UE features list for Rel-16 NR after RAN1#100-E Moderator (AT&T, NTT DOCOMO, INC.)

[2] R1-2001632 Discussion on UE feature for URLLC/IIoT ZTE

[3] R1-2001721 Discussion on Rel-16 URLLC/IIOT UE features vivo

[4] R1-2001782 Discussion on UE features for URLLC/IIoT OPPO

[5] R1-2001791 On UE Features for URLLC and IIoT Ericsson

[6] R1-2001795 UE features for URLLC China Unicom

[7] R1-2001828 Views on Rel-16 UE features for NR URLLC/IIoT MediaTek Inc.

[8] R1-2001927 Discussion on UE features for URLLC/IIoT LG Electronics

[9] R1-2002019 On UE features for Rel-16 eURLLC and IIoT Intel Corporation

[10] R1-2002070 Discussion of UE features for NR URLLC/IIoT CATT

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[12] R1-2002352 Discussions on UE Features for URLLC/IIoT Apple

[13] R1-2002399 UE features for URLLC/IIoT Panasonic Corporation

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[16] R1-2002591 Rel-16 UE features for URLLC Huawei, HiSilicon

[16] R1-2002869 Summary on Email discussion [100b-e-NR-UEFeatures-URLLC/IIoT-02] Moderator (NTT DOCOMO, INC.)