**3GPP TSG RAN WG1 #102e R1-2007016**

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

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

**Title:** **Summary on [102-e-NR-UEFeatures-URLLC/IIoT-02]**

**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-URLLC/IIoT-02] Email discussion/approval on UE features for URLLC/IIoT (17th – 20th August) – Hiroki (DCM)

* Whether to add licensed/unlicensed differentiation for FG11-6 or not
* Whether to add components for the restriction on the number of monitoring occasions per slot/half-slot to FG11-2 or not
* Whether/how to add new FGs for the reference cell number for DC PDCCH BD/CCE limit
* Whether/how to add new FG for independent cancellation of the overlapping channels in an intra-band UL CA

1. FG11-6

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| 11.  NR\_L1enh\_URLLC | 11-6 | PUSCH repetition Type A | 1. PUSCH transmission with Rel-15 behavior with or without slot aggregation.   • With slot aggregation, the number of repetitions can be dynamically indicated (as agreed for Rel-16).  • When dynamically indicated, the number of repetitions is jointly coded with SLIV in TDRA table, by adding an additional column for the number of repetitions in the TDRA table. | One of {5-16, 5-17] | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signalling |

Following proposals are made in contributions.

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| [2] | We are not sure this FG needs FR1 and FR2 differentiation. Clarification is needed. |
| [10] | **FG 11-6:**   * PUSCH repetition with dynamic indication is also supported in unlicensed bands. Hence, we propose to add a licensed/unlicensed differentiation for this FG. |

Based on the above contributions, it is agreed to discuss following point in the email discussion [12].

**Discussion point #6**

* **Whether to add licensed/unlicensed differentiation for FG11-6 or not**

During the preparation phase, following comments were provided [12].

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| Company | Comment |
| Ericsson | * For “licensed/unlicensed differentiation for FG11-6 or not”: we do not see any justification why this is need for FG11-6 in particular. We recommend not to include this in email discussion scope. We are open for discussion in the future if the question is sufficiently justified. |

## 2.1 Proposal and discussion

Based on the contribution and the discussion in preparation phase, following proposal is made. The reporting type of FG11-6 had been discussed and the current design (Per UE without differentiation) was just agreed in [101-e-Post-NR-UE-Features-12].

### **FL proposal 1:**

* **The licensed/unlicensed differentiation is not introduced for FG11-6.**

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:

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| Company | Comment |
| DOCOMO | Support the FL proposal 1. We don’t think the licensed/unlicensed differentiation is needed. Even in case the differentiation is needed, gNB can manage it by configuring *pusch-TimeDomainAllocationListForDCI-Format0-1-r16* or *pusch-TimeDomainAllocationListForDCI-Format0-2-r16* for each BWP. For example, UE reports FG 11-6 without licensed/unlicensed differentiation, and gNB configures *pusch-TimeDomainAllocationListForDCI-Format0-1-r16* for the BWP of licensed and does not configure *pusch-TimeDomainAllocationListForDCI-Format0-1-r16* for the BWP of unlicensed. |
| ZTE | Support the FL proposal 1. We don’t see clear motivation for such FG. |
| Qualcomm | To respond to DOCOMO’s comment, UE capabilities are more about UE’s complexities and also IODTs. A feature may need to be tested in different bands (FR1/FR2, licensed/unlicesnsed etc.) It is not about how the network should/can configure different features. |
| Huawei, HiSilicon | We support the FL proposal. We also don't see strong motivation to do the differentiation here. |
| vivo | Support the FL proposal. We would like to understand how the PUSCH repetition Type A would work in combination with multi-PUSCH grant that is configured for DCI 0\_1 in unlicensed band especially considering if the time-domian resource for multi-PUSCH span across more than one slot. It is better to be discussed in NR-U session. |
| Nokia, NSB | We are OK with the FL proposal in principle. |
| Ericsson | Support FL proposal 1 |
| Apple | It is not clear to us why we are discussing the licensed/unlicensed differentiation for this FG in particular. |
| Qualcomm 2 | The feture pointed out by Ericsson is a different one. Our point is that Type-A PUSCH which is dynamically scheduled can be used in an unlicensed band too (CG-PUSCH cannot and that is something to consider in Rel. 17.) Given the applicability of the feature to unlicensed band too, we would like to add the differentiation for the case of repetition with DG-PUSCH. |

1. FG11-2

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| 11.  NR\_L1enh\_URLLC | 11-2 | Rel-16 PDCCH monitoring capability | 1. Supported combination(s) of (X, Y, μ). For each reported combination, the UE supports the limit C on the maximum number of non-overlapped CCEs for channel estimation per PDCCH monitoring span and the limit M on the maximum number of monitored PDCCH candidates per PDCCH monitoring span 2. Maximum number of DL and UL unicast DCI formats in a span   For the set of monitoring occasions which are within the same span:   * Processing one unicast DCI scheduling DL and one unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for FDD * Processing one unicast DCI scheduling DL and two unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for TDD * Processing two unicast DCI scheduling DL and one unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for TDD |  | Yes | N/A |  | Per FS for component 1  Note: Indicating support of this capability in a band in a BC implies that only rel-16 monitoring can be configured in a CA configuration for the BC if the CA configuration includes the band and if rel-16 monitoring is configured for the band | N/A | N/A | N/A | This capability is signaled for SCS 15 kHz and 30 kHz.  For μ=0 and 1, candidate value set for (X, Y, μ): {(7, 3, μ), (4, 3, μ), (2, 2, μ)}  For component 1, a list of separate UE capabilities (X, Y, μ)for processing capability #1;  For component 1, a list of separate UE capabilities (X, Y, μ)for processing capability #2; | Optional with capability signalling |

In [4], following proposal is made.

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| In RAN1#101-2 meeting, it was agreed to remove FG3-5b from prerequisite feature groups for FG11-2. The main reason is that the motivations to introduce spans in Rel-15 and in Rel-16 are different. Since FG 3-5b is not the prerequisite of FG 11-2 anymore, we think the restriction on the number of monitoring occasions per slot defined in FG 3-5b should be included in FG 11-2 also. Without this restriction, UE may end up with up to 14 monitoring occasions per slot, which is extremely complicated for the UE implementation.   |  |  |  |  | | --- | --- | --- | --- | | 11.  NR\_L1enh\_URLLC | 11-2 | Rel-16 PDCCH monitoring capability | 1. Supported combination(s) of (X, Y, μ). For each reported combination, the UE supports the limit C on the maximum number of non-overlapped CCEs for channel estimation per PDCCH monitoring span and the limit M on the maximum number of monitored PDCCH candidates per PDCCH monitoring span 2. Maximum number of DL and UL unicast DCI formats in a span   For the set of monitoring occasions which are within the same span:   * Processing one unicast DCI scheduling DL and one unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for FDD * Processing one unicast DCI scheduling DL and two unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for TDD * Processing two unicast DCI scheduling DL and one unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for TDD  1. The number of different start symbol indices of PDCCH monitoring occasions per slot including PDCCH monitoring occasions of FG-3-1, is no more than 7. 2. The number of different start symbol indices of PDCCH monitoring occasions per half-slot including PDCCH monitoring occasions of FG-3-1 is no more than 4 in SCell. | |

Based on the above contribution, it is agreed to discuss following point in the email discussion [12].

**Discussion point #8**

* **Whether to add components for the restriction on the number of monitoring occasions per slot/half-slot to FG11-2 or not**

## 3.1 Proposal and discussion

Based on the contribution, following proposal is made.

### **FL proposal 2:**

* **The following components for the restriction on the number of monitoring occasions per slot/half-slot are added to FG11-2.**
  + **The number of different start symbol indices of PDCCH monitoring occasions per slot including PDCCH monitoring occasions of FG-3-1, is no more than 7.**
  + **The number of different start symbol indices of PDCCH monitoring occasions per half-slot including PDCCH monitoring occasions of FG-3-1 is no more than 4 in SCell.**

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| 11.  NR\_L1enh\_URLLC | 11-2 | Rel-16 PDCCH monitoring capability | 1. Supported combination(s) of (X, Y, μ). For each reported combination, the UE supports the limit C on the maximum number of non-overlapped CCEs for channel estimation per PDCCH monitoring span and the limit M on the maximum number of monitored PDCCH candidates per PDCCH monitoring span 2. Maximum number of DL and UL unicast DCI formats in a span   For the set of monitoring occasions which are within the same span:   * Processing one unicast DCI scheduling DL and one unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for FDD * Processing one unicast DCI scheduling DL and two unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for TDD * Processing two unicast DCI scheduling DL and one unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for TDD  1. The number of different start symbol indices of PDCCH monitoring occasions per slot including PDCCH monitoring occasions of FG-3-1, is no more than 7. 2. The number of different start symbol indices of PDCCH monitoring occasions per half-slot including PDCCH monitoring occasions of FG-3-1 is no more than 4 in SCell. |  | Yes | N/A |  | Per FS for component 1  Note: Indicating support of this capability in a band in a BC implies that only rel-16 monitoring can be configured in a CA configuration for the BC if the CA configuration includes the band and if rel-16 monitoring is configured for the band | N/A | N/A | N/A | This capability is signaled for SCS 15 kHz and 30 kHz.  For μ=0 and 1, candidate value set for (X, Y, μ): {(7, 3, μ), (4, 3, μ), (2, 2, μ)}  For component 1, a list of separate UE capabilities (X, Y, μ)for processing capability #1;  For component 1, a list of separate UE capabilities (X, Y, μ)for processing capability #2; | Optional with capability signalling |

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: Intel

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| Company | Comment |
| DOCOMO | Agree with the FL proposal 2. |
| Intel | Cannot agree to the addition of the new components for the following reasons:   * It is not clear whether there is any practical benefits to UE complexity by limiting # of starting symbols for PDCCH MOs; * Such scheduling constraints were not present in Rel-15 either; * It is not clear what, if any, relationship exists between not having FG 3-5b as a pre-requisite for FG 11-2 and the proposed new components. |
| ZTE | We don’t see the reasoning here. What’s the difference between supporting 7 MOs with 2-symbol CORESET and 14 MOs with one-symbol CORESET? If the former can be supported why not for the latter case? |
| Qualcomm | Agree with the proposal. These constraints are the same as those for FG 3-5b. |
| Huawei, HiSilicon | Agree with the proposal.  Firstly, these restrictions are exactly included in FG 3-5b, which means the restriction exists in Rel-15. The main reason to introduce at that time is from UE implementation complexity perspective, so we believe it will have impact the complexity.  Secondly, I think the main reason for companies not supporting FG 3-5b as the prerequisite is mainly due to nested reporting structure in FG 3-5b but people don’t want to support in in FG 11-2. |
| vivo | Support the proposal 2. |
| Nokia, NSB | We tend to agree with Intel and ZTE here, i.e. we do not support proposal 2. |
| Ericsson | Do not agree with FL proposal 2. The monitoring span and related features are introduced to facilitate UE implementation. We do not see any benefits to introduce further constraints on starting symbol. |
| Apple | Support the proposal in principle. However, it is not clear to us:   1. why do we need “including PDCCH monitoring occasions of FG-3-1”? This FG is not built on top of FG 3-1, different from FG 3-5b. 2. We wonder why here we are not using floor (14/X) for component 3, same as FG 3-5b, with X being the smallest reported span gap. |
| Intel (round 2) | While we stand corrected on the second bullet in our previous response – that, FG 3-5b did include similar restrictions, it is still not clear why the same constraints need to be repeated for the new PDCCH monitoring feature. There is a significant difference compared to FG 3-5b in terms of the BD/CCE limits being applied on a span-level, and with such gating, the benefits from these additional constraints to UE implementation would be rather limited. On the other hand, these would severely constrain the gNB’s ability to configure SS sets appropriately considering different reliability targets for different traffic flows, e.g., via configuration of overlapping SS sets. |

1. New FGs for DC

Following proposals are made in contributions.

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| [6] | There are UE capabilities for the reference cell number for CA PDCCH BD/CCE limit for rel-16 monitoring and mixed monitoring as FG 11-2a and 11-2c. In the last meeting, similar to rel-15, UE capabilities related to DC PDCCH BD/CCE limit were agreed, but they are not reflected in the current UE feature table. Hence, we propose the addition of those capabilities as described below.  ***Proposal 4:*** *Adopt the addition of UE capabilities related to DC PDCCH BD/CCE limit as described below.*   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 11.  NR\_L1enh\_URLLC | 11-2d | Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span for MCG and for SCG when configured with NR-NR DC with Rel-16 PDCCH monitoring capability on all the serving cells | 1. Supported combination of (*pdcch-BlindDetectionMCG-UE-r16*, *pdcch-BlindDetectionSCG-UE-r16*)    * Candidate values for *pdcch-BlindDetectionMCG-UE-r16* is 1 to *pdcch-BlindDetectionCA-r16*-1    * Candidate values for *pdcch-BlindDetectionSCG-UE-r16* is 1 to *pdcch-BlindDetectionCA-r16*-1 | 11-2 | Yes | N/A |  | Per BC | N/A | N/A | N/A |  | Optional with capability signalling | | 11.  NR\_L1enh\_URLLC | 11-2e | Number of carriers for CCE/BD scaling for MCG and for SCG when configured with NR-NR DC with mix of Rel. 16 and Rel. 15 PDCCH monitoring capabilities on different carriers | 1. Supported combination(s) of (*pdcch-BlindDetectionMCG-UE-r15*, *pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16*, *pdcch-BlindDetectionSCG-UE-r16*)    * Candidate values for *pdcch-BlindDetectionMCG-UE-r15* is 0 to *pdcch-BlindDetectionCA-r15*    * Candidate values for *pdcch-BlindDetectionSCG-UE-r15* is 0 to *pdcch-BlindDetectionCA-r15*    * Candidate values for *pdcch-BlindDetectionMCG-UE-r16* is 0 to *pdcch-BlindDetectionCA-r16*    * Candidate values for *pdcch-BlindDetectionSCG-UE-r16* is 0 to *pdcch-BlindDetectionCA-r16* | 11-2b | Yes | N/A |  | Per BC | N/A | N/A | N/A | One combination of (*pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16*) corresponds to one combination of (*pdcch-BlindDetectionCA-r15, pdcch-BlindDetectionCA-r16*) | Optional with capability signalling | |
| [10] | **FG 11-2d and FG 11-2e (new FGs for Rel. 16 PDCCH with NR-DC):**   * Added in the URLLC section. |

Based on the above contributions, it is agreed to discuss following point in the email discussion [12].

**Discussion point #9**

* **Whether/how to add new FGs for the reference cell number for DC PDCCH BD/CCE limit**

## 4.1 Proposal and discussion

Based on the contributions, following proposal is made.

**FL proposal 3:**

* **Add FG11-2d and 11-2e to URLLC UE features list as below**

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| 11.  NR\_L1enh\_URLLC | 11-2d | Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span for MCG and for SCG when configured with NR-NR DC with Rel-16 PDCCH monitoring capability on all the serving cells | 1. Supported combination of (*pdcch-BlindDetectionMCG-UE-r16*, *pdcch-BlindDetectionSCG-UE-r16*)    * Candidate values for *pdcch-BlindDetectionMCG-UE-r16* is 1 to *pdcch-BlindDetectionCA-r16*-1    * Candidate values for *pdcch-BlindDetectionSCG-UE-r16* is 1 to *pdcch-BlindDetectionCA-r16*-1 | 11-2 | Yes | N/A |  | Per BC | N/A | N/A | N/A |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-2e | Number of carriers for CCE/BD scaling for MCG and for SCG when configured with NR-NR DC with mix of Rel. 16 and Rel. 15 PDCCH monitoring capabilities on different carriers | 1. Supported combination(s) of (*pdcch-BlindDetectionMCG-UE-r15*, *pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16*, *pdcch-BlindDetectionSCG-UE-r16*)    * Candidate values for *pdcch-BlindDetectionMCG-UE-r15* is 0 to *pdcch-BlindDetectionCA-r15*    * Candidate values for *pdcch-BlindDetectionSCG-UE-r15* is 0 to *pdcch-BlindDetectionCA-r15*    * Candidate values for *pdcch-BlindDetectionMCG-UE-r16* is 0 to *pdcch-BlindDetectionCA-r16*    * Candidate values for *pdcch-BlindDetectionSCG-UE-r16* is 0 to *pdcch-BlindDetectionCA-r16* | 11-2b | Yes | N/A |  | Per BC | N/A | N/A | N/A | One combination of (*pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16*) corresponds to one combination of (*pdcch-BlindDetectionCA-r15, pdcch-BlindDetectionCA-r16*) | Optional with capability signalling |

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 |
| DOCOMO | Agree with the FL proposal 3. |
| Intel | Support FL Proposal 3. |
| ZTE | Fine with FL proposal 3. |
| Qualcomm | * Add “synchronous” in the descrption, i.e., “ … configured with synchronous NR-NR DC …” * The value range range in case pdcch-BlindDetectionCA is not reported is missing. * The inequality constraints are missing. |
| Huawei, HiSilicon | **Support the proposal in principle.**  Some suggestion on the update of the component for FG 11-2d as below:   * Candidate values for pdcch-BlindDetectionMCG-UE-r16 is 1 to pdcch-BlindDetectionCA-r16-1 * Candidate values for pdcch-BlindDetectionSCG-UE-r16 is 1 to pdcch-BlindDetectionCA-r16-1 * pdcch-BlindDetectionMCG-UE-r16 + pdcch-BlindDetectionSCG-UE-r16 >= pdcch-BlindDetectionCA-r16   Some suggestion on the update of the component for FG 11-2e as below:   * If the UE reports *pdcch-BlindDetectionCA-r15*,   + Candidate values for *pdcch-BlindDetectionMCG-UE-r15* is 0 to *pdcch-BlindDetectionCA-r15*   + Candidate values for *pdcch-BlindDetectionSCG-UE-r15* is 0 to *pdcch-BlindDetectionCA-r15*   + *pdcch-BlindDetectionMCG-UE-r15* + *pdcch-BlindDetectionSCG-UE-r15*>= *pdcch-BlindDetectionCA-r15* * Otherwise, if is a maximum total number of downlink cells for which the UE is provided *monitoringCapabilityConfig-r16 = r15monitoringcapability*   + Candidate values for *pdcch-BlindDetectionMCG-UE-r15* is [0, 1, 2]   + Candidate values for *pdcch-BlindDetectionSCG-UE-r15* is [0, 1, 2]   + *pdcch-BlindDetectionMCG-UE-r15* + *pdcch-BlindDetectionSCG-UE-r15* >= * If the UE reports *pdcch-BlindDetectionCA-r16*,   + Candidate values for *pdcch-BlindDetectionMCG-UE-r16* is 0 to *pdcch-BlindDetectionCA-r16*   + Candidate values for *pdcch-BlindDetectionSCG-UE-r16* is 0 to *pdcch-BlindDetectionCA-r16*   + *pdcch-BlindDetectionMCG-UE-r16* + *pdcch-BlindDetectionSCG-UE-r16*>= *pdcch-BlindDetectionCA-r16* * Otherwise, if is a maximum total number of downlink cells for which the UE is provided *monitoringCapabilityConfig-r16 = r16monitoringcapability*   + Candidate values for *pdcch-BlindDetectionMCG-UE-r16* is [0, 1]   + Candidate values for *pdcch-BlindDetectionSCG-UE-r16* is [0, 1]   + *pdcch-BlindDetectionMCG-UE-r16* + *pdcch-BlindDetectionSCG-UE-r16* >= |
| vivo | Support the proposal 3. |
| Nokia, NSB | Support proposal 3 |
|  |  |

Based on the discussion in GTW session, following agreements were made.

**Agreements:**

* **Agree in principle to introduce FG11-2d and 11-2e to URLLC UE features list as below**
  + FFS details

### **Updated FL proposal 3:**

* **For FG11-2d and 11-2e,**
  + **In FG name, “configured with NR-NR DC” is changed to “configured with synchronous NR-NR DC”**
  + **“pdcch-BlindDetectionMCG-UE-r16 + pdcch-BlindDetectionSCG-UE-r16 >= pdcch-BlindDetectionCA-r16” is added to component 1 description of FG11-2d**
  + **The component description of FG11-2e is updated as below:**
  + **If the UE reports *pdcch-BlindDetectionCA-r15*,** 
    - **Candidate values for *pdcch-BlindDetectionMCG-UE-r15* is 0 to *pdcch-BlindDetectionCA-r15***
    - **Candidate values for *pdcch-BlindDetectionSCG-UE-r15* is 0 to *pdcch-BlindDetectionCA-r15***
    - ***pdcch-BlindDetectionMCG-UE-r15* + *pdcch-BlindDetectionSCG-UE-r15*>= *pdcch-BlindDetectionCA-r15***
  + **Otherwise, if is a maximum total number of downlink cells for which the UE is provided *monitoringCapabilityConfig-r16 = r15monitoringcapability***
    - **Candidate values for *pdcch-BlindDetectionMCG-UE-r15* is [0, 1, 2]**
    - **Candidate values for *pdcch-BlindDetectionSCG-UE-r15* is [0, 1, 2]**
    - ***pdcch-BlindDetectionMCG-UE-r15* + *pdcch-BlindDetectionSCG-UE-r15* >=**
  + **If the UE reports *pdcch-BlindDetectionCA-r16*,** 
    - **Candidate values for *pdcch-BlindDetectionMCG-UE-r16* is 0 to *pdcch-BlindDetectionCA-r16***
    - **Candidate values for *pdcch-BlindDetectionSCG-UE-r16* is 0 to *pdcch-BlindDetectionCA-r16***
    - ***pdcch-BlindDetectionMCG-UE-r16* + *pdcch-BlindDetectionSCG-UE-r16*>= *pdcch-BlindDetectionCA-r16***
  + **Otherwise, if is a maximum total number of downlink cells for which the UE is provided *monitoringCapabilityConfig-r16 = r16monitoringcapability***
    - **Candidate values for *pdcch-BlindDetectionMCG-UE-r16* is [0, 1]**
    - **Candidate values for *pdcch-BlindDetectionSCG-UE-r16* is [0, 1]**
    - ***pdcch-BlindDetectionMCG-UE-r16* + *pdcch-BlindDetectionSCG-UE-r16* >=**

Companies are encouraged to check above updated 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:

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| Company | Comment |
| Ericsson | * For FG name, suggest to reuse phrase in 38.213 V16.2.0 section 10, “configured for NR-DC operation”. For example, this is the sentence in 38.213: “When a UE is configured for NR-DC operation and is provided *monitoringCapabilityConfig-r16* = *r15monitoringcapability* for at least one downlink cell …” * For the value range & inequality constraints: they should be captured in “Note” column, not as component description. This was done for FG 6-25a in Rel-15. |
| Quadomm | For 11-2d, the following is missing:  Otherwise, if is a maximum total number of downlink cells for which the UE is provided *monitoringCapabilityConfig-r16* = *r16monitoringcapability* and the UE is configured on both the MCG and the SCG for NR-DC as indicated in *UE-NR-Capability*  - the value of *pdcch-BlindDetectionMCG-UE-r16* or of *pdcch-BlindDetectionSCG-UE-r16* is 1,  - *pdcch-BlindDetectionMCG-UE-r16* + *pdcch-BlindDetectionSCG-UE-r16* >= . |
| Samsung | Regarding more description (2nd and 3rd bullet), the contents are correct (and we understand that rel-15 did similarly ☺), but we are not sure if this needs to be captured here mainly because it would make description (potentially unnecessarily) pretty long. After all, all these description is already explicitly captured in RAN1 spec, and we do not think not describing them here would affect RAN2 signaling design. |
|  |  |

1. New FG for independent cancellation of the overlapping channels in an intra-band UL CA

In [7], following proposal is made.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| For inter-UE UL cancellation, we introduced FG11-7b to handle the phase discontinuity issue for intra-band CA. In fact, a similar issue exists for intra-UE prioritization when a high priority channel cancels a low priority channel with a potential change of transmit power and duration. Therefore, we propose to add a new FG which has a pre-requisite of either 11-4 or 12-1.  **Proposal 2-5: Introduce a new FG to handle phase discontinuity issue for intra-band CA in case of intra-UE prioritization:**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 12. NR\_IIOT | 12-1b | Independent cancellation of the overlapping channels in an intra-band UL CA | 1. For a UE indicating the capability of pa-PhaseDiscontinuityImpacts, and if the PUCCH or PUSCH on at least one serving cell is cancelled due to the overlapping with a high priority PUCCH or PUSCH transmission, the UE may cancel the (repetition of the) PUSCHs transmission on all other intra-band serving cell(s). The cancellation of the (repetition of the) PUSCH transmission on the set of intra-band serving cell(s) includes all symbols from the earliest symbol that is overlapping with the first cancelled symbol of the PUSCH on the serving cell. | 6-23, one of {11-4, 12-1} | Yes | N/A |  | Per band | N/A | N/A | N/A | If UE indicates 6-23 but does not support this FG, UE is not expected to be scheduled simultaneous PUCCH/PUSCHs on multiple carriers but receiving cancellation only for subset of carriers in intra-band carriers. | Optional with capability signaling | |

Based on the above contribution, it is agreed to discuss following point in the email discussion [12].

**Discussion point #10**

* **Whether/how to add new FG for independent cancellation of the overlapping channels in an intra-band UL CA**

## 5.1 Proposal and discussion

Based on the contribution, following proposal is made.

### **FL proposal 4:**

* **A new FG for independent cancellation of the overlapping channels in an intra-band UL CA is introduced as below.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12. NR\_IIOT | 12-1b | Independent cancellation of the overlapping channels in an intra-band UL CA | 1. For a UE indicating the capability of pa-PhaseDiscontinuityImpacts, and if the PUCCH or PUSCH on at least one serving cell is cancelled due to the overlapping with a high priority PUCCH or PUSCH transmission, the UE may cancel the (repetition of the) PUSCHs transmission on all other intra-band serving cell(s). The cancellation of the (repetition of the) PUSCH transmission on the set of intra-band serving cell(s) includes all symbols from the earliest symbol that is overlapping with the first cancelled symbol of the PUSCH on the serving cell. | 6-23, one of {11-4, 12-1} | Yes | N/A |  | Per band | N/A | N/A | N/A | If UE indicates 6-23 but does not support this FG, UE is not expected to be scheduled simultaneous PUCCH/PUSCHs on multiple carriers but receiving cancellation only for subset of carriers in intra-band carriers. | Optional with capability signaling |
| 11.  NR\_L1enh\_URLLC | 11-7 | UL cancelation scheme for self-carrier | 1. Supports group common DCI (i.e. DCI format 2\_4) for cancelation indication on the same DL CC as that scheduling PUSCH or SRS 2. UL cancelation for PUSCH  * Cancellation is applied to each PUSCH repetition individually in case of PUSCH repetitions  1. UL cancelation for SRS symbols that overlap with the cancelled symbols |  | Yes | N/A |  | Per FS  Per FS is selected because the FG is very demanding in UE processing, considering that this can be a UE with processing capability 1 but required to be able to cancel according to processing capability 2, and hence it is important to take into account the BC information for dimensioning purpose | N/A | N/A | N/A | More than one monitoring occasion for DCI format 2\_4 per slot is applied only if the UE reports to support FG 3-5 or FG 3-5a or FG 3-5b or 11-2 or 11-2a | Optional with capability signalling |

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 |
| DOCOMO | Agree with the FL proposal in principle. We are fine with either independent FG from FG11-7b or combining this FG and FG11-7b for the progress. |
| Intel | Fine with FL Proposal 4. Also fine with the approach suggested by DOCOMO to combine with FG 11-7b. |
| ZTE | Prefer to combine with FG 11-7b since it seems no much difference in terms of UE complexity on independent cancellation between intra-UE and inter-UE cancellation. |
| Qualcomm | FG 11-4 should be removed as a prerequisite. FG 11-4 is not about intra-UE cancellation; The capability for PUCCH+PUCCH collision handling is explicitly mentioned for FG 12-1. |
| Huawei, HiSilicon | We are fine with the proposal here. |
| vivo | We support to introduce the new FG for intra-UE cancellation. It is noted that FG 11-7b is mainly for UL CI. But we are also open to merge this FG and FG 11-7b. |
| Nokia, NSB | We are OK with the proposal, or else combining it into an existing FG. |
| Moderator | Based on the discussion in GTW session, we should discuss more on whether defining separate FG or merging with existing FG (11-7), as well as prerequisite FG (e.g., 11-4 may not be neccesary). |
| Ericsson | Agree with the proposal in principle. Comments:   * On how to reflect the intention of the proposal, we prefer combining this with FG 11-7b, i.e., updating FG 11-7b to include the intra-UE case as well. * Regarding the component description, cancellation of PUCCH should be included as well.   “For a UE indicating the capability of pa-PhaseDiscontinuityImpacts, and if the PUCCH or PUSCH on at least one serving cell is cancelled due to the overlapping with a high priority PUCCH or PUSCH transmission, the UE may cancel the (repetition of the) PUSCH or PUCCH transmission on all other intra-band serving cell(s). The cancellation of the (repetition of the) PUSCH or PUCCH transmission on the set of intra-band serving cell(s) includes all symbols from the earliest symbol that is overlapping with the first cancelled symbol of the PUSCH or PUCCH on the serving cell.” |
| Qualcomm | It is not clear why this FG is needed. If there are LP PUSCHs on multiple carriers, when a HP PUCCH is to be transmitted, all the PUSCHs will automatically be dropped sine simultaneous PUCCH+PUSCH is not supported in NR. |

1. Conclusion

**FL proposal 1:**

* **The licensed/unlicensed differentiation is not introduced for FG11-6.**

**FL proposal 2:**

* **The following components for the restriction on the number of monitoring occasions per slot/half-slot are added to FG11-2.**
  + **The number of different start symbol indices of PDCCH monitoring occasions per slot including PDCCH monitoring occasions of FG-3-1, is no more than 7.**
  + **The number of different start symbol indices of PDCCH monitoring occasions per half-slot including PDCCH monitoring occasions of FG-3-1 is no more than 4 in SCell.**

**Agreements:**

* **Agree in principle to introduce FG11-2d and 11-2e to URLLC UE features list as below**
  + FFS details

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11.  NR\_L1enh\_URLLC | 11-2d | Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span for MCG and for SCG when configured with NR-NR DC with Rel-16 PDCCH monitoring capability on all the serving cells | 1. Supported combination of (*pdcch-BlindDetectionMCG-UE-r16*, *pdcch-BlindDetectionSCG-UE-r16*)    * Candidate values for *pdcch-BlindDetectionMCG-UE-r16* is 1 to *pdcch-BlindDetectionCA-r16*-1    * Candidate values for *pdcch-BlindDetectionSCG-UE-r16* is 1 to *pdcch-BlindDetectionCA-r16*-1 | 11-2 | Yes | N/A |  | Per BC | N/A | N/A | N/A |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-2e | Number of carriers for CCE/BD scaling for MCG and for SCG when configured with NR-NR DC with mix of Rel. 16 and Rel. 15 PDCCH monitoring capabilities on different carriers | 1. Supported combination(s) of (*pdcch-BlindDetectionMCG-UE-r15*, *pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16*, *pdcch-BlindDetectionSCG-UE-r16*)    * Candidate values for *pdcch-BlindDetectionMCG-UE-r15* is 0 to *pdcch-BlindDetectionCA-r15*    * Candidate values for *pdcch-BlindDetectionSCG-UE-r15* is 0 to *pdcch-BlindDetectionCA-r15*    * Candidate values for *pdcch-BlindDetectionMCG-UE-r16* is 0 to *pdcch-BlindDetectionCA-r16*    * Candidate values for *pdcch-BlindDetectionSCG-UE-r16* is 0 to *pdcch-BlindDetectionCA-r16* | 11-2b | Yes | N/A |  | Per BC | N/A | N/A | N/A | One combination of (*pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16*) corresponds to one combination of (*pdcch-BlindDetectionCA-r15, pdcch-BlindDetectionCA-r16*) | Optional with capability signalling |

**Updated FL proposal 3:**

* **For FG11-2d and 11-2e,**
  + **In FG name, “configured with NR-NR DC” is changed to “configured with synchronous NR-NR DC”**
  + **“pdcch-BlindDetectionMCG-UE-r16 + pdcch-BlindDetectionSCG-UE-r16 >= pdcch-BlindDetectionCA-r16” is added to component 1 description of FG11-2d**
  + **The component description of FG11-2e is updated as below:**
  + **If the UE reports *pdcch-BlindDetectionCA-r15*,** 
    - **Candidate values for *pdcch-BlindDetectionMCG-UE-r15* is 0 to *pdcch-BlindDetectionCA-r15***
    - **Candidate values for *pdcch-BlindDetectionSCG-UE-r15* is 0 to *pdcch-BlindDetectionCA-r15***
    - ***pdcch-BlindDetectionMCG-UE-r15* + *pdcch-BlindDetectionSCG-UE-r15*>= *pdcch-BlindDetectionCA-r15***
  + **Otherwise, if is a maximum total number of downlink cells for which the UE is provided *monitoringCapabilityConfig-r16 = r15monitoringcapability***
    - **Candidate values for *pdcch-BlindDetectionMCG-UE-r15* is [0, 1, 2]**
    - **Candidate values for *pdcch-BlindDetectionSCG-UE-r15* is [0, 1, 2]**
    - ***pdcch-BlindDetectionMCG-UE-r15* + *pdcch-BlindDetectionSCG-UE-r15* >=**
  + **If the UE reports *pdcch-BlindDetectionCA-r16*,** 
    - **Candidate values for *pdcch-BlindDetectionMCG-UE-r16* is 0 to *pdcch-BlindDetectionCA-r16***
    - **Candidate values for *pdcch-BlindDetectionSCG-UE-r16* is 0 to *pdcch-BlindDetectionCA-r16***
    - ***pdcch-BlindDetectionMCG-UE-r16* + *pdcch-BlindDetectionSCG-UE-r16*>= *pdcch-BlindDetectionCA-r16***
  + **Otherwise, if is a maximum total number of downlink cells for which the UE is provided *monitoringCapabilityConfig-r16 = r16monitoringcapability***
    - **Candidate values for *pdcch-BlindDetectionMCG-UE-r16* is [0, 1]**
    - **Candidate values for *pdcch-BlindDetectionSCG-UE-r16* is [0, 1]**
    - ***pdcch-BlindDetectionMCG-UE-r16* + *pdcch-BlindDetectionSCG-UE-r16* >=**

**FL proposal 4:**

* **A new FG for independent cancellation of the overlapping channels in an intra-band UL CA is introduced as below.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12. NR\_IIOT | 12-1b | Independent cancellation of the overlapping channels in an intra-band UL CA | 1. For a UE indicating the capability of pa-PhaseDiscontinuityImpacts, and if the PUCCH or PUSCH on at least one serving cell is cancelled due to the overlapping with a high priority PUCCH or PUSCH transmission, the UE may cancel the (repetition of the) PUSCHs transmission on all other intra-band serving cell(s). The cancellation of the (repetition of the) PUSCH transmission on the set of intra-band serving cell(s) includes all symbols from the earliest symbol that is overlapping with the first cancelled symbol of the PUSCH on the serving cell. | 6-23, one of {11-4, 12-1} | Yes | N/A |  | Per band | N/A | N/A | N/A | If UE indicates 6-23 but does not support this FG, UE is not expected to be scheduled simultaneous PUCCH/PUSCHs on multiple carriers but receiving cancellation only for subset of carriers in intra-band carriers. | Optional with capability signaling |

Reference

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

[2] R1-2005361 Remaining issues on Rel-16 UE features vivo

[3] R1-2005423 Discussion on NR Rel-16 UE Features ZTE

[4] R1-2005814 Remaining details of Rel-16 NR UE features Huawei, HiSilicon

[5] R1-2005857 Rel-16 UE feature Intel Corporation

[6] R1-2006124 Remaining issues on NR Rel-16 UE features Samsung

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

[8] R1-2006677 Remaining aspects of Rel-16 UE features Nokia, Nokia Shanghai Bell

[9] R1-2006703 Discussion on NR Rel-16 UE features NTT DOCOMO, INC.

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

[11] R1-2006874 Remaining details of Rel-16 NR UE features Ericsson

[12] R1-2006710 Summary on UE features for URLLC/IIoT Moderator (NTT DOCOMO, INC.)

Appendix: UE features list for URLLC/IIoT 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**  **( 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 | 11-1 | Monitoring DCI format 1\_2 and DCI format 0\_2 | 1. Supports monitoring DCI format 1\_2 for DL scheduling 2. Supports monitoring DCI format 0\_2 for UL scheduling |  | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-1a | Monitoring both DCI format 0\_1/1\_1 and DCI format 0\_2/1\_2 in the same search space | 1. Supports monitoring both DCI format 0\_1/1\_1 and DCI format 0\_2/1\_2 in the same search space | 11-1 | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-1b | Type 1 HARQ-ACK codebook support for relative TDRA for DL | 1. Support Type 1 HARQ-ACK codebook for TDRA using the starting symbol of the PDCCH monitoring occasion in which the DL assignment is detected as the reference of the SLIV | 11-1 | Yes | N/A |  | Per UE | No | Yes  Note: Differentiation is from the perspective of the scheduled carrier | N/A |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-2 | Rel-16 PDCCH monitoring capability | 1. Supported combination(s) of (X, Y, μ). For each reported combination, the UE supports the limit C on the maximum number of non-overlapped CCEs for channel estimation per PDCCH monitoring span and the limit M on the maximum number of monitored PDCCH candidates per PDCCH monitoring span 2. Maximum number of DL and UL unicast DCI formats in a span   For the set of monitoring occasions which are within the same span:   * Processing one unicast DCI scheduling DL and one unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for FDD * Processing one unicast DCI scheduling DL and two unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for TDD * Processing two unicast DCI scheduling DL and one unicast DCI scheduling UL per scheduled CC across this set of monitoring occasions for TDD |  | Yes | N/A |  | Per FS for component 1  Note: Indicating support of this capability in a band in a BC implies that only rel-16 monitoring can be configured in a CA configuration for the BC if the CA configuration includes the band and if rel-16 monitoring is configured for the band | N/A | N/A | N/A | This capability is signaled for SCS 15 kHz and 30 kHz.  For μ=0 and 1, candidate value set for (X, Y, μ): {(7, 3, μ), (4, 3, μ), (2, 2, μ)}  For component 1, a list of separate UE capabilities (X, Y, μ)for processing capability #1;  For component 1, a list of separate UE capabilities (X, Y, μ)for processing capability #2; | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-2a | Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span when configured with DL CA with Rel-16 PDCCH monitoring capability on all the serving cells | 1. Capability on the number of CCs for monitoring a maximum number of BDs and non-overlapped CCEs per span when configured with DL CA with Rel-16 PDCCH monitoring capability on all the serving cells    * Candidate value for the component: {2, 3, …, 16} 2. Supported span arrangement for CA    * Candidate value for the component: {aligned spans only, aligned spans and non-aligned spans} | 11-2 | Yes | N/A |  | Per BC | N/A | N/A | N/A |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-2b | Mix of Rel. 16 PDCCH monitoring capability and Rel. 15 PDCCH monitoring capability on different carriers | 1. Support Rel-15 monitoring capability and Rel-16 monitoring capability on different serving cells | 11-2 | Yes | N/A |  | Per FS  Note: Per FS is selected because same type with 3-5b is preferred | N/A | N/A | N/A |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-2c | Number of carriers for CCE/BD scaling with DL CA with mix of Rel. 16 and Rel. 15 PDCCH monitoring capabilities on different carriers | 1. Supported combination(s) of (pdcch-BlindDetectionCA-R15, pdcch-BlindDetectionCA-R16)    * Candidate values for pdcch-BlindDetectionCA-R15 is 1 to 15    * Candidate values for pdcch-BlindDetectionCA-R16 is 1 to 15 2. Supported span arrangement for CA    * Candidate value for the component: {aligned spans only, aligned spans and non-aligned spans} | 11-2b | Yes | N/A |  | Per BC | N/A | N/A | N/A | The minimum of the summation of capability on the number of CCs with Rel-15 PDCCH monitoring capability and the capability on the number of CCs with Rel-16 PDCCH monitoring capability is 3 | Optional with capability signalling |
| 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.   1. Supported sub-slot configuration 2. [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 FS  Per FS is selected because in bands or BCs with large number of carriers or large BW, the UE’s processing power is spent on PDCCH/PDSCH decoding, and hence in some cases the support of the new codebook or some codebook configurations may not be possible | N/A | N/A | N/A | Candidate value set for component 2:  { 7-symbol\*2, 2-symbol\*7 and 7-symbol\*2} for NCP or { 6-symbol\*2, 2-symbol\*6 and 6-symbol\*2} for ECP  The number of PUCCHs for CSI reporting per slot is not impacted compared with Rel-15 by introducing the new HARQ-ACK CBs  A UE supporting 11-3 is also expected to support FGs 4-1, 4-3, 4-4, 4-5, and 4-19 with a “slot” being replaced by a sub-slot of length 2 or 7 symbols for NCP and (2 and 6 symbols for ECP) for the PUCCH formats that can be accommodated in the corresponding sub-slot durations  [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) | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | [11-3c] | 2 PUCCH of format 0 or 2 for a single 7\*2 subslot based HARQ-ACK codebook | 1) 2 PUCCH format 0/2 in different symbols and once per subslot for HARQ-ACK,  2) 2 PUCCH format 0 in different symbols and once per subslot for SR | 11-3 | Yes | N/A |  | TBD | TBD | TBD | TBD |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | [11-3d] | 2 PUCCH of format 0 or for a single 2\*7 subslot based HARQ-ACK codebook | 1) 2 PUCCH format 0/2 in different symbols and once per subslot for HARQ-ACK,  2) 2 PUCCH format 0 in different symbols and once per subslot for SR | 11-3 | Yes | N/A |  | TBD | TBD | TBD | TBD |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | [11-3e] | 1 PUCCH format 0 or 2 and 1 PUCCH format 1, 3 or 4 in the same subslot for a single 2\*7-symbol HARQ-ACK codebooks | If the UE supports a 2\*7-symbol subslot HARQ-ACK codebook, the UE also supports:  1) 1 PUCCH format 0 or 2 and 1 PUCCH format 1, 3 and 4 in the same subslot | 11-3 | Yes | N/A |  | TBD | TBD | TBD | TBD |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | [11-3f] | 2 PUCCH transmissions in the same subslot for a single 2\*7-symbol HARQ-ACK codebooks which are not covered by 11-3d and 11-3e | If the UE supports a 2\*7 subslot HARQ-ACK codebook, the UE also supports:  2 PUCCH transmissions in the same subslot for a single 2\*7-symbol HARQ-ACK codebooks which are not covered by 11-3d and 11-3e | 11-3 | Yes | N/A |  | TBD | TBD | TBD | TBD |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | [11-3g] | SR/HARQ-ACK multiplexing once per subslot using a PUCCH (or HARQ-ACK piggybacked on a PUSCH) when SR/HARQ-ACK are supposed to be sent with different starting symbols in a subslot | If a UE supports a subslot based HARQ-ACK codebook, the UE also supports:  Overlapping PUCCH resources with different starting symbols in a subslot | 11-3 | Yes | N/A |  | TBD | TBD | TBD | TBD |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-4 | Two HARQ-ACK codebooks with up to one sub-slot based HARQ-ACK codebook (i.e. slot-based + slot-based, or slot-based + sub-slot based) simultaneously constructed for supporting HARQ-ACK codebooks 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 codebooks 3. 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 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. Support intra-UE multiplexing/prioritization of UL overlapping channels/signals with two priority levels for HARQ-ACK |  | Yes | N/A |  | Per FS  Per FS is selected because in bands or BCs with large number of carriers or large BW, the UE’s procesing power is spent on PDCCH/PDSCH decoding, and hence in some cases the support of the new codebook or some codebook configurations may not be possible | N/A | N/A | N/A | If a UE reports both 11-3 and 11-4, it can support two slot-based HARQ-ACK codebooks, and one slot-based and one-sub-slot-based HARQ-ACK codebooks. If a UE reports 11-4 but not 11-3, it can only support two slot-based HARQ-ACK codebooks.  The number of PUCCHs for CSI reporting per slot is not impacted compared with Rel-15 by introducing the new HARQ-ACK CBs | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-4a | Two sub-slot based HARQ-ACK codebooks simultaneously constructed for supporting HARQ-ACK codebooks 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 codebooks 3. 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 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. [Supported maximum number of actual PUCCH transmissions for HARQ-ACK within a slot] | 11-3 and 11-4 | Yes | N/A |  | Per FS  Per FS is selected because in bands or BCs with large number of carriers or large BW, the UE’s procesing power is spent on PDCCH/PDSCH decoding, and hence in some cases the support of the new codebook or some codebook configurations may not be possible | N/A | N/A | N/A | The number of PUCCHs for CSI reporting per slot is not impacted compared with Rel-15 by introducing the new HARQ-ACK CBs | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-4b | DL priority indication in DCI with mixed DCI formats | 1. Support of priority indicator field configured in DCI formats 1\_1 and 1\_2 in a BWP when configured to monitor both DCI formats 1\_1 and 1\_2 in the BWP | 11-1, 11-4 | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | [11-4c] | 2 PUCCH of format 0 or 2 for Two HARQ-ACK codebooks with up to one 7\*2-symbol sub-slot based HARQ-ACK codebook | If the UE supports a 7\*2-symbol subslot HARQ codebook, the UE also supports:  1) 2 PUCCH format 0/2 in different symbols and once per subslot for HARQ-ACK,  2) 2 PUCCH format 0 in different symbols and once per subslot for SR | 11-4 | Yes | N/A |  | TBD | TBD | TBD | TBD |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | [11-4d] | 2 PUCCH of format 0 or 2 in consecutive symbols for two HARQ-ACK codebooks with up to one 2\*7-symbol sub-slot based HARQ-ACK codebook | If the UE supports a 2\*7-symbol subslot HARQ codebook, the UE also supports:  1) 2 PUCCH format 0/2 in different symbols and once per subslot for HARQ-ACK,  2) 2 PUCCH format 0 in different symbols and once per subslot for SR | 11-4 | Yes | N/A |  | TBD | TBD | TBD | TBD |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | [11-4e] | 2 PUCCH of format 0 or 2 for two subslot based HARQ-ACK codebooks | If the UE supports two subslot HARQ codebooks, the UE also supports:  1) 2 PUCCH format 0/2 in different symbols and once per subslot per codebook for HARQ-ACK,  2) 2 PUCCH format 0 in different symbols and once per subslot per codebook for SR | 11-4a | Yes | N/A |  | TBD | TBD | TBD | TBD |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | [11-4f] | 1 PUCCH format 0 or 2 and 1 PUCCH format 1, 3 or 4 in the same subslot for HARQ-ACK codebooks with up to one 2\*7-symbol subslot based HARQ-ACK codebook | If the UE supports a 2\*7 subslot HARQ-ACK codebook, the UE also supports:  1) 1 PUCCH format 0 or 2 and 1 PUCCH format 1, 3 and 4 in the same subslot of the codebook | 11-4 | Yes | N/A |  | TBD | TBD | TBD | TBD |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | [11-4g] | 1 PUCCH format 0 or 2 and 1 PUCCH format 1, 3 or 4 in the same subslot for two subslot based HARQ-ACK codebooks | If the UE supports two subslot HARQ-ACK codebooks both configured with 2\*7 symbols, the UE also supports:  1) 1 PUCCH format 0 or 2 and 1 PUCCH format 1, 3 and 4 in the same subslot of a codebook | 11-4a | Yes | N/A |  | TBD | TBD | TBD | TBD |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | [11-4h] | 2 PUCCH transmissions in the same subslot for two HARQ-ACK codebooks with up to one 2\*7-symbol subslot which are not covered by 11-4c and 11-4e | If the UE supports two HARQ-ACK codebooks with up to one subslot based codebook with 2\*7-symbol configuration, the UE also supports:  1) 2PUCCH transmissions in the same subslot of the codebook which are not covered by 11-4c and 11-4e | 11-4 | Yes | N/A |  | TBD | TBD | TBD | TBD |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | [11-4i] | 2 PUCCH transmissions in the same subslot for two subslot based HARQ-ACK codebooks  which are not covered by 11-4d and 11-4f | If the UE supports two HARQ-ACK codebooks both with 2\*7-symbol configuration, the UE also supports:  1) 2PUCCH transmissions in the same subslot of a codebook which are not covered by 11-4d and 11-4f | 11-4a | Yes | N/A |  | TBD | TBD | TBD | TBD |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-5 | PUSCH repetition Type B | 1. For a transport block, one dynamic UL grant or one configured grant schedules two or more PUSCH repetitions that can be in one slot, or across slot boundary in consecutive available slots. 2. Dynamic indication of the nominal number of repetitions in the DCI scheduling dynamic PUSCH. 3. The time window within which valid symbols are used for transmission is L\*K, starting from the first symbol indicated by the SLIV in TDRA field. 4. PUSCH repetition type B is supported for DCI format 0\_1 and DCI format 0\_2 (for DG and type 2 CG). 5. S and L are separately indicated (4-bit for S and 4-bit for L). L <= 14. 6. Handling of interaction with DL/UL directions depending on whether dynamic SFI is configured or not, including both cases with and without higher layer parameter InvalidSymbolPattern configured 7. Supported maximum number of PUSCH transmissions within a slot for all TB(s), where each actual repetition for PUSCH repetition type B is counted as 1 PUSCH transmission, separately reported for UE processing capability 1 and for UE processing capability 2 if UE supports both processing capabilities   Note: Number of TBs are based on reported Rel-15 capability on number of TBs, and reported value for component 7 cannot be smaller than the reported value of the number of TBs   1. Supported PUSCH hopping scheme |  | Yes | N/A |  | Per FS  Note: Per FS is selected to follow Rel-15 reporting type for number of TBs to be supported | N/A | N/A | N/A | Candidate value for component 7: {2, 3, 4, 7, 8, 12}  Candidate value for component 8: {Inter-slot hopping, Inter-repetition hopping, both Inter-slot hopping and Inter-repetition hopping}  PUSCH repetition type B with configured grant is applied only if UE reports the support of FG 5-19 or FG 5-20, and subjected to the capability of FG 5-19 and FG 5-20  The case that both dynamic SFI and InvalidSymbolPattern are configured is applied only if UE reports the support of FG3-6 | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-6 | PUSCH repetition Type A | 1. PUSCH transmission with Rel-15 behavior with or without slot aggregation.   • With slot aggregation, the number of repetitions can be dynamically indicated (as agreed for Rel-16).  • When dynamically indicated, the number of repetitions is jointly coded with SLIV in TDRA table, by adding an additional column for the number of repetitions in the TDRA table. | One of {5-16, 5-17] | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-7 | UL cancelation scheme for self-carrier | 1. Supports group common DCI (i.e. DCI format 2\_4) for cancelation indication on the same DL CC as that scheduling PUSCH or SRS 2. UL cancelation for PUSCH  * Cancellation is applied to each PUSCH repetition individually in case of PUSCH repetitions  1. UL cancelation for SRS symbols that overlap with the cancelled symbols |  | Yes | N/A |  | Per FS  Per FS is selected because the FG is very demanding in UE processing, considering that this can be a UE with processing capability 1 but required to be able to cancel according to processing capability 2, and hence it is important to take into account the BC information for dimensioning purpose | N/A | N/A | N/A | More than one monitoring occasion for DCI format 2\_4 per slot is applied only if the UE reports to support FG 3-5 or FG 3-5a or FG 3-5b or 11-2 or 11-2a | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-7a | UL cancelation scheme for cross-carrier | 1. Supports group common DCI (i.e. DCI format 2\_4) for cancelation indication on a different DL CC than that scheduling PUSCH or SRS 2. UL cancelation for PUSCH  * Cancellation is applied to each PUSCH repetition individually in case of PUSCH repetitions  1. UL cancelation for SRS symbols that overlap with the cancelled symbols |  | Yes | N/A |  | Per FS  Per FS is selected because the FG is very demanding in UE processing, considering that this can be a UE with processing capability 1 but required to be able to cancel according to processing capability 2, and hence it is important to take into account the BC information for dimensioning purpose | N/A | N/A | N/A | More than one monitoring occasion for DCI format 2\_4 per slot is applied only if the UE reports to support FG 3-5 or FG 3-5a or FG 3-5b or 11-2 or 11-2a | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-7b | Independent cancellation of the overlapping PUSCHs in an intra-band UL CA | 1. For a UE indicating the capability of pa-PhaseDiscontinuityImpacts, and if the PUSCH on at least one serving cell is cancelled, the UE may cancel the (repetition of the) PUSCHs transmission on all other intra-band serving cell(s). The cancellation of the (repetition of the) PUSCH transmission on a the set of intra-band serving cell(s) includes all symbols from the earliest symbol that is overlapping with the first cancelled symbol of the PUSCH on the serving cell for which the DCI format 2\_4 is applicable to. | 6-23, 11-7 | Yes | N/A |  | Per band | N/A | N/A | N/A | If UE indicates 6-23 but does not support this FG, UE is not expected to be scheduled simultaneous PUSCHs on multiple carriers but receiving UL CI only for subset of carriers in intra-band carriers | Optional with capability signaling |
| 11.  NR\_L1enh\_URLLC | 11-8 | Enhanced UL power control scheme | 1. For DG-PUSCH, one bit (separately from SRI) in UL grant is used to indicate the P0 value if SRI is present in the UL grant, and 1 or 2 bits is used to indicate the P0 value if SRI is not present in the UL grant |  | Yes | N/A |  | Per UE | No | Yes  Note: Differentiation is from the perspective of the scheduled carrier | N/A |  | Optional with capability signaling |
| 11.  NR\_L1enh\_URLLC | 11-9 | Multiple active configured grant configurations for a BWP of a serving cell | 1. Supports up to 12 configured/active configured grant configurations in a BWP of a serving cell.   • Separate RRC parameters for different configured grant configurations  • Separate activation for different configured grant Type 2 configurations  • Separate release for different configured grant Type 2 configurations   1. Supported maximum number of configured/active configured grant configurations in a BWP of a serving cell   Candidate values for component 2: {1, 2, 4, 8, 12}   1. Supported maximum number of configured/active configured grant configurations across all serving cells   Candidate values for component 3: {2, …, 32} | One of {5-19, 5-20} | Yes | N/A |  | Per band | N/A | N/A | N/A | For component 3: Total number in FR1 is not greater than X value reported for FR1. Total number in FR2 is not greater than X value reported for FR2.Total number across FR1 and FR2 is not greater than the larger of the FR1 and FR2 values | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-9a | Joint release in a DCI for two or more configured grant Type 2 configurations for a given BWP of a serving cell | 1. M<=4 bits indication in the Release DCI is used for indicating which CG configuration(s) is/are released, where the association between each state indicated by the indication and the CG configuration(s) is   • Up to 2^M states are higher layer configurable, where each of the state can be mapped to a single or multiple CG configurations to be released  • In case of no higher layer configured state(s), separate release is used where the release corresponds to the CG configuration index indicated by the indication | 11-9 | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-10 | Type 2 configured grant release by DCI format 0\_1 | 1. Support of type 2 configured grant release by DCI format 0\_1 | 5-20 | Yes | N/A |  | Per UE | No | No | N/A | A UE supporting this feature and 11-1 (DCI format 0\_2/1\_2) shall also support 11-11 (Type 2 configured grant release by DCI format 0\_2). | Optional with capability signalling |
| 11.  NR\_L1enh\_URLLC | 11-11 | Type 2 configured grant release by DCI format 0\_2 | 1. Support of type 2 configured grant release by DCI format 0\_2 | 5-20, 11-1 | Yes | N/A |  | Per UE | No | No | N/A | A UE supporting this feature shall also support 11-10 (Type 2 configured grant release by DCI format 0\_1). | Optional with capability signalling |

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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 |
| 12. NR\_IIOT | 12-1 | UL intra-UE multiplexing/prioritization of overlapping channel/signals with two priority levels in physical layer | Support intra-UE multiplexing/prioritization of overlapping PUCCH/PUCCH and PUCCH/PUSCH with two priority levels in physical layer (PHY)   1. [Configuration of PHY priority level for CG PUSCH and SR, and dynamic indication of priority level for dynamic PUSCH with a single DCI format] 2. Multiplexing/prioritization between UL channels/signals with the same PHY priority level 3. Prioritization between UL channels/signals with different PHY priority levels 4. Additional number of symbols (d1) needed beyond the PUSCH preparation time for cancelling a low priority UL transmission. 5. 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 FS  Per FS is selected because this FG involves various kinds of prioritization/cancellation/multiplexing, it is very processing intensive, and hence it is important to have finer granularity so that the UE does not have to under-report based on the worst band/band combination | N/A | N/A | N/A | Candidate value set for component 4: {0, 1, 2}  Candidate value set for component 5: {0, 1, 2}  The relationship between this feature and the feature of up to two HARQ-ACK codebooks of 11-4 and 11-4xshould be further discussed. | Optional with capability signaling |
| 12. NR\_IIOT | 12-1a | UL priority indication in DCI with mixed DCI formats | Support of priority indicator field configured in DCI formats 0\_1 and 0\_2 in a BWP when configured to monitor both DCI formats 0\_1 and 0\_2 in the BWP | 12-1 and 11-1 | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signalling |
| 12. NR\_IIOT | 12-2 | Multiple SPS configurations | 1. Support of up to 8 configured SPS configurations in a BWP of a serving cell and up to 32 configured SPS configurations in a cell group, including separate RRC parameters and separate activation/release for different SPS configurations 2. The max number of active SPS configurations in a BWP of a serving cell 3. The max number of active SPS configurations across all serving cells 4. The related HARQ-ACK enhancements to support multiple active SPS configurations | 5-18 DL SPS | Yes | N/A |  | Per band | N/A | N/A | N/A | Component-2, candidate value set is {1, 2, …, 8}  Component-3, candidate value set is [{2, …, 32}] | Optional with capability signaling |
| 12. NR\_IIOT | 12-2a | Joint release in a DCI for two or more SPS configurations for a given BWP of a serving cell | 1. M<=4 bits indication in the Release DCI is used for indicating which SPS configuration(s) is/are released, where the association between each state indicated by the indication and the SPS configuration(s) is   • Up to 2^M states are higher layer configurable, where each of the state can be mapped to a single or multiple SPS configurations to be released  • In case of no higher layer configured state(s), separate release is used where the release corresponds to the SPS configuration index indicated by the indication   1. The related HARQ-ACK enhancements to support joint release | 12-2 | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signaling |
| 12. NR\_IIOT | 12-3 | SPS release by DCI format 1\_1 | Support of SPS release by DCI format 1\_1 | 5-18 DL SPS | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 12. NR\_IIOT | 12-3a | SPS release by DCI format 1\_2 | Support of SPS release by DCI format 1\_2 | 5-18 DL SPS and 11-1 | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |
| 12. NR\_IIOT | 12-5 | Configuration of aggregation factor per SPS configuration | Support of configurable PDSCH aggregation factor ({1, 2, 4, 8}) per DL SPS configuration | 5-18 DL SPS | Yes | N/A |  | Per UE | No | Yes | N/A |  | Optional with capability signaling |
| 12. NR\_IIOT | 12-6 | Support of SPS periodicity shorter than 10 ms | Support of SPS periodicity shorter than 10 ms | 5-18 DL SPS | Yes | N/A |  | Per UE | No | Yes | N/A |  | Optional with capability signalling |