**3GPP TSG RAN WG1 #101 R1-20xxxxx**

**e-Meeting, May 25th – June 5th, 2020**

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

**Title:** **Summary on [101-e-Post-NR-UE-Features-12]**

**Agenda Item:** **7.2.11.5**

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

1. Introduction

This contribution summarizes the following email discussion/approval regarding UE features for URLLC/IIoT after RAN1#101-e meeting.

[101-e-Post-NR-UE-Features-12] Email discussion/approval for remaining issues on UE features for URLLC/IIoT till 8/4 – Hiroki (DCM)

* Whether/how to define a new FG for “[TB CRC for cancelled initial PUSCH with CBG based re-transmission]”
* Whether/how to define FGs [11-3c to 3g] and [11-4c to 4i]
* Whether/how to define [component 3] for FG11-3
* Whether/how to define [component 4] and [component 6] for FG11-4/4a as well as [component 1] for FG12-1
* How to define reporting type for FG11-6
* How to define prerequisite feature groups for FG12-1

At the RAN#88-e meeting, following proposals were endorsed [3]. Hence, for RAN1 UE features list for NR-U, above remaining issue should be solved by the end of the first week of August e-meeting at latest.

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| * RAN1 and RAN4 shall strive to complete all FFS on Rel-16 UE capabilities impacting RAN2 specification by the end of their first week of August e-meeting   + NBC changes to Rel-16 UE capabilities specifications are possible based on consensus in the RAN#89-e. For Rel-16 specification approved later than RAN#89-e, NBC changes are not allowed as a general rule. * No extra effort is taken on specifying basic feature groups for certain scenario/purpose before finalizing UE capabilities for each WI in each WG. * It is confirmed that each feature group (FG) including potential basic feature group has its own capability bit, and RAN2 finalizes UE capabilities specification in Q3 irrespective of whether a FG is part of basic feature groups for certain scenario/purpose or not. |

1. Discussion on whether/how to define a new FG for “[TB CRC for cancelled initial PUSCH with CBG based re-transmission]”

## 2.1 Summary on the discussion in [1]

**Proposal 1:**

* **A new FG 12-1x for “TB CRC for cancelled initial PUSCH with CBG based re-transmission” is added in UE features list for IIoT**
  + **Component description is “PUSCH TB CRC calculated according to Section 6.2.1 of TS 38.212 for a re-transmission of a TB in case the initial transmission was cancelled and CBG-based re-transmission is configured”**
  + **Type of FG12-1x is “Per band”**
  + **[FG5-25] FG12-1 is prerequisite feature group for FG12-1x**
  + **FG12-1x is “Optional with capability signaling”**

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| 12-1x | TB CRC for cancelled initial PUSCH with CBG based re-transmission | PUSCH TB CRC calculated according to section 6.2.1 of TS38.212 for a re-transmission of a TB in case the initial transmission was cancelled and CBG-based re-transmission is configured | 5-25 | Yes | N/A |  | Per band | N/A | N/A |  | The cancellation could be due to support of ULCI and/or intra-UE prioritization | Optional with capability signaling |

During the email discussion [101-e-Post-NR-UE-Features-02], following views were provided.

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| Company | Comment |
| MediaTek | We acknowledge the issue of CBG based re-transmission for cancelled initial PUSCH. However, we believe this should be addressed in RAN1 specs rather than introducing a FG. |
| Samsung | Our opinion remains that there is no need to define FG 12-1x – the overall issue is marginal and there is no supporting RAN1 agreement. |
| Intel | We prefer not to introduce separate capability now, assuming that we continue the discussions in RAN1 as part of R16 eURLLC maintenance form RAN1 #101-E. |
| ZTE | Based on the discussion in URLLC maintenance, it is premature to introduce this capability now. |
| Qualcomm | We disagree that the issue is marginal (as pointed out by several chipset vendors.) However, we are open to continue the discussion as part of maintenance. |
| LG | We also think it is premature to add separate FG. It is still in discussions. |
| Huawei, HiSilicon | We support introducing a new FG, however based on the current situation we are Ok to continue the discussion in maintenance first, anyway the bahvior for UEs not capable of supporting this potential FG12-1x will need to be defined in the specification also. |
| Nokia, NSB | Our views remain the same, that the new FG is not needed, as explained during email discussion captured above. RAN1 will address the issue in the RAN1 specs (as mentioned by Mediatek). |
| Ericsson | No new FG for TB CRC. Delete this topic from UE feature discussion.  Even if something needs to be done for TB CRC, this belongs to Rel-16 maintenance, e.g., change to 38.212. There has been ongoing discussion in Rel-16 URLLC maintenance. |
| Moderator (NTT DOCOMO) | Based on the above feedbacks, we cannot agree to introduce the new FG now. RAN1 should continue the discussion as part of Rel-16 URLLC maintenance.  Therefore, proposal 1 is removed. |
| Apple | We also think the issue should be addressed and strongly disagree that the issue is marginal. However, given that the intention is to further discuss the issue further as part of maintenance, it seems pre-mature to agree on a new FG now. Therefore we agree on Moderator’s decision. |

## 2.2 Discussion in email discussion [101-e-Post-NR-UE-Features-12] after RAN1#101-e

Based on the discussion in [101-e-Post-NR-UE-Features-02], RAN1 should also discuss the possibility of addressing the issue on CBG-based retransmission for cancelled initial transmission by specification modification without introducing the new capability. In addition, as introduced in Section 1, RAN1 should strive for resolving all FFSs by the end of the first week of August meeting.

Therefore, the proposal is to not introduce the FG if companies can be converged to solve the issue by maintenance discussion without introducing the new FG.

### **Proposal 1:**

* **A new FG for “TB CRC for cancelled initial PUSCH with CBG based re-transmission” is NOT introduced.**

Companies are encouraged to provide feedback if any in below.

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| Company | Comment |
| DOCOMO | Support the proposal. We acknowledge the issue of re-transmission of partial TB in case initial transmission is cancelled. However, it should be addressed in RAN1 spec. |
| Apple | We think the issue is very important for UE implementation and should be addressed. We do not think we should conclude not to introduce the FG right now. It would make sense to wait until after we make decision in the maintenance session. As mentioned, the issue can be prioritized for the first week of the August meeting. Once the decision is made in the maintenance session, it would be clear if there is any need to add this UE feature. |
| Samsung | Agree. |
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1. Discussion on whether/how to define FGs [11-3c to 3g] and [11-4c to 4i]

## 3.1 Summary on the discussion in [1]

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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**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | | Mandatory/Optional |
| 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 | [11-4c] | 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 |

Based on the discussion in [101-e-NR-UEFeatures-URLLCIIoT-01], following proposal was made in email discussion [101-e-Post-NR-UE-Features-02].

**Proposal 3:**

* **Confirm working assumption (with removing 11-3a/3b as already agreed)**
  + **Type of FG11-3c/d/e/f/g and FG11-4c/d/e/f/g/h/i is “Per FS”**
    - **Per FS is selected because the processing power the UE has to spend on preparing PUCCH has a relation with PDSCH processing power and that is related to number of carriers on which the UE has to process PDSCH.**

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| Company | Comment |
| Samsung | OK to confirm WA. |
| Intel | Fine with the proposal. |
| ZTE | We are fine with confirming the WA, while cannot agree with per FS reporting. Per UE report as Rel-15 is sufficient. |
| Qualcomm | We support confirming the WA. The reason for per FS signaling was explained before (including the relation between the number of PUCCHs and the impact of PDCCH/PDSCH processing.) |
| LG | Fine with the proposal. |
| Huawei, HiSilicon | Support proposal 3 here. One question for clarification from companies as below:   * For FG 11-4e to define “short PUCCH + short PUCCH” for two sub-slot HARQ-Codebook, according to the current definition does it mean that 2 PUCCHs with HARQ-ACK will be allowed per sub-slot? |
| Nokia, NSB | Our views have not changed since last Friday, i.e. we have concerns on the introduction of these FGs. In any case, if they are considered per UE rerporting would be sufficient, as pointed out by ZTE above. |
| Ericsson | **With inclusion of the agreed note below, in our view, the WA should not be confirmed. The proposed FGs are already covered by Rel-15 as described in detail below.**   * **Add a note “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” for FG11-3**   **Detailed comments:**  **Working assumption:**   * **Introduce separated FGs for FG11-3/4 based on below list and discuss further on possible reformulating FG structure**   + **~~UL Control channel for a single 7\*2symbol subslot based HARQ-ACK codebook (11-3a)~~**   + **~~UL Control channel for a single 2\*7symbol subslot based HARQ-ACK codebook (11-3b)~~**   + **2 PUCCH of format 0 or 2 for a single 7\*2 subslot based HARQ-ACK codebook (11-3c)**     - **Ericsson: Not needed. Equivalent to FG 4-2:** 2 PUCCH of format 0 or 2 in consecutive symbols   + **2 PUCCH of format 0 or for a single 2\*7 subslot based HARQ-ACK codebook (11-3d)**     - **Ericsson: Not needed. Coverd by FG 4-22a:** 2 PUCCH transmissions in the same slot which are not covered by 4-22 and 4-2   + **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 (11-3e)**     - **Ericsson: Not needed. Coved by FG 4-22:** 1 PUCCH format 0 or 2 and 1 PUCCH format 1, 3, or 4 in the same slot   + **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 (11-3f)**      - **Ericsson: Not needed. Covered by FG 4-22a.**   + **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 (11-4b)**     - **Ericsson: Not needed. Given that “up to on” implies that, one PUCCH format 0 oe 2 per sub-slot, we don’t think it is needed. This is equvalent to FG for PUCCH format 0 per slot or PUCCHformat 2 per slot which are covered by Rel-15.**   + **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 (11-4c)**     - **Ericsson: Not needed. Equivalent to FG 4-2:** 2 PUCCH of format 0 or 2 in consecutive symbols   + **2 PUCCH of format 0 or 2 for two subslot based HARQ-ACK codebooks (11-4d)**     - **Ericsson: Not needed. It seems the FG implies one PUCCH format 0 or 2 in each of the two sub-slots. Similar comments as 11-4e.**   + **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 (11-4e)**     - **Ericsson: Not needed. Given that “up to on” implies that, one PUCCH format 0 or 2 per sub-slot or 1, 3 or 4 per sub-slot, although the sub-slots with short and long PUCCH format belong to the same slot, with interpreting subs-lot as slot it is equvalent to FG for one PUCCH per slot in Rel-15. For PUCCH format 0 and 1 are covered as basic features in FG 4-1, and for PUCCH format 2,3,4 are covered by 4-3 to 4-7.**   + **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 (11-4f)**     - **Ericsson: Not needed. Similar comment as 11-4e.**   + **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 (11-4g)**     - **Ericsson: Not needed. This is equivalent to FG 4-22a.**   + **2 PUCCH transmissions in the same subslot for two subslot based HARQ-ACK codebooks which are not covered by 11-4d and 11-4f (11-4h)**     - **Ericsson: Not needed. This is equivalent to FG 4-22a.**   + **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 (11-3g)**     - **Ericsson: Not needed. This is civered by 4-19a.** |
| Moderator (NTT DOCOMO) | Based on the above feedbacks, there are some companies cannot accept the proposal 3, especially on the part of “Per FS” reporting although the reason for per FS is provided.  In this case, we would need to continue discussion of the working assumption unfortunately, and hence proposal 3 is removed. |
| Apple | Fine with Proposal 3 |

## 3.2 Discussion in email discussion after RAN1#101-e

Based on the discussion in [101-e-Post-NR-UE-Features-02], RAN1 should continue discussion based on the latest proposal as below. Some compromise on either or both of reporting type and FG structure should be considered.

### **Proposal 2:**

* **Confirm working assumption on FG11-3c/d/e/f/g and FG11-4c/d/e/f/g/h/i**
  + **Type of FG11-3c/d/e/f/g and FG11-4c/d/e/f/g/h/i is “Per FS”**
    - **Per FS is selected because the processing power the UE has to spend on preparing PUCCH has a relation with PDSCH processing power and that is related to number of carriers on which the UE has to process PDSCH.**

Companies are encouraged to provide feedback if any in below.

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| Company | Comment |
| DOCOMO | Fine with Proposal 2 |
| Apple | Support the proposal in principle, but we have the following comments:   * + We would like to change “once per subslot” to “in a subslot” or “at most once per subslot”. The difference is that “once per subslot” implies the frequency, i.e., the UE needs to be able to support one in EVERY subslot. But “in a subslot” only says the UE cannot handle more than this limit in a particular sub-slot. Given that we still have the open point on defining the max number of PUCCHs for HARQ-ACK in a slot, using “once per subslot” could be misleading.   + FG 11-4e/4g/4i may need further consideration on the description because with FG11-4a, the two codebooks may have two different subslot configurations. That is, we could have one codebook using 2-symbol subslot, and another codebook using 7-symbol subslot. In this case, the definition of “per subslot” in the FG descriptions is unclear, and this issue needs to be addressed.   For FG 11-3f, add “-symbol” as follows: “If the UE supports a 2\*7-symbol subslot HARQ-ACK codebook, the UE also supports”. |
| Samsung | Okay with proposal 2. But, main motivation of having [11-3c to 3g] and [11-4c to 4i] is that it limits the number of PUCCH transmissions within a slot. In this sense, it is understood that [11-4 c to 4i] can be covered by [Supported maximum number of actual PUCCH transmissions for HARQ-ACK within a slot] for FG 11-4/4a, and [11-3c to 3g] can be covered by [Supported maximum number of actual PUCCH transmissions for HARQ-ACK within a slot] under FG 11-3 if component 3 of FG 11-3 is replaced by [Supported maximum number of actual PUCCH transmissions for HARQ-ACK within a slot]. |
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1. Discussion on whether/how to define component 3 of FG11-3

## 4.1 Summary on the discussion in [1]

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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**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 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 |

Based on the discussion in [101-e-NR-UEFeatures-URLLCIIoT-02], following proposals on component 3 and reporting type for FG11-3 were made [1].

**Proposal 4:**

* **Component 3 is kept for FG11-3**
* **Type of FG11-3 is 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.**

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| Company | Comment |
| Samsung | No need for component 3. There is no such restriction in Rel-15 (e.g. one PUCCH can be at end of one slot and next PUCCH can be at beginning of next slot) or for multi-TRP. There was no discussion/motivation during the WI phase. |
| Intel | We still do not see a need for component 3, and especially so, since clear limits on #s of PUCCH formats by extending R15 FGs (as in Proposal 3 above). |
| ZTE | We have concerns on keeping component 3. The reasons are as follows:  1. Back to back PUCCH transmission is already supported in Rel-15 and it is typical. For instance, two back to back PUCCHs allocated in the end of a slot is a typical configuration.  2. Support a separation between two PUCCHs would make the whole resources more fragmented by PUCCH.  3. If a UE supporting 2-symbol subslot configuration, while the minimum gap between sub-slots is 7 symbols, it means the UE can only support at most 2 PUCCHs in one slot. What’s the fundamental difference compared to supporting 7-symbol subslot configuration?    In addition, it’s not quite clear how does component 3 work. For instance, if a UE reports support of subslot configuration with { 2-symbol\*7 and 7-symbol\*2) and reports combination (A, B) = (7, 7), does the UE still support 2-symbol\*7 configuration considering B=7 is define as sub-slot duration? If so, which kind of pattern the UE can support? |
| Qualcomm | Support the proposal. |
| LG | We also do not see a need for component 3. It is clearly defined how many PUCCH can be transmitted per subslot or slot in proposal 3. |
| Huawei, HiSilicon | **Support the proposal.**  Reasons for keeping component **3 are given as below, which intends to address the concerns above from companies.**  @ Samsung @ ZTE   * There was comment before that back to back PUCCHs in different slots is supported in Rel-15. However, in Rel-15 case probably is not typical case, once it happens still some chance for UE to handle by borrowing capability from some other place, also in rel-15 probably capability # 1 will be used which leave more room for UEs to do some extra random happen thing.   @ZTE   * Secondly, keep component 3) is beneficial from URLLC perspective, it can enable a UE that cannot support 7 actual PUCCHs in a lot can still operate with 2 symbol sub-slot, which can enable starting the PUCCH transmission asap to reduce the lateny, and which is actually the main motivation for sub-slot HARQ-ACK feedback. With component 3 here, if a UE supporting 2-symbol sub-slot, one potential benefit is that it can also support the case of 3 PUCCHs per slot. * If a UE reports the support of 2-symbol\*7, then a reasonable capability reporting will not only include (7, 7) for (A, B), e.g. it will include like (4, 2) and/or (2, 2). That is, the support of sub-slot configuration is only used to define the potential starting location of PUCCH in a slot, while (A, B) is to define the gap for actual PUCCH transmission.   @ Intel   * Firstly, the component 3 is to define not only the number of PUCCHs per slot, but also the gap between two actual PUCCHs, which is very important for UE capability, because we also need to consider the preocssing UE needs to do from receving the PDSCH to transmit PUCCH, not just transmit PUCCH itself. To support back-to-back PUCCHs, then it will have impact on the processing pipeline, which will result in difficulty to handle the processing with one processing unit. Increase more processing unit for sure will increase the UE complexity.   With proposal 2, the number of PUCCHs in a slot is clear, but the gap is still not defined. As explained above, the gap between two actual PUCCH transmission are very important also. |
| Nokia, NSB | No need for component 3 from our point of view. Otherwise fine with FL proposal. |
| Ericsson | * Delete component 3 from FG 11-3. There has been no discussion of combination (A,B) in PUCCH configuration at all. This concept is not needed. * The reason for “per FS” does not sound right. FG 11-3 does not call for “support of the new codebook or some codebook configurations”. It only requires sub-slot based HARQ-ACK feedback. In this sense, we prefer ‘per UE’. |
| Moderator (NTT DOCOMO) | Based on the feedbacks, both component 3 part and reporting type part seem not acceptable for some companies.  Therefore, we would need to continue discussion on these points unfortunately, and hence proposal 4 is removed unless companies objecting to the proposal can accept the proposal for the progress now. |
| Apple | For component 3, we have been supportive of the intention to provide some relaxation for UE implementation, while still providing the latency reduction. E.g. it is very unlikely there is a PDSCH every 2 symbols (which would require one HARQ-ACK every 2 symbols). For PDSCH that comes less frequent, the UE could still provide HARQ-ACK feedback based on 2-symbol sub-slot.  On Component 3 itself, I would like to confirm my understanding related to the comments from other companies above. My understanding is that (7, 7) is only for 7-symbol \* 2 configuration, and it is normal operation without any relaxation. That is why it is always present. For 2-symbol \* 7 configuration, a UE has a choice to report either (4, 2) (with a gap) or (2, 2) (without a gap).  Fine with per-FS reporting. |
| Moderator (NTT DOCOMO) | Based on further consideration, I’d like to ask companies to accept only the proposal of “Per FS” for FG11-3 for the progress if possible. The reason for “Per FS” is already provided by proponents and this part of proposal seems acceptable to almost all companies. |
| Ericsson | We can accept updated proposal 4 for sake of progress. |

**Updated proposal 4:**

* **Type of FG11-3 is 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.**

## 4.2 Discussion in email discussion after RAN1#101-e

Based on the discussion in [101-e-Post-NR-UE-Features-02], the proposal is to remove [component 3] since larger number of companies prefer to not keep it.

### **Proposal 3:**

* **Component 3 is removed from FG11-3**

Companies are encouraged to provide feedback if any in below.

|  |  |
| --- | --- |
| Company | Comment |
| DOCOMO | Support Proposal 3 |
| Apple | We still prefer to keep Component 3 because (1) it provides some relaxation for UE implementation; (2) practically speaking, back-to-back HARQ-ACK transmission for 2-symbol sub-slot does not seem to have compelling use cases. |
| Samsung | Agree. |
|  |  |

1. Discussion on whether/how to define [component 4 and 6] for FG11-4/4a as well as [component 1] for FG12-1

## 5.1 Summary on the discussion in [1]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 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]   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.   [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 |
| 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.   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 | [11-4] | 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 |

Based on the discussion in [101-e-NR-UEFeatures-URLLCIIoT-02], RAN1 had the discussion on component 4 and 6 for FG11-4/4a.

**Proposal 5:**

* **Component 4 is kept for FG11-4/4a**
* **Component 6 is removed from FG11-4/4a**

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | Support for indication of different priorities by DCI format for FG11-4/4a is an optional UE capability per RAN1 agreements (and per basic principle of FG design). The FGs make it mandatory.  Support adding two sub-components for component 4. One as is if the UE indicates the capability and one for using DCI 0\_1/1\_1 for low priority and DCI 0\_2/1\_2 for high priority if the UE does not indicate the capability.  Open to any other suggestion that is according to RAN1 agreements and according to basic principles of FG design for an optional UE feature.  OK with the proposal for Component 6. |
| Intel | We support that Component 4 should be kept, while for Component 6 we are open to keeping it as well to limit cases with “too many PUCCHs” in case both CBs are sub-slot-based.  Component 4 in FG 11-4/4a:  *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*  Component 4 implies that when a UE, indicating support of intra-UE prioritization involving PUCCH with HARQ-ACK, is configured with a single set of DCI formats (either 0\_1/1\_1 or 0\_2/1\_2), then the UE should be able to determine priority based on dynamic indication in the DCI. This clearly follows from the working assumption from RAN1 #99:  Working assumption:  When a single PDSCH/PUSCH processing timeline is configured in the carrier, at least when only DCI format 0\_1/1\_1 is configured or only DCI format 0\_2/1\_2 is configured in USS per BWP, a DCI format (from the formats 0\_1/1\_1/0\_2/1\_2) can be used to schedule PDSCH with different HARQ-ACK priorities or PUSCH with different priorities.   * 1-bit field in DCI can be configured as the PHY identification of the priority * No indication of different priorities by DCI formats 0\_0/1\_0   As can be seen from the above, Component 4 is literally the same as the WA. There is nothing mandated beyond RAN1 agreemenets or against RAN1 agreements as far as component 4 is concerned. The recent discussions in RAN1 (as part of R16 URLLC maintenance) has been regarding the scenario when a UE is configured with both sets of formats 0\_1/1\_1 and 0\_2/1\_2, and does not relate to the presence of Component 4 as part of FG 11-4/4a. |
| ZTE | Support the proposal. Same understanding with Intel on component 4. |
| Qualcomm | We are open to keep component 6. As for component 4, we agree with the comments from Samsung. |
| LG | Support the proposal |
| Huawei/HiSilicon | Ok with the proposal for component 4.   * As to component 6, if we remove it, is it clear enough on the total number of PUCCHs per slot for all cases?   + Case 1 (Two slot based HARQ-ACK codebook): Is it common understanding that it is 2 PUCCHs? If yes probably we can add a note under FG 11-4 to say “2 PUCCHs for HARQ-ACK transmission per slot for two slot-based HARQ-ACK codebooks”.   + Case 2 (Two sub-slot based HARQ-ACK codebooks): Define by FG 11-4e/FG11-4g/FG-11-4i?   + Case 3: (One slot-based+one sub-slot based): Defined by FG11-4c, FG-114d, FG-114f and FG11-4h?   If the above is common understanding, and we won’t remove the above FGs, then probably ok to remove component 6 here. |
| Nokia, NSB | Support FL proposal. Component 4 certainly needs to be kept – and we sould be fine with the proposed clarification by Intel to differentiate from FG 11-4b. |
| Ericsson | Support FL proposal. |
| Moderator (NTT DOCOMO) | Based on above feedbacks, current proposal 5 may be acceptable with confirming following understandings commented by some companies.   * Component 4 is literally the same as the WA from RAN1#99. There is nothing mandated beyond RAN1 agreemenets or against RAN1 agreements as far as component 4 is concerned. The recent discussions in RAN1 (as part of R16 URLLC maintenance) has been regarding the scenario when a UE is configured with both sets of formats 0\_1/1\_1 and 0\_2/1\_2, and does not relate to the presence of Component 4 as part of FG 11-4/4a. * As to component 6, if we remove it, is it clear enough on the total number of PUCCHs per slot for all cases?   + Case 1 (Two slot based HARQ-ACK codebook): Is it common understanding that it is 2 PUCCHs? If yes probably we can add a note under FG 11-4 to say “2 PUCCHs for HARQ-ACK transmission per slot for two slot-based HARQ-ACK codebooks”.   + Case 2 (Two sub-slot based HARQ-ACK codebooks): Define by FG 11-4e/FG11-4g/FG-11-4i?   + Case 3: (One slot-based+one sub-slot based): Defined by FG11-4c, FG-114d, FG-114f and FG11-4h?   So, proposal 5 is kept for now, and if there is still concern on any of above, the corresponding part will be removed from proposal 5. |
| Apple | Component 4 seems necessary because it is for the case when either 1\_1 or 1\_2 is configured. We are also supportive of Samsung’s proposal of using DCI 1\_1 for low priority and DCI 1\_2 for high priority when both are configured as the baseline feature in 11-4.  We are open to keep component 6, with the same considerations as Intel. Even though the new FGs quoted by Huawei put a limit, that number can still be very quite large (7 or 14 PUCCHs per slot). |
| Huawei, HiSilicon  (Views on updated propsal) | Since the proposal 3 is removed right now, then it seems better to keep component 6 open at this stage. If companies really have controversial views on compoenent 6, then proposal 5 here can focus on component 4 first. |
| Moderator (NTT DOCOMO) | Based on further feedbacks and considerations, updated proposal 5 to keep both component 4 and 6 are provided as below. |
| Qualcomm2 | We are not fine to keep component 4; after RAN1 setteled on the details of the related topic in the maintenance session, adding component 4 can be discussed. |
| Ericsson | It seems difficult to reach consensus for both component 4 and 6. We are fine to keep both open.   * For component 4, we support keeping it; * For component 6, we can accept keeping it if there is a single fixed value for component 6 for sub-slot 2-symbol \* 7 case. |

Also, based on the discussion in [101-e-NR-UEFeatures-URLLCIIoT-02], following updated proposal for the details on FG12-1 was made.

**Proposal 8:**

* **Component 1 is kept for FG12-1 and modified as “Configuration of PHY priority level for CG PUSCH, SR and PUCCH for SPS”**
* **Type of FG12-1 is Per FSPC**
  + **Per FSPC 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**
* **The bracket is removed from Note for FG12-1**

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | Same reasoning as for Proposal 5. Component 1 is not agreeable. |
| Intel | For Component 1, the entire description (with suggested addition of PUCCH for SPS) should be kept, for same reasons as elaborated in response to Propsal 5.  For the Note for FG 12-1, we still think that it is not needed for UE to also support LCP restriction based on DCI priority indication if it supports 12-1. The dependency is the other way around – a UE needs to support FG 12-1 if it is to support LCP restriction based on DCI priority indication. |
| ZTE | We are fine with the proposal |
| Qualcomm | On component 1, we agree with Samsung that the same approach proposed under Proposal 5 should be taken here too.  We are fine to remove the brackets from the note too. |
| LG | We have similar view to Intel. Regarding component 1, we would like to keep original text, having both configured priority and dynamic priority. |
| Huawei/HiSilicon | 1. If we want to align with proposal 5, it seems component 1 should be kept without any change. Same handling needed for proposal 4 compoenent 4 and proposal 8 component 1 here. We prefer the way used in proposal 5. 2. As to the reporting type, do we really go down to “FSPC”? |
| Nokia, NSB | On the changed wording of component 1, we agree with Intel that the priority indication of at least one DCI format for DG PUSCH (as in Proposal 5) should be there – so we agree to keep the bullet but not with reducing its scope. We agreed to not support intra-UE prioritization – but this does simply not including cancelation as such. An alternative would be to have the configured and dynamically indicated priority separately – with the new formulation of Component 1, but then we would need to have similar component (let’s call it component 1a) included as well.    Component 1a (UL/PUSCH equivalent of component 4 of Proposal 5 based on the Intel wording there):  *Supports a DCI format (from the formats 0\_1/0\_2) scheduling PUSCH with different PHY priorities when only DCI format 0\_1/1\_1 is configured or only DCI format 0\_2/1\_2 is configured per BWP*  We are not ok with FSPC, as it leads to unnecessary overhead and fragmentation.  And we are fine to remove the brackets in the notes. |
| Ericsson | * For component 1, prefer to keep original text, i.e., it should include dynamic indication of priority level of PUSCH. * Regarding the note for FG12-1: the note should be deleted. Agree with Intel that LCP restriction depends on DCI priority indication. |
| Moderator (NTT DOCOMO) | Based on the above feedbacks, the same result can be applied to component 1 of FG12-1 and component 4 of FG11-4/4a.  Regarding the reporting type, it seems Per FSPC is not acceptable although the reason is provided, and hence the part will be removed from the proposal 8 unless there is any suggestion for compromise.  Regarding the note “A UE supporting this feature shall also support the LCP restriction based on DCI priority indication ([lch-ToGrantPriorityRestriction-r16]) and intra-UE prioritization in MAC ([lch-PriorityBasedPrioritization-r16])”, I’d like to ask companies to check if Intel’s comment below is the common understanding i.e., ok to replace the note by following text.  -“UE needs to support FG 12-1 if it is to support LCP restriction based on DCI priority indication”  Therefore, Proposal 8 is kept for now, and according to the further feedback from companies on above points, the proposal may be updated or removed. |
| Apple | Fine with removing the bracket for component 1. Also agree with Samsung and QC that we should take the same approach as Proposal 5.  We are fine with per FSPC reporting. If per FSPC is not acceptable, we would also be fine with per FS reporting, which is the same type as FG 11-4.  Agree with Intel that it is not needed for UE to also support LCP restriction based on DCI priority indication if it supports 12-1. Regarding the new note proposed by the moderator, it would be better to have this note for the FG for LCP restriction based on DCI priority indication (maybe RAN2 captured it already).  It is also not clear to us why the UE supporting 12-1 has to support intra-UE prioritization in MAC ([lch-PriorityBasedPrioritization-r16]). It seems that these two features can work independently.  Suggest changing the title to “UL intra-UE multiplexing/prioritization of overlapping channel/signals with two priority levels for SR and PUSCH in physical layer”. And similarly for the description: “Support intra-UE multiplexing/prioritization of UL overlapping channels/signals with two priority levels for SR and PUSCH in physical layer (PHY)”. Note that two-level HARQ-ACK priority is included as part of 11-4. |
| Huawei, HiSilicon  (View on updated proposal ) | 1. Since proposal 5 proposes to keep component 4 of FG 11-4/4a, then component 1 here should be the original text, i.e. “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. As to the reporting type, we can compromise to “FS”as Apple mentioned. 3. As to the note on LCP restriction, we would be fine with the suggestions from Intel. But it seems RAN2 is discussing the dependency of LCP restriction and PHY-based prioritization also, probably can leave it open right now, or leave it to RAN2. 4. We are fine with the suggestion from Apple on changing the title of the FG. |
| Moderator (NTT DOCOMO) | Based on above feedbacks, updated proposal 8 is provided as below.   * For component 1, same as updated proposal 5 for component 4 of FG11-4/4a, the proposal is to keep it as it is. * For reporting type, the proposal for compromise is “Per FS” according to comments from Apple and Huawei/HiSi. * Regarding the note on LCP restriction, it seems that at least we don’t need to have the note for FG12-1, and hence the proposal is to remove the note and it can be up to RAN2. * The suggested update on FG name and component description from Apple is added in the proposal. |
| Qualcomm2 | * Component 1 can be discussed later after RAN1 made agreement on the related issue. * We are not sure why SR and PUSCH should be mentioned. Apple has said above that the two-level priority for HARQ-ACK is included in FG 11-4; but, that is for supporting two HARQ-ACK codebooks. What a UE is expected to do if it supports a single HARQ-ACK codebook and also supports FG-12-1? Is the assumption then that PUCCH carrying HARQ-ACK can never collide with PUSCH or SR of a different priority? It seems that with the addition of SR and PUSCH in the title and the description, we are removing some possible scheduling scenarios. Hence, unless there is some clarification, we cannot accept the last two bullets of the proposal. |
| Ericsson | * We are OK with first 3 bullets in Updated Proposal 8. * We disagree with last two bullets in Updated Proposal 8. Original text should be kept for both FG name and component description. |
| Apple | To respond to QC and Ericsson’s comments on the last two bullets: if a UE supports a single HARQ-ACK codebook and supports two priority levels for SR and PUSCH (12-1 but no 11-4), it means that the UE will handle the intra-UE prioritization/multiplexing with low priority HARQ-ACK and low/high priority SR/PUSCH. If a UE supports two priority levels for HARQ-ACK, SR, and PUSCH (11-4 and 12-1), then the full intra-UE prioritization/multiplexing should be handled by the UE. Similarly, if a UE supports 11-4 only but not 12-1, it should be able to handle the intra-UE prioritization/multiplexing with low/high priority HARQ-ACK and low priority SR/PUSCH. I thought the intention is to separate the HARQ-ACK for DL and SR/PUSCH for UL by keeping both 11-4 and 12-1, which was why we suggested these changes to further clarify. If there is different understanding and we do not have time to coverge now, we could take some more time to reach the common understanding among all companies. As commented, this does not really have impact on the RAN2 signaling design. |

**Updated proposal 8:**

* **Type of FG12-1 is 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**
* **The note within bracket is removed for FG12-1**

## 5.2 Discussion in email discussion after RAN1#101-e

Based on the discussion in [101-e-Post-NR-UE-Features-02], RAN1 should resume the discussion based on latest proposal as below.

### **Proposal 4:**

* **Component 4 is kept for FG11-4/4a**
* **Component 6 is kept for FG11-4/4a**
* **Component 1 is kept for FG12-1**

Companies are encouraged to provide feedback if any in below.

|  |  |
| --- | --- |
| Company | Comment |
| DOCOMO | Support Proposal 4 in general.  Regarding component 4 for FG11-4/4a, current text should be kept as it is aligned with WA in RAN1#99. If additional agreement for the case when a UE is configured with both sets of formats 0\_1/1\_1 and 0\_2/1\_2 but does not support FG11-4b is obtained in Rel.16 maintenance, new text/component can be added.  Regarding component 1 for FG12-1, same as above, current text should be kept as it is aligned with WA in RAN1#99. If additional agreement for the case when a UE is configured with both sets of formats 0\_1/1\_1 and 0\_2/1\_2 but does not support FG12-1a is obtained in Rel.16 maintenance, new text/component can be added. |
| Apple | We are fine with the proposal in principle, but would suggest the following changes:   * For component 6 in FG 11-4/4a, we will also need to define the values. We think the component should be reported separately for different configurations.   + For FG 11-4, is it correct that this only applies to the case of “slot-based + sub-slot based” feedback? For slot-based+slot-based, the maximum is 2 so there may not be a need to introduce additional reporting. For slot-based + sub-slot based, we suggest {2, 3} for 7-symbol\*2 sub-slot configuration, and {2, 3, 4, 5, 6, 7} for 2-symbol\*7 sub-slot configuration.     - For slot-based + sub-slot-based, we propose a minimum value of 2 to be consistent with the maximum of 2 PUCCHs for HARQ-ACK for slot-based + slot-based.   + For FG 11-4a, we suggest {2, 3, 4} for 7-symbol\*2 sub-slot configuration, and {2, 3, 4, 5, 6, 7} if at least one of them has 2-symbol\*7 sub-slot configuration.     - We do not see the need for the UE to support two PUCCHs for HARQ-ACK in a sub-slot in case of 2-symbol sub-slot.   In addition, as commented earlier, we suggest changing the title to “UL intra-UE multiplexing/prioritization of overlapping channel/signals with two priority levels for SR and PUSCH in physical layer”. And similarly for the description: “Support intra-UE multiplexing/prioritization of UL overlapping channels/signals with two priority levels for SR and PUSCH in physical layer (PHY)”. Note that two-level HARQ-ACK priority is included as part of 11-4. |
| Samsung | Agree for Component 6 for FG 11-4/4a. Do not agree for Component 4 for FG 11-4/4a and Component 1 for FG12-1.  One reason is that support of different priorities for HARQ-ACK codebooks/PUSCH via priority indicator field is an optional feature and there is currently no other feature for such optionality. eMBB will not be operated with a very small DCI format size (no network vendor will compromise eMBB performance) and having an ~100 bit DCI format size for URLLC is undesirable.  Another reason is that there is no specification support through FG11-4/4a and FG12-1 for eMBB and URLLC operation as configurations are per DCI format and not per priority value.  For example, HARQ-ACK timing is defined by dl-DatatoUL-ACK and dl-DataToUL-ACK-ForDCI-Format1-2 and it is not possible to indicate different values for HARQ-ACK slot timing (slot or sub-slot) using priority indicator. The same also applies for the MCS tables, different number of cells for CA with Rel-15/Rel-16 PDCCH monitoring (eMBB/URLLC), reference of SLIV, and several other fields.  Basically, RRC configurations differentiate by DCI format and not by the priority indicator for the same DCI format.  Our proposal is to have a separate FG where DCI format 0\_1/1\_1 is used for eMBB as in Rel-15 and the new DCI formats 0\_2/1\_2 introduced in Rel-16 for URLLC are used for URLLC. |
|  |  |

1. Discussion on how to define reporting type of FG11-6

## 6.1 Summary on the discussion in [1]

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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**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Need of FDD/TDD differentiation** | **Need of FR1/FR2 differentiation** | **Capability interpretation for mixture of FDD/TDD and/or FR1/FR2** | **Note** | **Mandatory/Optional** |
| 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 |

Based on the discussion in [101-e-NR-UEFeatures-URLLCIIoT-02], following proposal was made in email discussion [101-e-Post-NR-UE-Features-02].

**Proposal 6:**

* **Type of FG11-6 is Per UE**
  + **Need of FDD/TDD differentiation is “No”**
  + **Need of FR1/FR2 differentiation is “Yes”**
* **One of {****5-16, 5-17} is a prerequisite feature group for FG11-6**

|  |  |
| --- | --- |
| Company | Comment |
| Samsung | Support the proposal |
| Intel | Fine with the proposal. |
| ZTE | We don’t see the need of FR1/FR2 differentiation for FG 11-6. |
| Qualcomm | We are fine with this proposal. |
| LG | Fine with the proposal. |
| Huawei/HiSilicon | We can accept it for progress. However, actually we don’t see very strong need to do FR1/FR2 differentitation here for FG11-6, since it is for PUSCH repetition type A. No reason that FR2 may not support it? |
| Nokia, NSB | Support FL proposal |
| Ericsson | FG 11-6 is almost the same as Rel-15 “pusch-RepetitionMultiSlots”. In Rel-15, need of FR1/FR2 differentiation is “No”. Hence FG 11-6 should also have no need of FR1/FR2 differentiation. |
| Moderator (NTT DOCOMO) | Based on the above feedbacks and discussion so far, since this is the proposal for compromise, I’d like to ask again to consider this proposal for the progress. I’d also like to ask if per UE without FRx differentiation is acceptable for the progress. |
| Apple | Fine with the proposal |
| Moderator (NTT DOCOMO) | Based on further consideration with checking the discussion on this issue so far, I’d like to update the proposal 6 as “Per UE without FRx differentiation” since it is acceptable except for one company. As commented above, FG11-6 is almost same as Rel-15 FG5-17 which does not have FRx differentiation. |
| Qualcomm2 | All companies, but 2, are fine with setting FR1/FR2 differenation to Yes. We think the differentiation should be set to YES. |
| Ericcson | Support updated proposal 6. |

**Updated proposal 6:**

* **One of {5-16, 5-17} is a prerequisite feature group for FG11-6**

## 6.2 Discussion in email discussion after RAN1#101-e

Based on the discussion in [101-e-Post-NR-UE-Features-02], RAN1 should resume the discussion based on latest proposal as below.

### **Proposal 5:**

* **Type of FG11-6 is Per UE**
  + **Need of FDD/TDD differentiation is “No”**
  + **Need of FR1/FR2 differentiation is “Yes”**

Companies are encouraged to provide feedback if any in below.

|  |  |
| --- | --- |
| Company | Comment |
| DOCOMO | We object to the proposal 5. This FG is very close to the prerequisite FGs, i.e. FG5-16 or FG5-17, and none requires xDD/FRx differentiation. |
| Apple | Fine with the proposal. |
| Samsung | Can accept proposal for the progress. But, we are not sure the motivation of having “Need of FR1/FR2 differentiation is Yes” |
|  |  |

1. Discussion on how to define prerequisite feature group of FG12-1

## 7.1 Summary on the discussion in RAN1#101-e

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 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.   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 | [11-4] | 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 |

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | 1. The main bullet “Support intra-UE multiplexing/prioritization of overlapping PUCCH/PUCCH and PUCCH/PUSCH with two priority levels in physical layer (PHY)” depend on the email discussion #02 under CG AI, since the current wording doesn’t include PUSCH + PUSCH case. |
| Qualcomm | Note: some parts of the FL proposal is not related to FG 12-1 (it seems to be a typo.)   * For component 1, the priority of PUCCH for SPS is also configured; this is not included. * No prequisite FG is needed. The UE may only support a single codebook, but supports multiple services in the uplink. * Type should take the band information into account; we prefer to have it as FSPC. * The note on the relation to the MAC based capabilities is not clear. This needs some discussions. |
| Intel | * FG 11-4 need not be a pre-requisite * Perhaps best to wait for resolution of CG-CG/CG-DG cases as pointed out by Huawei. * In the Note column, modify as: A UE supporting this feature shall also support ~~the LCP restriction based on DCI priority indication ([~~*~~lch-ToGrantPriorityRestriction-r16~~*~~]) and~~ intra-UE prioritization in MAC ([*lch-PriorityBasedPrioritization-r16*]). Technical reason below:   + The support of LCP restriction based on DCI priority requires support of 12-1 as a pre-requisite, and this dependency is sufficient. A UE reporting support of FG #12-1 should not be mandated to also support DCI indication based LCP restriction. |
| Nokia, NSB | * The case of CG PUSCH versus DG PUSCH multiplexing/prioritization should be part of this FG as well, and hence we prefer to revert to the previous formulation. Otherwise we are fine with the FL proposals |
| Moderator (NTT DOCOMO) | Typo is corrected.  Further discussion on following points seems necessary.   * Whether or not to include PUSCH+PUSCH case * Whether 11-4 is prerequisite FG or not * Type * Note on the relation to MAC based capabilities (whether suggested modification from Intel is fine for all) |
| Apple | * There is no need to have FG 11-4 as the pre-requisite, as we are separating the DL HARQ-ACK priority handling and UL SR/PUSCH priority handling. * We prefer to have the type as per FSPC. * Suggest changing the title to “UL intra-UE multiplexing/prioritization of overlapping channel/signals with two priority levels for SR and PUSCH in physical layer”. And similarly for the description: “Support intra-UE multiplexing/prioritization of UL overlapping channels/signals with two priority levels for SR and PUSCH in physical layer (PHY)”. * Add a component “Supports a DCI format (from the formats 0\_1/0\_2) scheduling PUSCH with different priorities when only one of the DCI formats 0\_1 and 0\_2 is configured per BWP”, which seems to be missing after the UL DCI formats are removed from 11-4. |
| ZTE | Support the proposal with including PUSCH+PUSCH case |
|  |  |

**Updated FL proposal 10:**

* **Component 1 is kept for FG12-1**
* **FG11-4 is a prerequisite feature group for FG12-1**
* **Type of FG12-1 is Per UE**
  + **Need of FDD/TDD differentiation is “No”**
  + **Need of FR1/FR2 differentiation is “No”**
* **The bracket is removed from Note for FG12-1**

|  |  |
| --- | --- |
| Company | Comment |
| Moderator (NTT DOCOMO) | FG name and component description can be updated later since there is no ASN.1 impact.  We should prioritize type discussion.  Based on feedbacks so far,   * Support per UE without xDD/FRx differentiation: Huawei, HiSi, Intel, Nokia, NSB, ZTE * Supporte per FSPC: Qualcomm, Apple   So, clear reason for per FSPC or compromised proposal (e.g., per UE with FRx differentiation) is necessary. |
| Nokia, NSB | We agree that a very clear reason needs to be given to justify FSPC proposal. Otherwise we should agree with FL proposal. |
| Apple | As we commented for FG 11-4 and above, we do not see the need to have FG 11-4 as the prerequisite here. Please see our comments in the table above.  We have a strong preference to have it per FSPC. As this FG involves various kinds of prioritization/cancellation/multiplexing, it is very processing intensive. Therefore, it is important to have finer granularity so that the UE does not have to under-report based on the worst band/band combination. |
| Huawei, HiSilicon | 1. It is not necessary to have FG 11-4 as the prerequisite. Since both can work independently now. 2. The main bullet of FG 12-1 “Support intra-UE multiplexing/prioritization of overlapping PUCCH/PUCCH and PUCCH/PUSCH with two priority levels in physical layer (PHY)” depend on the email discussion #02 under CG AI, since the current wording doesn’t include PUSCH + PUSCH case. |
| Qualcomm | * We do NOT agree with type as Per UE. Any form of cancellation has an impact on UE processing power and the envelope it can support. We can accept the type as per FS. * We do not agree to include FG 11-4 as a prequisite. * For PUCCH of SPS, it is still unclear which FG captures the 2-level priority support. * Regarding component 1, this part “and dynamic indication of priority level for dynamic PUSCH with a single DCI format Multiplexing/prioritization between UL channels/signals with the same PHY priority leve” should be removed for now since there was no conclusion in the related AI. |
| Nokia, NSB | We are mostly fine with the FL proposal. We would like more explanations on why FS is truly required, but given the very late stage in the discussion we can accept that as a compromise. |
| Ericsson | We support Updated FL proposal 10 except that we don’t see why 11-4 should be a prerequisite. Intra-UE multiplexing/prioritization of overlapping PUCCH/PUCCH and PUCCH/PUSCH with two priority levels in physical layer (PHY) can happen even if there is only a single HARQ-ACK codebook, for example: PUSCH of two priority levels. |

## 7.2 Discussion in email discussion after RAN1#101-e

Based on the discussion in RAN1#101-e meeting, the proposal is to remove [11-4] from prerequisite feature group of FG12-1.

### **Proposal 6:**

* **FG[11-4] is removed from prerequisite feature group of FG12-1**

Companies are encouraged to provide feedback if any in below.

|  |  |
| --- | --- |
| Company | Comment |
| DOCOMO | Support Proposal 6.  In addition, PUSCH vs PUSCH (other than DG vs CG) case should be included in the main bullet as follows:  “Support intra-UE multiplexing/prioritization of overlapping PUCCH/PUCCH, ~~and~~ PUCCH/PUSCH, and PUSCH/PUSCH with two priority levels in physical layer (PHY)” |
| Apple | Support Proposal 6  Regarding DOCOMO’s comments, we do not agree that PUSCH/PUSCH should be added in the description, because we do not support DG vs DG or DG vs CG. The only remaining case is CG vs CG, which is left to UE implementation. |
| Samsung | Can accept proposal for the progress. |
|  |  |

1. Conclusion

TBD

Reference

[1] R1-2005106 Summary on [101-e-Post-NR-UE-Features-02] Moderator (NTT DOCOMO, INC.)

[2] R1-2005110 RAN1 UE features list for Rel-16 NR updated after RAN1#101-e Moderators (AT&T, NTT DOCOMO, INC.)

[3] RP-201284 Summary on email discussion [R15\_R16\_UE\_features] Moderator (NTT DOCOMO, INC.)

Appendix: Latest UE features list for URLLC and IIoT [2]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |  |
| 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 | [11-4] | 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 |