**3GPP TSG RAN WG1 #110bis-e R1-2210275**

**e-Meeting, October 10th – 19th, 2022**

**Agenda item:** 8.16.1

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

**Title:** Summary#1 on UE features for enhanced IIoT and URLLC

**Document for:** Discussion and Decision

# **Introduction**

This document summarizes contributions submitted to AI 8.16.1 regarding UE features for enhanced IIoT and URLLC and captures company views based on the announcement in the following email thread.

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| [110bis-e-R17-UE-features-01] Email discussion on Rel-17 UE features topics 1 by October 19 – Hiroki (NTT DOCOMO)   * eIIoT & URLLC, RedCap, UE power saving, coverage enhancement, NB-IoT & eMTC, sidelink, MBS, 5G terrestrial broadcast, UL TX switching, SDT |

# **Discussion on UE features for enhanced IIoT and URLLC**

## **2.1 25-3a and 25-3b: PUCCH Repetition enhancements**

In [1], FGs 25-2 and 25-3b are captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 25. NR\_IIOT\_URLLC\_enh | 25-3a | Repetitions for PUCCH format 0, 1, 2, 3 and 4 over multiple PUCCH subslots using dynamic repetition indication | Repetitions for PUCCH format 0, 1, 2, 3 and 4 over multiple PUCCH subslots based on dynamic repetition indication.  Note: Dynamic PUCCH repetition factor indication is only supported for HARQ-ACK | [25-3  30-5] | Yes | N/A |  | Per FS | N/A | N/A | N/A |  | Optional with capability signaling |
| 25. NR\_IIOT\_URLLC\_enh | 25-3b | Inter-subslot frequency hopping for PUCCH repetitions | 1. Support inter-subslot frequency hopping for PUCCH repetition operation of PUCCH Formats 0, 1, 2, 3 and 4 for 7OS slot-based PUCCH configurations.  2. Support inter-subslot frequency hopping for PUCCH repetition operation of PUCCH Format 0 and Format 2 for 2OS slot-based PUCCH configurations | [TBD] | Yes | N/A |  | Per FS | N/A | N/A | N/A |  | Optional with capability signaling |

Following views are provided in contributions for the RAN1#110bis-e meeting.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| [2] | Huawei, HiSilicon | 1. For FG 25-3a, there is no need to add 30-5 from coverage as the prerequisite. Sub-slot based repetition can apply same mechanism that designed for slot based repetition in terms of dynamic number indication, but as to the UE capability no strong dependency. 2. For FG 25-3b, the prerequisite can be “25-3 or 25-3a”. If only FG 25-3 is listed there, the question is whether hopping can be done in case of dynamic indication of the repetitions, in our understanding the hopping can be applicable either.   ***Proposal 10: Updating FG25-3a/25-3b as follows in red:***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 25. NR\_IIOT\_URLLC\_enh | 25-3a | Repetitions for PUCCH format 0, 1, 2, 3 and 4 over multiple PUCCH subslots using dynamic repetition indication | Repetitions for PUCCH format 0, 1, 2, 3 and 4 over multiple PUCCH subslots based on dynamic repetition indication.  Note: Dynamic PUCCH repetition factor indication is only supported for HARQ-ACK | ~~[~~25-3  ~~30-5]~~ | Yes | N/A |  | Per FS | N/A | N/A | N/A |  | Optional with capability signaling | | 25. NR\_IIOT\_URLLC\_enh | 25-3b | Inter-subslot frequency hopping for PUCCH repetitions | 1. Support inter-subslot frequency hopping for PUCCH repetition operation of PUCCH Formats 0, 1, 2, 3 and 4 for 7OS slot-based PUCCH configurations.  2. Support inter-subslot frequency hopping for PUCCH repetition operation of PUCCH Format 0 and Format 2 for 2OS slot-based PUCCH configurations | 25-3 or 25-3a | Yes | N/A |  | Per FS | N/A | N/A | N/A |  | Optional with capability signaling | |
| [4] | vivo | **FG 25-3a**  For FG 25-3a, the pre-requisite FG 30-5, i.e., dynamic slot-based repetition, corresponds coverage enhancement feature, while FG 25-3a targets meeting URLLC requirements. There is no strong correlation between these two features. A URLLC UE may only implement sub-slot based repetitions without supporting slot-based repetitions. Therefore, the pre-requisite FG 30-5 is not needed and should be removed from FG 25-3a.  *Proposal 6: For FG25-3a, the prerequisite 30-5 should be removed from FG 25-3a.*   |  |  |  |  | | --- | --- | --- | --- | | 25-3a | Repetitions for PUCCH format 0, 1, 2, 3 and 4 over multiple PUCCH subslots using dynamic repetition indication | Repetitions for PUCCH format 0, 1, 2, 3 and 4 over multiple PUCCH subslots based on dynamic repetition indication.  Note: Dynamic PUCCH repetition factor indication is only supported for HARQ-ACK | ~~[~~25-3  ~~30-5]~~ |   **FG 25-3b**  For UE supporting FG 25-3b, inter-subslot frequency hopping can be used for repetition based on semi-static or dynamic indication. So, prerequisite FG for FG 25-3b should be FG 25-3 or 25-3a.  *Proposal 7: For FG25-3b, the prerequisite should be FG 25-3 or 25-3a.*   |  |  |  |  | | --- | --- | --- | --- | | 25-3b | Inter-subslot frequency hopping for PUCCH repetitions | 1. Support inter-subslot frequency hopping for PUCCH repetition operation of PUCCH Formats 0, 1, 2, 3 and 4 for 7OS slot-based PUCCH configurations.  2. Support inter-subslot frequency hopping for PUCCH repetition operation of PUCCH Format 0 and Format 2 for 2OS slot-based PUCCH configurations | ~~[TBD]~~ 25-3 or 25-3a | |
| [5] | OPPO | **FG 25-3/3a/3b: PUCCH Repetition enhancements**  For FG 25-3a, it is preferred to remove FG 30-5 from the prerequisite feature groups since there is no dependency for these two features although the mechanism of dynamic indication of repetition number is the same.  For FG 25-3b, the prerequisite feature groups should include FG 25-3 for support of sub-slot PUCCH repetition.  ***Proposal 1: Remove FG 30-5 from the prerequisite feature groups for FG 25-3a.***  ***Proposal 2: The prerequisite feature groups for FG 25-3b includes FG 25-3.*** |
| [6] | NTT DOCOMO, INC. | For FG 25-3a, prerequisite feature group should at least include FG 25-3. The main controversial point is whether to include FG 30-5 in the prerequisite groups. In our understanding, sub-slot based PUCCH repetitions may result in slot based PUCCH repetitions in some cases. Therefore, it is preferred to include FG 30-5. On the other hand, if majority companies think it not necessary, we are also fine to not include FG 30-5.  **Proposal 2-1: Prefer to keep FG 25-3 and FG 30-5 as prerequisite feature groups for FG 25-3a. Only to include FG 25-3 as prerequisite feature group is also fine.**  For FG 25-3b, FG 25-3b can be supported for UE reporting support of FG 25-3 or FG 25-3a. Therefore, “FG 25-3 or FG 25-3a” can be added as prerequisite feature group for FG 25-3b.  **Proposal 2-2: Include “FG 25-3 or FG 25-3a” as prerequisite feature group for FG 25-3b.** |
| [8] | Nokia, Nokia Shanghai Bell | * **25-3a:** * Confirm 25-3 and 30-5 as pre-requisites. * **25-3b:** * Missing pre-requisite FG: FG 25-3 |

Based on above, following proposals should be discussed at the RAN1#110bis-e meeting.

### **Proposal 2-1-1:**

* **Apply one of the following alternatives for prerequisite FG for FG 25-3a:**
  + **Alt.1: keep 25-3 [2, 4, 5, 6]**
  + **Alt.2: keep 25-3 and 30-5 [6, 8]**

|  |  |
| --- | --- |
| Company | Comment |
| OPPO | Prefer Alt-1. |
| DOCOMO | Prefer Alt 1, but also OK with Alt 2. |
| Huawei, HiSilicon | Alt.1.  There is no need to add 30-5 from coverage as the prerequisite. Sub-slot based repetition can apply same mechanism that designed for slot based repetition in terms of dynamic number indication, but as to the UE capability no strong dependency. |
| Intel | We slightly prefer Alt 2 with similar reason as explained by Docomo, but we’re also fine with Alt 1. |

### **Proposal 2-1-2:**

* **Apply one of the following alternatives for prerequisite FG for FG 25-3b:**
  + **Alt.1: 25-3 or 25-3a [2, 4, 6]**
  + **Alt.2: 25-3 only [5, 8]**

|  |  |
| --- | --- |
| Company | Comment |
| OPPO | Because 25-3 is very likely a prerequisite of 25-3a (ref. Proposal 2-1-1), and the difference between 25-3 and 25-3a is just the “dynamic repetition indication” added in 25-3a, which however has noting to do with inter-subslot frequency hopping as targeted by 25-3b, we do not see essential difference between Alt-1 and Alt-2. So **we think Alt-2 is good enough**. Meanwhile, **we can also accept Alt-1** if it is the majority preference. |
| DOCOMO | Prefer Alt 1, since FG 25-3b can be supported for UE reporting support of FG 25-3 or FG 25-3a.  On the other hand, as commented by OPPO, considering FG 25-3 is very possible to be prerequisite of FG 23-3a, we are also fine with Alt 2. |
| Huawei, HiSilicon | Alt.1.  The prerequisite can be “FG 25-3 or FG 25-3a”. If only FG 25-3 is listed there, the question is whether hopping can be done in case of dynamic indication of the repetitions, in our understanding the hopping can be applicable either. |
| Intel | We prefer Alt 1, and we have similar question with HW. |

## **2.2 25-6: Retransmission of cancelled HARQ-ACK**

In [1], FG 25-6 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 25. NR\_IIOT\_URLLC\_enh | 25-6 | Enhanced type 3 HARQ-ACK codebook feedback | 1. Support feedback of enhanced type 3 HARQ-ACK codebook, triggered by a DCI 1\_1 and DCI format 1\_2 (for a UE supporting DCI format 1\_2, 11-1)  2. Support configuration of up to 8 enhanced type 3 HARQ-ACK codebooks.  3. Support feedback of a dynamically selected enhanced type 3 HARQ-ACK codebook based on triggering information in DCI 1\_1 and DCI 1\_2 (for a UE supporting DCI format 1\_2, 11-1)  4. Support transmission of enhanced type 3 HARQ-ACK codebook using the first or second PUCCH configuration based on PHY priority indication in the triggering DCI (for a UE supporting two HARQ-ACK codebooks / PUCCH config in 11-4)  5. Supported maximum number of actual PUCCH transmissions for [type 3 or] enhanced type 3 HARQ-ACK codebook feedback within a slot | 10-16 | Yes | N/A |  | Per band | N/A | N/A | N/A | For component 2, the UE indicates its capability in the number of enhanced type 3 HARQ-ACK codebooks: {1, 2, 4, 8}  For component 3, the dynamic indication is only supported if the UE for component 2 supports more than one enhanced type 3 HARQ-ACK codebook to be configured  Candidate values for component 5 is: {1, 2, 3, 4, 5, 6, 7}. | Optional with capability signaling |

Following views are provided in contributions for the RAN1#110bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [2] | Huawei, HiSilicon | 1. For component 5, “type 3 or” should be kept. For a UE supporting FG 25-6, gNB can configure either type 3 HARQ-ACK codebook or enhanced type 3 HARQ-ACK codebook, thus the reported value for component 5 should be applied to both type 3 HARQ-ACK codebook and enhanced HARQ-ACK codebook type. Note that we don't think this will change the Rel-16 behaviour, since it is applied only when the UE reports the support of FG25-6. If UE doesn't support FG 25-6 but only FG 10-16, then still follow Rel-16 behaviour. |
| [4] | vivo | **FG25-6**  FG 25-6 is related to either type 3 HARQ-ACK codebook or enhanced type 3 HARQ-ACK codebook. The reported maximum number of actual PUCCH transmissions should be applied to both type 3 HARQ-ACK codebook and enhanced HARQ-ACK codebook type. So, we prefer to keep [ type 3 or] in the component 5  *Proposal 8: For FG25-6, [ type 3 or] in the component 5 can be kept.* |
| [6] | NTT DOCOMO, INC. | For FG 25-6, since the motivation to include component 5 is to address companies’ concern on number of type 3 or enhanced type 3 HARQ-ACK CBs in one slot, we think the “type 3 or” should be kept.  **Proposal 2-3: Keep “type 3 or” in component 5 of FG 25-6.** |
| [8] | Nokia, Nokia Shanghai Bell | * **25-6:** * Remove the yellow marked ’type 3 or’ from the FG components, as Type 3 CB is a Rel-16 feature already. |

Based on above, following proposals should be discussed at the RAN1#110bis-e meeting.

### **Proposal 2-2:**

* **Apply one of the following alternatives for the description of the component 5 for FG 25-6:**
  + **Alt.1: keep “type 3 or” [2, 4, 6]**
  + **Alt.2: remove “type 3 or” [8]**

|  |  |
| --- | --- |
| Company | Comment |
| OPPO | Prefer Alt-1. |
| DOCOMO | Prefer Alt 1. |
| Huawei, HiSilicon | Alt 1.  For component 5, “type 3 or” should be kept. For a UE supporting FG 25-6, gNB can configure either type 3 HARQ-ACK codebook or enhanced type 3 HARQ-ACK codebook, thus the reported value for component 5 should be applied to both type 3 HARQ-ACK codebook and enhanced HARQ-ACK codebook type. Note that we don't think this will change the Rel-16 behaviour, since it is applied only when the UE reports the support of FG25-6. If UE doesn't support FG 25-6 but only FG 10-16, then still follow Rel-16 behaviour. |
| Intel | We prefer Alt 1. |

## **2.3 25-9 to 25-10c: PUCCH cell switching**

In [1], FGs 25-9 to 25-10c are captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 25. NR\_IIOT\_URLLC\_enh | 25-9 | Semi-static PUCCH cell switching for a single PUCCH group only | 1. Semi-static PUCCH cell switching using configured time-domain domain pattern of applicable PUCCH cell / carrier for a single PUCCH group only. This component indicates one of the candidate values {only primary PUCCH group can support PUCCH cell switch, only secondary PUCCH group can support PUCCH cell switch, either primary or secondary PUCCH group can support PUCCH cell switch}  2. For the PUCCH group supporting semi-static PUCCH cell switch, for a BC, the UE reports one or multiple of supported configuration(s) of PUCCH group config, where each supported configuration includes the following information   * one or multiple carrier type pairs that can support PUCCH cell switch, where the carrier type are selected from {FR1 licensed TDD, FR2 licensed TDD} |  | Yes | N/A |  | Per BC | N/A  (TDD only) | N/A | N/A | Note: this feature applies to cells in the same TAG only  If UE supporting this FG also supports both FGs 6-9 and 6-9a or both FGs 22-7b and 22-7c or FGs 22-6 or 22-6a when UE is not configured with two NR PUCCH groups, the UE supports the cases of both same and different numerologies between switchable cells. Otherwise, the UE supports the case of same numerology between switchable cells | Optional with capability signaling |
| 25. NR\_IIOT\_URLLC\_enh | 25-9a | Semi-static PUCCH cell switching for two PUCCH groups | Semi-static PUCCH cell switching using configured time-domain domain pattern of applicable PUCCH cell / carrier  For the BC, the UE reports one or multiple of supported configuration(s) of {primary PUCCH group config, secondary PUCCH group config} where for each supported configuration,   * The “primary PUCCH group config” includes following information:   + one or multiple carrier type pairs that can support PUCCH cell switch, where the carrier type are selected from {FR1 licensed TDD, FR2 licensed TDD} * The “secondary PUCCH group config” includes following information:   + one or multiple carrier type pairs that can support PUCCH cell switch, where the carrier type are selected from {FR1 licensed TDD, FR2 licensed TDD} |  | Yes | N/A |  | Per BC | N/A  (TDD only) | N/A | N/A | Note: this feature applies to cells in the same TAG only  If UE supporting this FG also supports both FGs 6-9 and 6-9a or both FGs 22-7b and 22-7c, the UE supports the cases of both same and different numerologies between switchable cells. Otherwise, the UE supports the case of same numerology between switchable cells | Optional with capability signaling |
| 25. NR\_IIOT\_URLLC\_enh | 25-10 | PUCCH cell switching based on dynamic indication for same length of overlapping PUCCH slots/sub-slots for a single PUCCH group only | 1. PUCCH cell switching based on dynamic indication in the DCI scheduling the PUCCH for same length (in physical time) of overlapping PUCCH slots/sub-slots for a single PUCCH group only. This component indicates one of the candidate values {only primary PUCCH group can support PUCCH cell switch, only secondary PUCCH group can support PUCCH cell switch, either primary or secondary PUCCH group can support PUCCH cell switch}  2. For the PUCCH group supporting PUCCH cell switching based on dynamic indication in the DCI scheduling the PUCCH for same length (in physical time) of overlapping PUCCH slots/sub-slots, for a BC, the UE reports one or multiple of supported configuration(s) of PUCCH group config, where each supported configuration includes the following information   * one or multiple carrier type pairs that can support PUCCH cell switch, where the carrier type are selected from {FR1 licensed TDD, FR2 licensed TDD} |  | Yes | N/A |  | Per BC | N/A (TDD only) | N/A | N/A | Note: this feature applies to cells in the same TAG only  If UE supporting this FG also supports both FGs 6-9 and 6-9a or both FGs 22-7b and 22-7c or FGs 22-6 or 22-6a when UE is not configured with two NR PUCCH groups, the UE supports the cases of both same and different numerologies between switchable cells. Otherwise, the UE supports the case of same numerology between switchable cells | Optional with capability signaling |
| 25. NR\_IIOT\_URLLC\_enh | 25-10a | PUCCH cell switching based on dynamic indication for different length of overlapping PUCCH slots/sub-slots for a single PUCCH group only | 1. PUCCH cell switching based on dynamic indication in the DCI scheduling the PUCCH for different length (in physical time) of overlapping PUCCH slots/sub-slots for a single PUCCH group only. This component indicates one of the candidate values {only primary PUCCH group can support PUCCH cell switch, only secondary PUCCH group can support PUCCH cell switch, either primary or secondary PUCCH group can support PUCCH cell switch}  2. For the PUCCH group supporting PUCCH cell switching based on dynamic indication in the DCI scheduling the PUCCH for different length (in physical time) of overlapping PUCCH slots/sub-slots, for a BC, the UE reports one or multiple of supported configuration(s) of PUCCH group config, where each supported configuration includes the following information   * one or multiple carrier type pairs that can support PUCCH cell switch, where the carrier type are selected from {FR1 licensed TDD, FR2 licensed TDD} |  | Yes | N/A |  | Per BC | N/A  (TDD only) | N/A | N/A | Note: this feature applies to cells in the same TAG only  If UE supporting this FG also supports both FGs 6-9 and 6-9a or both FGs 22-7b and 22-7c or FGs 22-6 or 22-6a when UE is not configured with two NR PUCCH groups, the UE supports the cases of both same and different numerologies between switchable cells. Otherwise, the UE supports the case of same numerology between switchable cells | Optional with capability signaling |
| 25. NR\_IIOT\_URLLC\_enh | 25-10b | PUCCH cell switching based on dynamic indication for same length of overlapping PUCCH slots/sub-slots for two PUCCH groups | PUCCH cell switching based on dynamic indication in the DCI scheduling the PUCCH for same length (in physical time) of overlapping PUCCH slots/sub-slots for two PUCCH groups  For the BC, the UE reports one or multiple of supported configuration(s) of {primary PUCCH group config, secondary PUCCH group config} where for each supported configuration,   * The “primary PUCCH group config” includes following information:   + one or multiple carrier type pairs that can support PUCCH cell switch, where the carrier type are selected from {FR1 licensed TDD, FR2 licensed TDD} * The “secondary PUCCH group config” includes following information:   + one or multiple carrier type pairs that can support PUCCH cell switch, where the carrier type are selected from {FR1 licensed TDD, FR2 licensed TDD} |  | Yes | N/A |  | Per BC | N/A  (TDD only) | N/A | N/A | Note: this feature applies to cells in the same TAG only  If UE supporting this FG also supports both FGs 6-9 and 6-9a or both FGs 22-7b and 22-7c, the UE supports the cases of both same and different numerologies between switchable cells. Otherwise, the UE supports the case of same numerology between switchable cells | Optional with capability signaling |
| 25. NR\_IIOT\_URLLC\_enh | 25-10c | PUCCH cell switching based on dynamic indication for different length of overlapping PUCCH slots/sub-slots for two PUCCH groups | PUCCH cell switching based on dynamic indication in the DCI scheduling the PUCCH for different length (in physical time) of overlapping PUCCH slots/sub-slots for two PUCCH groups  For the BC, the UE reports one or multiple of supported configuration(s) of {primary PUCCH group config, secondary PUCCH group config} where for each supported configuration,   * The “primary PUCCH group config” includes following information:   + one or multiple carrier type pairs that can support PUCCH cell switch, where the carrier type are selected from {FR1 licensed TDD, FR2 licensed TDD} * The “secondary PUCCH group config” includes following information:   + one or multiple carrier type pairs that can support PUCCH cell switch, where the carrier type are selected from {FR1 licensed TDD, FR2 licensed TDD} |  | Yes | N/A |  | Per BC | N/A  (TDD only) | N/A | N/A | Note: this feature applies to cells in the same TAG only  If UE supporting this FG also supports both FGs 6-9 and 6-9a or both FGs 22-7b and 22-7c, the UE supports the cases of both same and different numerologies between switchable cells. Otherwise, the UE supports the case of same numerology between switchable cells | Optional with capability signaling |

Following views are provided in contributions for the RAN1#110bis-e meeting.

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| [6] | NTT DOCOMO, INC. | A note regarding to PUCCH carrier type need to be added for FGs 25-9, 25-9a, 25-10, 25-10a, 25-10b, and 25-10c. Since carrier type is reported in FGs 6-9/6-9a/22-6/22-6a/22-7/22-7b/22-7c, the reported carrier type should also be addressed for PUCCH cell switching configuration. In other words, UE assumes that carrier/cell in carrier type(s) not reported as support for PUCCH transmission in the PUCCH group is not configured with PUCCH carrier switching.  **Proposal 2-7:**   * **For FGs 25-9, 25-10, 25-10a, add a note that “If UE supporting this FG also supports at least one of FGs 6-9/6-9a/22-6/22-6a/22-7/22-7b/22-7c, PUCCH cell switching can be configured only for cell with numerology (if any) and carrier type (if any) as reported in the FG(s)”.** * **For FGs 25-9a, 25-10b, 25-10c, add a note that “If UE supporting this FG also supports at least one of FGs 6-9/6-9a/22-7/22-7b/22-7c, PUCCH cell switching can be configured only for cell with numerology (if any) and carrier type (if any) as reported in the FG(s)”.** |

In [9], following feedbacks were provided at RAN1#110 meeting.

|  |  |
| --- | --- |
| QC | We are open to discuss this. But so far, we don’t see strong need to tie PUCCH cell switch FG with 6-9/6-9a/22-7/22-7b/22-7c in terms of numerology and carrier type. Anyway, at least the carrier type is included in the components of FGs 25-9a, 25-10b, 25-10c. We are not sure why UE has to rely on the carrier type of 6-9/6-9a/22-7/22-7b/22-7c for report the carrier type for PUCCH cell switch. |
| DOCOMO | Support.  Since carrier type is reported in FGs 6-9/6-9a/22-6/22-6a/22-7/22-7b/22-7c, the reported carrier type should also be addressed for PUCCH cell switching configuration. In other words, UE as-sumes that carrier/cell in carrier type(s) not reported as support for PUCCH transmission in the PUCCH group is not configured with PUCCH carrier switching. |
| Huawei, HiSilicon | It is not necessary since it should be obvious that the cells for PUCCH cell switching can only be the cell with numerology and carrier type as reported in those feature groups. However, we are fine to add these notes if companies want to make it clearer. |

Based on above, following proposals should be discussed at the RAN1#110bis-e meeting.

### **Proposal 2-3:**

* **Companies are encouraged to provide views on whether to add the following note:**
  + ***“If UE supporting this FG also supports at least one of FGs 6-9/6-9a/22-6/22-6a/22-7/22-7b/22-7c, PUCCH cell switching can be configured only for cell with numerology (if any) and carrier type (if any) as reported in the FG(s)”* to FGs 25-9, 25-10, 25-10a.**
  + ***“If UE supporting this FG also supports at least one of FGs 6-9/6-9a/22-7/22-7b/22-7c, PUCCH cell switching can be configured only for cell with numerology (if any) and carrier type (if any) as reported in the FG(s)”* to FGs 25-9a, 25-10b, 25-10c.**

|  |  |
| --- | --- |
| Company | Comment |
| DOCOMO | Support with the reason described above. |
| Huawei, HiSilicon | We are fine to add the note, though it seems not that necessary since it should be obvious that the cells for PUCCH cell switching can only be the cell with numerology and carrier type as reported in those feature groups. |
|  |  |

## **2.4 25-12: UE initiating a semi-static channel occupancy**

In [1], FG 25-12 is captured as below.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 25. NR\_IIOT\_URLLC\_enh | 25-12 | UE initiating a semi-static channel occupancy with configurations dependent on gNB semi-static channel access configurations | [Support initiating a semi-static channel access occupancy by the UE where the corresponding period is the same as, integer multiple of, or inter-factor of the period configured for a semi-static channel occupancy that can be initiated by gNB. ] | 10-1a | Yes | N/A |  | Per band | N/A | N/A | N/A | The signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |

Following views are provided in contributions for the RAN1#110bis-e meeting.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [2] | Huawei, HiSilicon | 1. FG 25-12: Add basic feature components agreed for a UE that can operate as an initiating device in the semi-static channel access mode as follows.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 25. NR\_IIOT\_URLLC\_enh | 25-12 | UE initiating a semi-static channel occupancy with configurations dependent on gNB semi-static channel access configurations | 1. Support initiating a semi-static channel access occupancy by the UE where the corresponding period is the same as, integer multiple of, or inter-factor of the period configured for a semi-static channel occupancy that can be initiated by gNB.  2. Sensing to initiate a semi-static CO or transmit after a gap greater than 16us from any transmission burst within a UE-initiated CO.  3. Determination of COT initiator assumption based on rules for configured UL  4. Validating COT initiator assumption indicated in UL scheduling DCI | 10-1a | Yes | N/A |  | Per band | N/A | N/A | N/A | The signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling | |
| [4] | vivo | **FG 25-12**  For FG 25-12, the following descriptions should also be captured in components column to ensure that a UE can operate as an initiating device in the semi-static channel access mode.   * 9us sensing to initiate a semi-static CO or transmit after a gap greater than 16us from any transmission burst within a UE-initiated CO. * Determination of COT initiator assumption based on rules for configured UL * Validating COT initiator assumption indicated in UL scheduling DCI |
| [6] | NTT DOCOMO, INC. | For FG 25-12, we are fine to confirm the highlighted component and add following components to clarify which features are included in FG 25-12:   * + Component 2: Sensing to initiate a semi-static CO or transmit after a gap greater than 16us from any transmission burst within a UE-initiated CO.   + Component 3: Determination of COT initiator assumption based on rules for configured UL   + Component 4: Validating COT initiator assumption indicated in UL scheduling DCI |
| [8] | Nokia, Nokia Shanghai Bell | * **25-12:** * Confirm the FG components (i.e. remove yellow highlight) |

Based on above, following proposal should be discussed at the RAN1#110bis-e meeting.

### **Proposal 2-4:**

* **Add the following components to FG 25-12:**
  + **Component 2: Sensing to initiate a semi-static CO or transmit after a gap greater than 16us from any transmission burst within a UE-initiated CO**
  + **Component 3: Determination of COT initiator assumption based on rules for configured UL**
  + **Component 4: Validating COT initiator assumption indicated in UL scheduling DCI**

|  |  |
| --- | --- |
| Company | Comment |
| DOCOMO | Fine with the proposal. |
| Huawei, HiSilicon | Support the proposal. |
| Intel | We support the proposal. |

## **2.5 25-16: Intra-UE multiplexing with different priorities**

In [1], FG 25-16 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 25. NR\_IIOT\_URLLC\_enh | 25-16 | HARQ-ACK with different priorities multiplexing on a PUCCH/PUSCH | 1. Support multiplexing a high-priority HARQ-ACK and a low-priority HARQ-ACK into a PUCCH. Support separate coding for the two HARQ-ACKs.  3. Support multiplexing a low-priority HARQ-ACK, a high-priority HARQ-ACK and a high-priority SR into a PUCCH.  4. Support multiplexing a low-priority HARQ-ACK in a high-priority PUSCH (conveying UL-SCH only). Support separate beta\_offset values for this priority combination.  5. Support multiplexing a high-priority HARQ-ACK in a low-priority PUSCH (conveying UL-SCH only). Support separate beta\_offset values for this priority combination.  6. Support multiplexing a low-priority HARQ-ACK, a high-priority PUSCH, a high-priority HARQ-ACK and/or CSI.  7. Support multiplexing a high-priority HARQ-ACK, a low-priority PUSCH, a low-priority HARQ-ACK and/or CSI. | [11-3, 12-1] | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signaling |

Following views are provided in contributions for the RAN1#110bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [2] | Huawei, HiSilicon | 1. Change 11-3 to “11-4 or 11-4a”, as 11-4/11-4a is the UE capability of supporting two HARQ-ACK codebook with different priorities. 2. Delete 12-1 from the prerequisite feature group for FG 25-16. 12-1 is to define prioritization of overlapping channel/signals with two priority levels in physical layer, while 25-17 here is to define multiplexing of overlapping channel/signals with two priority levels in physical layer. There is no need to couple these two capabilities. It also aligns with #capability 1 UE as agreed #107-e meeting. |
| [3] | ZTE | FG 11-4 is for a UE supporting two HARQ-ACK codebooks / PUCCH config, so it is needed as a prerequisite for FG 25-16. |
| [4] | vivo | **FG 25-16**  Since UE feature based on Rel-17 intra-UE multiplexing and Rel-16 intra-UE prioritization can be decoupled, FG 12-1 can be deleted. On the other hand, prerequisite FG 11-3 can be changed as 11-4, i.e. two HARQ-ACK codebooks with different priorities simultaneously constructed.  *Proposal 10: For FG 25-16, prerequisite FG is changed as 11-4 and FG 12-1 can be deleted.* |
| [5] | OPPO | **FG 25-16: Intra-UE multiplexing with different priorities**  Regarding to the prerequisite feature groups for FGs 25-16, FG 11-3 should be changed to FG 11-4 or one of {FG11-4, FG11-4a}. In addition, we prefer to remove FG 12-1 since it is unnecessary to couple Rel-16 intra-UE prioritization capability with Rel-17 intra-UE multiplexing capability. UE may choose to implement FG 25-16, while not to implement 12-1. This is because for a UE capable of intra-UE multiplexing almost no longer needs to perform cancelation between UL channels with different priorities.  ***Proposal 3: For the prerequisite feature groups of FG 25-16: change FG 11-3 to either FG 11-4 or one of {FG11-4, FG11-4a},*** ***and remove 12-1.*** |
| [6] | NTT DOCOMO, INC. | For FG 25-16, prerequisite feature groups can be “one of {FG 11-4, FG 11-4a}” as these are the UE capability of supporting two HARQ-ACK codebooks with different priorities. FGs 11-3 and 12-1 can be removed with the following reasons:   * + FG 11-3: it is not the capability of supporting two HARQ-ACK codebooks with different priorities.   + FG 12-1: it is not related to Rel-17 intra-UE multiplexing, while it is related to Rel-16 dropping/prioritization of different priorities.   **Proposal 2-5: Prerequisite FG is “one of {FG 11-4, FG 11-4a}” for FG 25-12.** |
| [7] | Qualcomm Incorporated | For FG 25-16, 12-1 should not be prerequisite for this FG. FG 12-1 is Rel-16 intra-UE prioritization. FG 25-16 is Rel-17 intra-UE multiplexing. A UE can choose to implement FG 25-16 direclty, without implementing FG 12-1. FGs11-3 and 11-4a are for sub-slot PUCCH transmissions. They are not prerequisite for FG 25-16. The only prerequisite sounds reasonable is 11-4.  ***Proposal 4-2:* Only 11-4 is set as prerequisite for FG 25-16. Remove “[11-3, 12-1]” on prerequisite for FG 25-16.** |
| [8] | Nokia, Nokia Shanghai Bell | * **25-16:** * Confirm the prerequisite FGs (i.e. remove yellow highlight) |

Based on above, following proposals should be discussed at the RAN1#110bis-e meeting.

### **Proposal 2-5:**

* **Apply one of the following alternatives for the prerequisite FGs for FG 25-16:**
  + **Alt.1: one of {11-4, 11-4a} [2, 5, 6]**
  + **Alt.2: FG 11-4 only [3, 4, 5, 7]**
  + **Alt.3: FGs 11-3 and 12-1 [8]**

|  |  |
| --- | --- |
| Company | Comment |
| OPPO | Either Alt-1 or Alt-2, whichever gaining the more supports. Further, it seems Alt-2 can be a subset of Alt-1 (because 11-4 is one of prerequisites of 11-4a). |
| DOCOMO | Support Alt.1.  For other alternatives, we have following comments:   * + Alt.2: FGs 11-4 and 11-4a are the UE capability of supporting two HARQ-ACK codebook with different priorities in our understanding. FG 11-4a should be included in addition to FG 11-4.   + Alt.3: FG 12-1 can be removed as it is not related to Rel-17 intra-UE multiplexing, while it is related to Rel-16 dropping/prioritization of different priorities. In addition, FG 11-3 can be removed as it is not the capability of supporting two HARQ-ACK codebook with different priorities. |
| Huawei, HiSilicon | We support Alt.1, as 11-4/11-4a is the UE capability of supporting two HARQ-ACK codebook with different priorities.  In addition, 12-1 should be removed from the prerequisite feature group for FG 25-16. 12-1 is to define prioritization of overlapping channel/signals with two priority levels in physical layer, while 25-17 here is to define multiplexing of overlapping channel/signals with two priority levels in physical layer. There is no need to couple these two capabilities. It also aligns with #capability 1 UE as agreed #107-e meeting. |
| Intel | We slightly prefer Alt 1. |

## **2.6 25-18: Parallel PUCCH and PUSCH transmission across CCs in inter-band CA**

In [1], FG 25-18 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 25. NR\_IIOT\_URLLC\_enh | 25-18 | Parallel PUCCH and PUSCH transmission across CCs in inter-band CA | Support simultaneous PUCCH and PUSCH transmissions of different priority on different cells for inter-band CA. | FFS | Yes | N/A |  | Per BC | N/A | N/A | N/A |  | Optional with capability signaling |

Following views are provided in contributions for the RAN1#110bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [2] | Huawei, HiSilicon | 1. For FG 25-18, the prerequisite can be FG 6-6 as FG 6-6 is the basic UE capability for supporting UL CA. |
| [4] | vivo | **FG 25-18**  For FG 25-18, basic UL CA capability can be taken as prerequisite, i.e., FG 6-6.  *Proposal 11: For FG 25-18, prerequisite FG 6-6 should be added.* |
| [6] | NTT DOCOMO, INC. | For FG 25-18, we are fine to include FG 6-6 as prerequisite feature group since FG 6-6 is the basic UE capability for supporting UL CA.  **Proposal 2-6: Prerequisite FG is FG 6-6 for FG 25-18.** |
| [7] | Qualcomm Incorporated | For FG 25-18, there is no strong need to set prerequisite for it.  ***Proposal 4-2:* No prerequisite is set for FG 25-18. Remove the FFS on prerequisite for FG 25-18.** |
| [8] | Nokia, Nokia Shanghai Bell | * **25-18:** * Pre-requisite feature groups: 6-6 (UL CA), 11-3, 12-1 |

Based on above, following proposals should be discussed at the RAN1#110bis-e meeting.

### **Proposal 2-6:**

* **Apply one of the following alternatives for the prerequisite FG for FG 25-18:**
  + **Alt.1: FG 6-6 [2, 4, 6]**
  + **Alt.2: No prerequisite FG is needed [7]**
  + **Alt.3: FGs 6-6, 11-3, and 12-1 [8]**

|  |  |
| --- | --- |
| Company | Comment |
| DOCOMO | Alt.1.  For FG 11-3, it is not clear why sub-slot based HARQ-ACK PUCCH feature has dependency with FG 25-18.  For FG 12-1, it should be unnecessary. FG 25-18 is applicable jointly with Rel-17 intra-UE multiplexing (i.e., FG 25-16), but it should be common understanding that FGs 12-1 and 25-16 cannot be applicable together. If FG 12-1 is a prerequisite FG for FG 25-18, joint operation of FGs 25-16 and 25-18 is not allowed. |
| Huawei, HiSilicon | Alt.1.  Fine with FG 6-6 as the prerequisite FGs for FG 25-18 as FG 6-6 is the basic UE capability for supporting UL CA. |
| Intel | We prefer Alt -1. |

## **2.7 25-19a: Propagation delay compensation**

In [1], FG 25-19a is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 25. NR\_IIOT\_URLLC\_enh | 25-19a | RTT-based Propagation delay compensation based on DL PRS for RTT-based PDC and SRS | 1. Support RTT-based Propagation delay compensation for time synchronization of the Uu interface based on DL PRS and SRS  2. Max number of DL PRS Resources in DL PRS Resource Set for PDC  Values = {1, 2, 4, 8, 16, 32, 64}  Note: 16, 32, 64 are only applicable to FR2 bands  3. Max number of DL PRS resources that UE can process in a slot.  a) FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHz  b) FR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHz | 2-53 | Yes | N/A |  | Per FS | N/A | N/A | N/A |  | Optional with capability signaling |

Following views are provided in contributions for the RAN1#110bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [3] | ZTE | In RAN1#110, there was discussion on whether to introduce a component of maximum DL PRS bandwidth for PDC for FG 25-19a. The proponents believed there may be incorrect performance prediction when PDC and positioning share the same PRS. The reason is that the PRS is configured by the LMF and the gNB does not know the exact bandwidth for PRS received by the UE. In positioning, PRS configuration is delivered by LMF. Actually, the PRS configuration is still configured by the gNB. The LMF just gathers all the PRS configuration from multiple gNBs and transmits the configurations to the UE. It means that the gNB can be aware of the receiving bandwidth at UE side. In addition, it was agreed that only the serving cell transmits the PRS and the UE is not expected to measure DL PRS outside the active BWP. In this case, the network just follow the maximum bandwidth reported for the serving cell. Therefore, the report of maximum DL PRS bandwidth is not needed for PDC.  ***Proposal 2:*** *Maximum DL PRS bandwidth in MHz should not be supported and reported by UE.*  It was agreed that PRS can be the spatial relation RS for SRS for PDC. Supporting PDC-PRS for UE-side RTT measurement does not mean the UE should support PDC-PRS as spatial relation RS for PDC-SRS. So using PDC-PRS as spatial relation source of SRS should be identified as a UE capability. It can be added as a component for FG 25-19a  ***Proposal 3:*** *Spatial relation for SRS for PDC based on PRS for PDC from the serving cell can be considered as a component of FG 25-19a.* |
| [5] | OPPO | **FG 25-19a: RTT-based PDC based on DL-PRS and SRS**  One pending issue is about the feature of PDC-PRS as spatial relation RS of PDC-SRS, which RAN1 agreed to discuss in UE feature session. It should be noted that the current TS 38.822 lists the spatial relation between positioning PRS and positioning SRS as a separate FG (FG 13-10b) for FR-2 only. It is also assumed in RAN1 PDC discussion that the benefit of such spatial relation for PDC is also mainly for FR-2.  ***Proposal 4: Adopt either of the following two options.***   * ***Option-1: Add “Spatial relation for SRS for PDC based on PRS for PDC from the serving cell” as a new FG other than FG25-19a, with “N/A (FR2 only)” for FR1/FR2 differentiation.*** * ***Option-2: Add “Spatial relation for SRS for PDC based on PRS for PDC from the serving cell. FR2 only.” as a new component to FG25-19a, and set “FR1/FR2 differentiation” of FG25-19a to “N/A”.*** |

In [9], following feedbacks were provided at RAN1#110 meeting.

|  |  |
| --- | --- |
| OPPO | In our view, taking PRS as spatial relation source signal is a different UE implementation task from taking the PRS as timing reference signal. Supporting PDC-PRS for UE-side RTT measurement does not mean the UE has to support PDC-PRS as spatial relation RS for PDC-SRS. So using PDC-PRS as spatial relation source of SRS should be a UE capability.  Between a new FG and a new component in FG25-19a, either way can work, but with a difference on how to indicate spatial relation as a FR2-only feature (if it is agreed to be FR2 only). Note that, most of, if not all, existing spatial-relation related UE features are FR2-only. We are ok to either of the following, as given in our contribution:   * ***Option-1: Add “Spatial relation for SRS for PDC based on PRS for PDC from the serving cell” as a new FG other than FG25-19a, with “N/A (FR2 only)” for FR1/FR2 differentiation.*** * ***Option-2: Add “Spatial relation for SRS for PDC based on PRS for PDC from the serving cell. FR2 only.” as a new component to FG25-19a, and set “FR1/FR2 differentiation” of FG25-19a to “N/A”.*** |
| DOCOMO | Fine to add a new component for support of PRS as spatial relation RS of SRS. |
| ZTE | Can be a component of FG 25-19a. |
| Nokia, NSB | Adding new components require clear justification at this stage, and we don’t see a strong nee for now. |
| Qualcomm | This is an FR2-only feature, we support to add it, and prefer Option 1(as a new FG) |
| Huawei, HiSilicon | We think have this reporting as a component (e.g. shown below) in FG 25-19a should be sufficient. However, we are open to introduce an additional FG also if companies prefer that way  4. Support of DL PRS as the spatial relation reference signal for period SRS  Candidate value for the component: {"yes", "no"} |

Based on above, following proposals should be discussed at the RAN1#110bis-e meeting.

### **Proposal 2-7:**

* **Companies are encouraged to provide views on whether to add new FG or component for support of PRS as spatial relation RS of SRS.**

|  |  |
| --- | --- |
| Company | Comment |
| OPPO | We prefer adding a new FG, because this feature should be for FR2 only while FG 25-19a does not differentiate FR1 and FR2. Meanwhile, we can also accept adding it as a component with explicit description that the component is for bands in FR2 only. |
| DOCOMO | We slightly prefer to add it as a new component with the explicit description that it is only for FR2 band. However, we are open to introduce it as a new FG if majority companies think it is more reasonable. |
| Huawei, HiSilicon | We think have this reporting as a component (e.g. shown below) in FG 25-19a should be sufficient. In addition, since now we agreed to adopt “per FS” as the reporting granularity for FG 25-19a already, then in theory UE can already do the differentiated reporting for FR1 and FR2.  4. Support of DL PRS as the spatial relation reference signal for period SRS  Candidate value for the component: {"yes", "no"} |
|  |  |

# **Conclusions**

TBD

# **References**

[1] R1-2207923 Updated RAN1 UE features list for Rel-17 NR after RAN1 #110 Thursday Moderators (AT&T, NTT DOCOMO, INC.)

[2] R1-2208461 Remaining issues for UE features set 1 topics Huawei, HiSilicon

[3] R1-2208530 Discussion on UE features for topics 1 ZTE

[4] R1-2208622 Remaining issues on UE features for MBS, Coeverage enhancement and URLLC vivo

[5] R1-2208868 Discussion on UE features (Topic-1) OPPO

[6] R1-2209886 Discussion on remaining issues regarding Rel-17 RAN1 UE features topics 1 NTT DOCOMO, INC.

[7] R1-2209963 Discussion on Rel-17 UE features topic 1 Qualcomm Incorporated

[8] R1-2210098 Remaining issues for UE features topics 1 Nokia, Nokia Shanghai Bell

[9] R1-2208114 Summary#3 on UE features for enhanced IIoT and URLLC Moderator (NTT DOCOMO, INC.)