**3GPP TSG RAN WG1 #100bis-e R1-20xxxxx**

e-Meeting, April 20th – 30th, 2020

Source: NTT DOCOMO, INC.

Title: Summary on Email discussion [100b-e-NR-UEFeatures-NRU-03]

Agenda Item: 7.2.11.2

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

# **Introduction**

This contribution summarizes the following email discussion in AI 7.2.11.2 regarding UE features for NR-U.

[100b-e-NR-UEFeatures-NRU-03] Email discussion/approval on feature groups structure related to DL+UL operation for NR-U (20th-24th April) – (DCM, Hiroki)

* Discuss on followings regarding 10-3 to 10-3b and [10-12]
  + Whether or not 10-3/10-3a/10-3b/10-3c can be combined into a single FG
  + Whether or not 10-12 can be combined into 10-3b/10-3c
    - If not, whether or not 10-12 can be split for PF2 and PF3 separately
* Discuss whether or not 10-13a is needed as a FG
* Discuss whether or not 10-18/10-24/10-28 can be combined into a single FG
* Discuss whether or not following update can be applied

|  |  |  |
| --- | --- | --- |
| 10-21a | Support using ED threshold for UL to DL COT sharing | 1. Use ULtoDL-CO-SharingED-Threshold-r16 for cat 4 LBT for scheduled UL to share COT with gNB for DL  2. Use ULtoDL-CO-SharingED-Threshold-r16 for cat 4 LBT for CG-PUSCH to share COT with gNB for DL  3. Indicate in CG-UCI the COT sharing information |
| 10-21b | Support UL to DL COT sharing | 1. Support cat 4 LBT for scheduled UL to share COT with gNB for DL without ULtoDL-CO-SharingED-Threshold-r16  2. Support cat 4 LBT for CG-PUSCH to share COT with gNB for DL without ULtoDL-CO-SharingED-Threshold-r16  3. Indicate in CG-UCI the COT sharing information |

* Discuss whether or not 10-22 is needed

# **10-3 to 10-3c and [10-12]: PRB interlace mapping for PUSCH and PUCCH**

In [1], FGs 10-3 to 10-3c are captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 10. NR-unlicensed | 10-3 | PRB interlace mapping for PUSCH | 1. PRB interlace frequency domain resource allocation for PUSCH | 10-1 or 10-2  Need discussion for licensed use | Yes | N/A |  | Per band | N/A | N/A |  | Support of PRB interlace PUSCH | Optional with capability signalling |
| 10-3a | PRB interlace mapping for PUCCH format 0 and format 1 | 1. PRB interlace frequency domain resource allocation for PUCCH format 0 and format 1 | 10-1 or 10-2  Need discussion for licensed use | Yes | N/A |  | Per band | N/A | N/A |  | Support of PRB interlace PUCCH format 0/1 | Optional with capability signalling |
| 10-3b | PRB interlace mapping for PUCCH format 2 | 1. PRB interlace frequency domain resource allocation for PUCCH format 2 | 10-1 or 10-2  Need discussion for licensed use | Yes | N/A |  | Per band | N/A | N/A |  | Support of PRB interlace PUCCH format 2 | Optional with capability signalling |
| 10-3c | PRB interlace mapping for PUCCH format 3 | 1. PRB interlace frequency domain resource allocation for PUCCH format 3 | 10-1 or 10-2  Need discussion for licensed use | Yes | N/A |  | Per band | N/A | N/A |  | Support of PRB interlace PUCCH format 3 | Optional with capability signalling |
|  | 10-12 | OCC for PRB interlace mapping for PF2 and PF3  FFS if need this capability, or if we split this for PF2 and PF3 separately | 1. OCC2  2. OCC4 | 10-3b or 10-3c | Yes | N/A |  | Per band | N/A | N/A |  | UE OCC capability for EPF2/EFP3 | Optional with capability signalling |

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

|  |  |  |
| --- | --- | --- |
| [2] | ZTE, Sanechips | There has been various enhancements made in NR-U WI on different aspects based on Rel-15 NR design. For the enhancements on the same aspect, it may not be a good way to split the features into too many small pieces and make all of them as optional. It would be hard for network to implement and utilize a meaningful Rel-16 functionality if different UEs support drastically different combinations of feature groups for one aspect.  For example for the interlace structure, currently there are 4 optional feature groups defined for PUSCH and each of the PUCCH formats respectively, which implies one UE may support interlaced PUSCH but not support interlaced PUCCH, or vice versa. This is not necessary, as in the RRC signalling there is only one parameter to just indicate whether the interlaced structure is enabled or not. Therefore, it would be better to merge them into one feature group. Similar principle can be applied to the enhancements on HARQ and configured grant.  ***Proposal 2:***   * ***To avoid implementation complexity, the enhancements on the same aspect should be combined into one feature group, including the following:***   + ***Interlaced structure: combine 10-3, 10-3a, 10-3b, and 10-3c***   + ***HARQ enhancement: combine 10-14, 10-15, 10-16, 10-16a, and 10-17***   + ***Configured grant: combine 10-18 and 10-28*** * Interlaced mapping including FG 10-3/3a/3b/3c.   The interlaced mapping is proposed to simplify the signalling of the FDRA of interlace in order to satisfy the OCB requirement from ESTI. There is no such OCB requirement for NR licensed spectrum, so we do not think there is a need to extend the application range for this feature. |
| [3] | vivo | For interlace UL related features (10-3, 10-3a, 10-3b, 10-3c), we do not see the need of extension to licensed band since interlace is introduced due to regulatory requirement on unlicensed band which doesn’t exist in licensed band.  Proposal 1: Interlace UL related features (10-3, 10-3a, 10-3b, 10-3c) should be limited to unlicensed band only and SS group switching related features (10-9, 10-9a, 10-9b) could be extended to licensed use. |
| [4] | OPPO | **FG 10-3b/12**: In Rel-15, UE capability of supporting PUCCH format 2, 3, 4 are separately reported. To analog with Rel-15, in NRU, enhanced PF2 and PF3 should also be separated in two FGs. Moreover, we should further discuss if OCC is an additional add-on capability. To our understanding, the OCC is not mandatory for supporting PF2 or PF3. Thus, it should be allowed that a UE supports PF2/PF3 without supporting OCC.   |  |  |  | | --- | --- | --- | | 10-3b | PRB interlace mapping for PUCCH format 2 | 1. PRB interlace frequency domain resource allocation for PUCCH format 2 | | 10-3~~b~~c | PRB interlace mapping for PUCCH format 3 | 1. PRB interlace frequency domain resource allocation for PUCCH format 3 | | ~~10-12~~ | ~~OCC for PRB interlace mapping for PF2 and PF3~~  ~~FFS if need this capability, or if we split this for PF2 and PF3 separately~~ | ~~1. OCC2~~  ~~2. OCC4~~ | | 10-12 | OCC for PRB interlace mapping for EPF2  FFS if need this capability | 1. OCC2  2. OCC4 | | 10-12a | OCC for PRB interlace mapping for EPF3  FFS if need this capability | 1. OCC2  2. OCC4 |   **Proposal 2: Separate OCC capability from PUCCH format 2 or format 3 with interlace mapping.** |
| [5] | MediaTek Inc. | Proposal 1: NR-U features can only be extended to licensed operation when uses cases and benefits are well justified. |
| [7] | Intel Corporation | Interlace design is a fundamental feature for uplink transmission in order to be complaint with the unlicensed band regulation. Also based on the agreement below (first two agreements), a gNB can configure the interlaced mapping for the whole cell both for PUCCH and PUSCH. From this perspective, it is proposed to merge the “PRB interlace frequency domain resource allocation” into 10-1 and 10-2.  Even though it is separately defined, it is proposed to combine 10-3/10-3a/10-3b/10-3c into a single feature group. This is because if interlace mapping is used for one PUCCH format, then other PUCCH formats also have to use interlace mapping based on the 3rd agreement below. However, we do not need to use the interlace mapping for licensed use since there is no reason for it.   |  | | --- | | Agreement:  In Rel-16, for a cell, the UE can expect that cell-specifically configured PUCCH resources and UE-specifically configured PUCCH resources either all have interlaced mapping or all have non-interlaced mapping as per Rel-15.   * Note: RRC parameters that are made redundant due to this agreement can be eliminated   Agreement:  In Rel-16, for a cell, the UE can expect that cell-specifically configured PUSCH resources and UE-specifically configured PUSCH resources either all have interlaced mapping or all have non-interlaced mapping as per Rel-15.   * Note: RRC parameters that are made redundant due to this agreement can be eliminated   Agreement:  In Rel-16, for a cell, the UE can expect that UE-specifically configured PUCCH resources and all PUSCH transmissions (scheduled and configured) after dedicated configurations either all have interlaced mapping or all have non-interlaced mapping as per Rel-15. |   **Proposal 3:**   * **Merge 10-3/10-3a/10-3b/10-3c into 10-1 and 10-2.** * **If not merged, combine 10-3/10-3a/10-3b/10-3c into a single feature group and remove “Need discussion for licensed use”.** |
| [8] | Ericsson | We understand that for DL only LAA deployments it is not necessary for the UE to support interlaced PUCCH, hence it makes sense to split the UE capability for interlacing into separate FGs, one for PUSCH and one for PUCCH. However, it is undesirable to further split the capability for interlaced PUCCH into 3 separate FGs for PF0/1, PF2, and PF3. This results in too fine grained capability signaling.   1. Merge FG 10-3a/b/c for PUCCH into a single FG. Keep FG 10-3 for PUSCH as a separate FG.   Regarding the FFS, in our view this capability should be kept, but it is not necessary to split into separate capabilities for PF2 and PF3   1. Keep FG-12; do not split into separate capabilities for PUCCH Format 2 and PUCCH Format 3 |
| [9] | Samsung | NR-U functions have been introduced to handle inherit problem of unlicensed band such as LBT failure and regulation. Hence, in our view, except FG-8 and FG-11 which are general function for licensed band, applicability of NR-U feature groups should be restricted to unlicensed band. If some of NR-U feature groups are identified to be beneficial for licensed band operation, we will be able to make an agreement for each.  Proposal 2: UE features for NR-U should be used only for unlicensed band. |
| [12] | Nokia, Nokia Shanghai Bell | * 10-3a/3b/3c: to be merged as a single feature group as originally proposed. If interlace is required it is required for all formats. * 10-12: It should be combined with 10-3a/b/c (PUCCH component). |
| [13] | Qualcomm Incorporated | |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 10-12 | OCC for PRB interlace mapping for PF2 and PF3 | 1. OCC2  2. OCC4 | 10-3b or 10-3c | Yes | N/A |  | Per band | N/A | N/A |  | UE OCC capability for EPF2/EFP3 | Optional with capability signalling | |
| [14] | Huawei, HiSilicon | |  |  |  | | --- | --- | --- | | Functionality | FGs | Need for licensed band operation | | PRB interlace mapping for PUSCH and PUCCH | 10-3 PRB interlace mapping for PUSCH  10-3a PRB interlace mapping for PUCCH format 0 and format 1  10-3b PRB interlace mapping for PUCCH format 2  10-3c PRB interlace mapping for PUCCH format 3 | Per band  There is no clear benefit for a UE to support those features for licensed bands at the cost of extra complexity at the UE and with increased complexity for multiplexing UEs with different uplink capabilities | |

## 2.1 Discussion 1

**Companies are encouraged to provide views on whether or not 10-3/10-3a/10-3b/10-3c can be combined into a single FG.**

**Combining them into a single FG supported by: NTT DOCOMO, Huawei, HiSilicon, Nokia, NSB (for 10-3a/b/c), Qualcomm (for 10-3a/b/c), Intel, Samsung (for 10-3a/b/c), ZTE**

**Objected (i.e., keeping them as separated FGs) by: vivo, MediaTek, Nokia, NSB (for 10-3), LG Electronics,**

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | We prefer to combine them into a single FG |
| vivo | Keeping them as separate FG. At least interlaced PUCCH and PUSCH should be separate since DL only LAA scenario doesn’t need to support interlaced PUCCH. For PUCCH, it is preferred to separate them into small payload and large payload formats, i.e. EPF0&1 and EPF2&3. So we are OK to combine 10-3b and 10-3c. |
| Nokia, NSB | We prefer to combine 10-3a/b/c into a single FG, but keep 10-3 separate as in some deployment scenarios the UE is not required to support PUCCH in unlicensed carrier. |
| Qualcomm | We are fine with combining 3a/3b/3c |
| LG Electronics | Prefer to keep them as the separated FGs. |
| MediaTek | We prefer to keep them separate. |
| Intel | We prefer to combine them into a single FG |
| Samsung | We are ok to combine 3a/3b/3c. |
| ZTE | Should be combined as there is only one RRC parameter to just indicate whether the interlaced structure is enabled or not |

**FL proposal:**

* FG10-3 is kept for “PRB interlace mapping for PUSCH”
* Combine 10-3a, 10-3b, and 10-3c into a single FG for “PRB interlace mapping for PUCCH”

## 2.2 Discussion 2

**Companies are encouraged to provide views on whether or not 10-12 can be combined into 10-3b/10-3c.**

**Combining them supported by: NTT DOCOMO, MediaTek, Nokia, NSB, Qualcomm, Intel, Samsung, ZTE**

**Objected (i.e., keeping them as separated FGs) by: Huawei, HiSilicon, vivo**

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | We prefer to combine 10-12 into 10-3b/10-3c, which can be further combined into a single FG |
| vivo | Keep as separated FG. |
| Nokia, NSB | We prefer to combine 10-12 into 10-3b/c. |
| Qualcomm | We are fine to combine 10-12 into 10-3b/3c |
| LG Electronics | Prefer to combine them by adding OCC into each of 10-3b and 10-3c. |
| MediaTek | We are fine with merging 10-12 to 10-3b/10-3c. |
| Intel | We prefer to combine them. |
| Samsung | We are ok to combine them |
| ZTE | We prefer to combine them |

**FL proposal:**

* Combine 10-12 into the FG combining 10-3a, 10-3b, and 10-3c

## 2.3 Discussion 3

**If 10-12 and 10-3b/3c are not combined, companies are encouraged to provide views on whether or not 10-12 can be split for PF2 and PF3 separately.**

**Further splitting 10-12 supported by:**

**Objected (i.e., not splitting 10-12) by: NTT DOCOMO**

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | We prefer not splitting 10-12 for PF2 and PF3 |
| Huawei, HiSilicon | We prefer not splitting 10-12 especially if 10-3b/10-3c are combined |
| vivo | Not splitting |
| Nokia, NSB | We prefer to have 10-3b/c combined, but if that is not agreeable we would still prefer to avoid splitting 10-12. |
| Qualcomm | We are fine not to split |
| MediaTek | We are fine with no splitting. |
| Intel | We prefer not to split it. |
| Samsung | We have a preference on no splitting |
| ZTE | We prefer not to split |

No further discussion is necessary

# **[10-13a]: Extended CP range of more than one symbol for CG-PUSCH**

In [1], FG 10-13a is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 10. NR-unlicensed | 10-13a | Extended CP range of more than one symbol for CG-PUSCH  FFS if need this capability |  | 10-1,  Do we need this for 10-2?  5-19 or 5-20 | Yes | N/A |  | Per band | N/A | N/A |  | How long a UE can generate the CP extension beyond 1 symbol for CG-PUSCH | Optional with capability signalling |

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

|  |  |  |
| --- | --- | --- |
| [4] | OPPO | **FG 10-13a**: during RAN1 discussion, there is no agreement that the CP extension for CG transmission could be more than one symbol. It is also unclear to us that which case needs to transmit CP extension with more than one symbol instead of transmitting the effective data. Our view is to remove this UE feature group.  **Proposal 3: Remove 10-13a from the NRU UE feature lists due to lack of agreement and motivation.** |
| [6] | LG Electronics | While we have discussed CG-PUSCH so far, any behaviour for CG-PUSCH is not differentiated between FBE and LBE cases. Therefore, if FG 10-13a is kept as a feature group, the prerequisite feature groups for this should be 10-2 in addition to 10-1.  **Proposal #2: Add 10-2 as prerequisite feature group for FG 10-13a, if FG 10-13a is needed as a feature group.** |
| [13] | Qualcomm Incorporated | |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 10-13a | Extended CP range of more than one symbol for CG-PUSCH | 1. UE supports generating a CP extension of length longer than 1 symbol for Configured Grant PUSCH transmission | 10-1,  5-19 or 5-20 | Yes | N/A |  | Per band | N/A | N/A |  | How long a UE can generate the CP extension beyond 1 symbol for CG-PUSCH | Optional with capability signalling | |

## 3.1 (Finished) Discussion 4

**Companies are encouraged to provide views on whether or not 10-13a is needed.**

**Keeping it (removing bracket) supported by: NTT DOCOMO, Huawei, HiSilicon, vivo, Qualcomm, LG Electronics, MediaTek, Intel, Samsung**

**Objected (i.e., removing it) by: Nokia, NSB (combined with 10-18), ZTE (combined with 10-18),**

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | Based on the agreement as below, the CP extension value can be longer than symbol duration. We are OK to remove the FFS.  Agreement #98bis:  The starting time offset applied by a UE at the beginning of a transmitted burst with a CG resource at the start of the transmission burst, is RRC configured and defined as the length of a CP extension of the first symbol that is located before the configured resource  • Regardless of SCS, the CP extension is up to 72 micro seconds with a granularity of 9 micro seconds |
| Huawei, HiSilicon | If it is deleted then it would be missing from the UE capabilities of NR-U |
| vivo | We prefer to keep it |
| Nokia, NSB | It should be combined with 10-18. |
| Qualcomm | We prefer to keep it |
| LG Electronics | We support to keep FG10-13a as a feature group. |
| MediaTek | We are fine with keeping this FG. |
| Intel | We prefer to keep it |
| Samsung | We prefer to keep it |
| ZTE | We share the similar view as Nokia. |

**FL proposal:**

* FG10-13a is kept for “Extended CP range of more than one symbol for CG-PUSCH”

# **10-18, 10-24 and 10-28: Configured grant enhancements**

In [1], FGs 10-18, 10-24 and 10-28 are captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 10. NR-unlicensed | 10-18 | Configured grant with retransmission in CG resources | 1. Support retransmission in CG resources  2. Support configured grant retransmission timer  3. Support DFI monitoring  4. Support CG-UCI in CG-PUSCH | 10-1 or 10-2,  5-19 or 5-20  Need discussion for licensed use | Yes | N/A |  | Per band | N/A | N/A |  | Support configured grant with retransmission in configured grant resource | Optional with capability signalling |
|  | 10-24 | CG-UCI multiplexing with HARQ ACK | 1. Support multiplexing CG-UCI with HARQ ACK | 10-18,  5-19 or 5-20  Need discussion for licensed use | Yes | N/A |  | Per band | N/A | N/A |  |  | Optional with capability signalling |
|  | 10-28 | Configured grant with Rel-16 enhanced resource configuration | 1. Support configuration of resources with cg-nrofSlots-r16 and cg-nrofPUSCH-InSlot-r16, | 10-18  5-19 or 5-20 | Yes | N/A |  | FFS Per band or Per UE | N/A | N/A |  |  | Optional with capability signalling |

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

|  |  |  |
| --- | --- | --- |
| [2] | ZTE, Sanechips | There has been various enhancements made in NR-U WI on different aspects based on Rel-15 NR design. For the enhancements on the same aspect, it may not be a good way to split the features into too many small pieces and make all of them as optional. It would be hard for network to implement and utilize a meaningful Rel-16 functionality if different UEs support drastically different combinations of feature groups for one aspect.  For example for the interlace structure, currently there are 4 optional feature groups defined for PUSCH and each of the PUCCH formats respectively, which implies one UE may support interlaced PUSCH but not support interlaced PUCCH, or vice versa. This is not necessary, as in the RRC signalling there is only one parameter to just indicate whether the interlaced structure is enabled or not. Therefore, it would be better to merge them into one feature group. Similar principle can be applied to the enhancements on HARQ and configured grant.  ***Proposal 2:***   * ***To avoid implementation complexity, the enhancements on the same aspect should be combined into one feature group, including the following:***   + ***Interlaced structure: combine 10-3, 10-3a, 10-3b, and 10-3c***   + ***HARQ enhancement: combine 10-14, 10-15, 10-16, 10-16a, and 10-17***   + ***Configured grant: combine 10-18 and 10-28*** * CG enhancement: FG 10-18 and 10-24.   The enhancement on the configured grant, for example the CG-UCI and retransmission on CG resources have been discussed in Rel-15, but not agreed at that moment. And then in Rel-16 URLLC WI, the configured grant has been enhanced with different approaches. If the enhancements in NR-U are applied to licensed spectrum, there will be two ways to do configured grant which are not compatible. It is not clear on the configurations and UE behavior for the operation of configured grant. So we think the CG enhancement shall not be applied to licensed spectrum at least in Rel-16. We can further discuss how to optimize the URLLC for NR-U in Rel-17. |
| [3] | vivo | For other UE features, the extension to licensed band could be considered if the benefit is identified in certain licensed scenario.  **Proposal 2: For UE features that are not agreed to be extended to licensed use, update “per band” to “per unlicensed band”.**  On **10-24/28 (***CG-UCI multiplexing with HARQ ACK* and *Configured grant with Rel-16 enhanced resource configuration*), we propose to remove the prerequisite 10-18 (*retransmission on CG resource*) as 10-18 is not essentially needed in all the cases for enhanced configured grant in NRU.  **Proposal 8: Remove the prerequisite 10-18 for 10-24/28.** |
| [4] | OPPO | **FG 10-28**: this FG is about the UE capability of supporting CG resource configuration. Moreover, there is a chicken-egg problem with FG 10-18. In our view, FG 10-28 is the pre-requisite FG for FG 10-18. Regarding repetition, in the rapporteur’s note, the CG repetition capability is already covered in Rel-15, but this should be clarified that the Rel-15 CG repetition is different from NRU CG repetition, for example, UE may select the first transmission occasion according to the CG resources and RV by itself in NRU. In this case, the CG dedicated feature should be additionally implemented, which is difficultly bundled with Rel-15 FG. It would be naturally possible that a UE supports Rel-15 CG repetition but not support NRU CG repetition. We would suggest that dedicated FG should be added to reflect this particular capability.   |  |  |  | | --- | --- | --- | | 10-18 | Configured grant with retransmission in CG resources | 1. Support retransmission in CG resources  2. Support configured grant retransmission timer  ~~3. Support DFI monitoring~~  ~~4. Support CG-UCI in CG-PUSCH~~ | | 10-28 | Configured grant with Rel-16 enhanced resource configuration | 1. Support configuration of resources with cg-nrofSlots-r16 and cg-nrofPUSCH-InSlot-r16~~,~~  2. Support DFI monitoring  3. Support CG-UCI in CG-PUSCH | | 10-28a | Configured grant repetition | 1. Support CG repetition  2. Support UE selected first transmission occasion and RV |   **Proposal 7: Move DFI monitoring and CG-UCI transmission from feature group 10-18 to 10-28.**  **Proposal 8: Introduce a feature group to support configured grant repetition in NRU.** |
| [5] | MediaTek Inc. | Proposal 1: NR-U features can only be extended to licensed operation when uses cases and benefits are well justified. |
| [8] | Ericsson | This feature should not have feature group 10-18 as a pre-requisite since the enhancement of resource configuration is also applicable to CG without the functionalities in 10-18.   1. For FG 10-28 remove the pre-requisite 10-18 |
| [9] | Samsung | NR-U functions have been introduced to handle inherit problem of unlicensed band such as LBT failure and regulation. Hence, in our view, except FG-8 and FG-11 which are general function for licensed band, applicability of NR-U feature groups should be restricted to unlicensed band. If some of NR-U feature groups are identified to be beneficial for licensed band operation, we will be able to make an agreement for each.  **Proposal 2: UE features for NR-U should be used only for unlicensed band.** |
| [13] | Qualcomm Incorporated | 10-28: Need discussion on if 10-18 is a prerequisite |
| [14] | Huawei, HiSilicon | |  |  |  | | --- | --- | --- | | Functionality | FGs | Need for licensed band operation | | CG with retransmission in CG resources | 10-18 Configured grant with retransmission in CG resources  10-24 CG-UCI multiplexing with HARQ ACK  10-28 Configured grant with Rel-16 enhanced resource configuration | Per band  The flexibility was introduced considering potential LBT failure in unlicensed band. No strong motivation to have it in licensed band. CG in licensed band is usually for URLLC and multiplexing of CG-UCI in CG-PUSCH might cause reliability issue. It might not be compatible with CG in Rel-15/16 in licensed band because UE will assume ACK when no NDI toggle is detected. | |

## 4.1 Discussion 5

**Companies are encouraged to provide views on whether or not 10-18/24/28 can be combined into a single FG.**

**Combining them into a single FG supported by: NTT DOCOMO (for 10-18 and 10-24), Huawei, HiSilicon, Nokia, NSB (for 10-18 and 10-28), Samsung (for 10-18 and 10-24), ZTE (for 10-18 and 10-28)**

**Objected (i.e., keeping them as separated FGs) by: NTT DOCOMO (for 10-28), vivo, MediaTek, Nokia, NSB (for 10-24), Qualcomm, LG Electronics, Intel,**

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | We prefer to combine 10-18 and 10-24 while 10-28 can be a separate FG since 10-28 can work without 10-18 or 10-24 |
| vivo | **Remove the prerequisite 10-18 for 10-24/28 and keep them as seperate** |
| Nokia, NSB | 10-24 can be a separate capability, but 10-28 should be combined with 10-18. |
| Qualcomm | We are fine to keep them separate, but in that case, need to discussion how to use 10-28 without 10-18 |
| LG Electronics | Prefer to keep them as separated FGs |
| MediaTek | We are fine with merging 10-24 into 10-18. However, for 10-28, it is for a different functionality than 10-18, and hence it should be kept as a separate FG. |
| Intel | We prefer to keep them separate |
| Samsung | We prefer to combine 10-18 and 10-24 into a single FG. |
| ZTE | We prefer to combine 10-18 and 10-28. |

**FL proposal:**

* Further discuss whether or not 10-18/24/28 or some of them are combined into a single FG

# **10-21: Support using ED threshold for UL to DL COT sharing**

In [1], FG 10-21 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 10. NR-unlicensed | 10-21 | Support using ED threshold for UL to DL COT sharing | 1. Use ULtoDL-CO-SharingED-Threshold-r16 for cat 4 LBT for scheduled UL to share COT with gNB for DL  2. Use ULtoDL-CO-SharingED-Threshold-r16 for cat 4 LBT for CG-PUSCH to share COT with gNB for DL  3. Indicate in CG-UCI the COT sharing information as configured in cg-COT-Sharing-r16 | 10-1 | Yes | N/A |  | Per band | N/A | N/A |  |  | Optional with capability signalling |

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

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [4] | OPPO | **FG 10-21**: In our view whether or not the ULtoDL-CO-SharingED-Threshold-r16 is provided, the CG-UCI indication fields will be implemented differently. And either way can support the COT sharing function. In this case, the UE should be allowed to report which one is supported.   |  |  |  | | --- | --- | --- | | 10-21a | Support using ED threshold for UL to DL COT sharing | 1. Use ULtoDL-CO-SharingED-Threshold-r16 for cat 4 LBT for scheduled UL to share COT with gNB for DL  2. Use ULtoDL-CO-SharingED-Threshold-r16 for cat 4 LBT for CG-PUSCH to share COT with gNB for DL  3. Indicate in CG-UCI the COT sharing information | | 10-21b | Support UL to DL COT sharing | 1. Support cat 4 LBT for scheduled UL to share COT with gNB for DL without ULtoDL-CO-SharingED-Threshold-r16  2. Support cat 4 LBT for CG-PUSCH to share COT with gNB for DL without ULtoDL-CO-SharingED-Threshold-r16  3. Indicate in CG-UCI the COT sharing information |   **Proposal 6: Introduce a feature group to support UL to DL COT sharing without using ED.** |

## 5.1 Discussion 6

**Companies are encouraged to provide views on whether or not following update can be applied**

|  |  |  |
| --- | --- | --- |
| 10-21a | Support using ED threshold for UL to DL COT sharing | 1. Use ULtoDL-CO-SharingED-Threshold-r16 for cat 4 LBT for scheduled UL to share COT with gNB for DL  2. Use ULtoDL-CO-SharingED-Threshold-r16 for cat 4 LBT for CG-PUSCH to share COT with gNB for DL  3. Indicate in CG-UCI the COT sharing information |
| 10-21b | Support UL to DL COT sharing | 1. Support cat 4 LBT for scheduled UL to share COT with gNB for DL without ULtoDL-CO-SharingED-Threshold-r16  2. Support cat 4 LBT for CG-PUSCH to share COT with gNB for DL without ULtoDL-CO-SharingED-Threshold-r16  3. Indicate in CG-UCI the COT sharing information |

**Applying the update supported by: NTT DOCOMO, Qualcomm, LG Electronics, Samsung (for components #2 and #3 of 10-21b)**

**Objected (i.e., not applying the update) by: NTT DOCOMO, Qualcomm, LG Electronics, Samsung (for component #1 of 10-21b), Nokia, NSB**

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | Component #1 of 10-21b is the UE behavior when ULtoDL-CO-SharingED-Threshold-r16 is not configured, and hence, it is not UE capability but should be supported by UE. For components #2 and #3 of 10-21b, as they are the UE behavior when ULtoDL-CO-SharingED-Threshold-r16 is not configured but cg-COT-SharingOffset-r16 is configured, they can be defined as the components of a new FG |
| Huawei, HiSilicon | In OPPO’s proposal, it would be good to clarify that 10-21a allows both PDCCH and PDSCH transmission from gNB, while 10-21b only allows PDCCH transmission from gNB, in the UL-to-DL shared COT. This should be clarified even if those as 2 components in the same FG. |
| vivo | Sharing same view with docomo |
| Nokia, NSB | We prefer to keep 10-21 are originally proposed, i.e. without the update. |
| Qualcomm | Agree with docomo |
| LG Electronics | Agree with NTT DOCOMO |
| Samsung | We share same view with NTT DOCOMO. |
| ZTE | Agree with FL |

**FL proposal:**

* Update 10-21 as follows:

|  |  |  |
| --- | --- | --- |
| 10-21a | Support using ED threshold for UL to DL COT sharing | 1. Use ULtoDL-CO-SharingED-Threshold-r16 for cat 4 LBT for scheduled UL to share COT with gNB for DL  2. Use ULtoDL-CO-SharingED-Threshold-r16 for cat 4 LBT for CG-PUSCH to share COT with gNB for DL  3. Indicate in CG-UCI the COT sharing information |
| 10-21b | Support UL to DL COT sharing | 1. Support cat 4 LBT for CG-PUSCH to share COT with gNB for DL without ULtoDL-CO-SharingED-Threshold-r16  2. Indicate in CG-UCI the COT sharing information |

# **10-22: No gap 2-step RACH msgA transmission**

In [1], FG 10-22 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 10. NR-unlicensed | 10-22 | No gap 2-step RACH msgA transmission | 1. Support transmitting PRACH and PUSCH of msgA without gap in between  FFS if RAN1 can disallow this in NR-U. | 10-1 or 10-2 and 9-1 | Yes | N/A |  | Per band | N/A | N/A |  | For licensed case, a minimum gap between PRACH and PUSCH of msgA is introduced, but is not applicable to NR-U | Optional with capability signalling |

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

|  |  |  |
| --- | --- | --- |
| [5] | MediaTek Inc. | As to 10-22, in Rel-16, msgA PRACH and msgA PUSCH are only allowed to be transmitted in different slots. Looking at the R15 PRACH configuration for TDD in FR1 (Table 6.3.3.2-3 in 38.211), there would be always gaps between msgA PRACH and msgA PUSH for formats A1/A2/A3. While for formats B1, C0, A1/B1, A2/B2, A3/B3, there would be always a gap in between the associated RACH occasion and PUSCH occasion expect for the last RACH occasion in a slot. Now, it only leaves formats B4 and C2 on the table which in total have 46 out of the 256 preambles. If not all the UEs in the cell can support no gap in between its msgA PRACH and msgA PUSCH transmissions, it means there should be gaps in the cell-specifically configured PRACH resources and PUSCH resources. The “no-gap msgA” is only applicable to CFRA.  **Observation 1: The cases that UE can take advantage from supporting no gap in between msgA PRACH and msgA PUSCH are not many.**  **Proposal 14: Apply the same gap defined in the R15 to msgA PRACH for NR-U.**  **Proposal 15: Remove 10-22 from the UE feature list.** |
| [6] | LG Electronics | In general, it seems beneficial to allow continuous transmission (with no gap) between PRACH and PUSCH for a same msgA especially for NR-U, in terms of reducing the channel access procedure to be performed by the UE. Regarding this issue, the method to support no gap between RACH and PUSCH is discussed in our companion paper [2] (e.g., by using extended CP of PUSCH).  **Proposal #6: Further discuss how to support no gap between RACH and msgA PUSCH for 2-step RACH procedure, under corresponding NR-U agenda item.** |
| [8] | Ericsson | As indicated in our contribution in the Initial Access Enhancements agenda item, we support no gap (N = 0) for unlicensed operation since it enables MsgA configuration using some PRACH formats with a gap of less than 16us between PRACH and PUSCH thus avoiding an extra LBT operation. This is one of the primary benefits of 2-step RACH in unlicensed.   1. FG 10-22 is needed so that UEs can indicate support for no gap (N = 0) between the PRACH and PUSCH parts of MsgA for 2-step RACH |
| [9] | Samsung | During the email discussion, following feature groups (10-19c, 10-22, and 10-31) have been added without discussion in NR-U WI. These features would affect not only UE behaviour but also gNB implementation so that sufficient discussion should be proceeded before the introduction. Hence, we propose to remove above feature groups in UE feature list for NR-U at this stage.  **Proposal 1: Remove FG 10-19c, 10-22, and 10-31 in UE feature list for NR-U.** |
| [10] | Apple | FG 10-22 proposed to introduce UE capability to indicate support 2-step RACH procedure without gap between PRACH and PUSCH of MsgA. We acknowledge the comment that there is no agreement made in NR-U session to support this. On the other hand, we understand the benefits without gap for unlicensed operation and can be fine to support it in case of same numerology between PRACH and PUSCH. However, if different numerologies between PRACH and PUSCH are configured, the gap agreed under 2-step WI should be used. The FG 10-22 is modified correspondingly to implement the suggestion.   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 10-22 | No gap 2-step RACH msgA transmission | 1. Support transmitting PRACH and PUSCH of msgA without gap in between if a same numerology is configured; 2. With Gap between PRACH and msgA if different numerologies are configured.   FFS if RAN1 can disallow this in NR-U. | 10-1 or 10-2 and 9-1 | Per-band | Optional with capability signalling |   **Proposal 3:**   * *Modify the FG 10-22 to support no gap between PRACH and PUSCH Msg-A in case of same numerology; Otherwise, support the gap if different numerologies are configured.* |
| [14] | Huawei, HiSilicon | **FG 10-22 (No gap 2-step RACH msgA transmission)**  In 2-step RACH agenda item, a minimum gap is defined between msgA PRACH and msgA PUSCH for licensed operation, and no such decision is made for unlicensed operation.  Agreements**:**   * The minimum transmission gap between the end of msgA PRACH and the beginning of msgA PUSCH (guard time excluded) is no less than Ngap symbols, as specified in TS 38.213, i.e., 2 or 4 symbols depending on the SCS   + This is not applied for NR-U   + Note: This is aligned with Rel-15   This means that there is no agreement for NR-U of what should be the minimum gap between the end of msgA PRACH and the beginning of msgA PUSCH (guard time excluded), including no agreement to support no gap in NR-U. What values of gap can a UE be allowed to signal as a capability for NR-U? The default, as clarified in the agreement copied above, should be aligned with Rel-15.  In the moderator’s proposal, “*FFS if RAN1 can disallow this in NR-U*” in FG10-22 is incorrect and should be changed to “*FFS if RAN1 can allow this in NR-U*”.   |  |  |  | | --- | --- | --- | | 10-22 | No gap 2-step RACH msgA transmission | Support transmitting PRACH and PUSCH of msgA without gap in between  FFS if RAN1 can disallow this in NR-U. |   We think that the licensed band design is sufficient for 2-step RACH with NR-U, and allows reusing the same BS receiver implementation, which is the Rel-15 implementation. If a UE has to perform LBT between PRACH and PUSCH of msgA, then the UE will either pass LBT and be able to transmit msgA faster than by 4-step RACH even with a 2 or 4 symbols gap, or the UE will fail LBT which probably indicates that it would be better for the UE to choose another 20 MHz channel for initial access in unlicensed band because the current 20 MHz channel is already heavily congested since the UE would have passed on LBT and failed one LBT in a short interval. Therefore a NR-U UE can reuse the 2-step RACH FG to signal its capability and there is no need for a specified NR-U FG for 2-step RACH.  Hence, “FFS if RAN1 can disallow this in NR-U” in FG10-22 is incorrect and should be changed to “FFS if RAN1 can allow this in NR-U”.  ***Proposal 3: No gap is not supported for NR-U and 10-22 (no gap 2-step RACH msgA transmission) should be deleted until further agreement.*** |

## 6.1 Discussion 7

**Companies are encouraged to provide views on whether or not 10-22 is needed.**

**Keeping it supported by: NTT DOCOMO, MediaTek (with brackets), LG Electronics**

**Objected (i.e., removing it) by: Huawei, HiSilicon**

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | We believe that the no-gap between msgA PRACH and msgA PUSCH is beneficial for NR-U operation in order to avoid two LBT process for PRACH and PUSCH, respectively.  On the other hand, we may need the discussion / clarification for the condition of no-gap. In our understanding, one of the back ground of specifying the gap is to consider the different SCS between PRACH and PUSCH. Thus, the same SCS for PRACH and PUSCH may be a condition of supporting the no-gap. |
| Huawei, HiSilicon | Agreement is required first for this feature. |
| vivo | Decide until it is concluded in NRU discussion |
| Nokia, NSB | Wait for conclusions in NR-U maintenance first. |
| Qualcomm | Need discussion first. |
| LG Electronics | Prefer to keep it for now (and to wait for the relevant decision under AI 7.2.2.2.2). |
| MediaTek | This is being discussed under NR-U in this meeting. Before any agreement is made, we prefer to keep this FG with brackets and notes to clarify. |
| Intel | Wait for the decision of the discussion under AI 7.2.2.2.2 |
| Samsung | We need a discussion first for this FG. |
| ZTE | Agree with FL |

**FL proposal:**

* Further discuss whether or not 10-22 is needed

# **Conclusion**

**Agreements:**

* FG10-3 is kept for “PRB interlace mapping for PUSCH”
* Combine 10-3a, 10-3b, and 10-3c into a single FG for “PRB interlace mapping for PUCCH”
* FG10-13a is kept for “Extended CP range of more than one symbol for CG-PUSCH”
* FG10-21a is kept for “Support using ED threshold given by gNB for UL to DL COT sharing”

**FL proposal:**

* Combine 10-12 into the FG combining 10-3a, 10-3b, and 10-3c
* Further discuss whether or not 10-18/24/28 or some of them are combined into a single FG
* FG10-21b is kept for “Support without using ED threshold given by gNB for UL to DL COT sharing”
* Further discuss whether or not 10-22 is needed

TBD

# **References**

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

[2] R1-2001715 Discussion on the UE features for NR-U ZTE, Sanechips

[3] R1-2001720 Discussion on Rel-16 NRU UE features vivo

[4] R1-2001765 Discussion on UE feature for NRU OPPO

[5] R1-2001826 Views on Rel-16 UE features for NR-U MediaTek Inc.

[6] R1-2001941 Discussion on UE features for NR-U LG Electronics

[7] R1-2002016 UE features for NR-U Intel Corporation

[8] R1-2002037 UE features for NR-U Ericsson

[9] R1-2002151 UE features for NR-U Samsung

[10] R1-2002350 Discussions on NR-U UE features Apple

[11] R1-2002393 Discussion on UE feature for NR-U Sharp

[12] R1-2002480 On UE features NR Unlicensed Nokia, Nokia Shanghai Bell

[13] R1-2002563 Discussion on NR-U UE features Qualcomm Incorporated

[14] R1-2002589 Rel-16 UE features for NR-U Huawei, HiSilicon

[15] R1-2002683 UE Features for NR-U TCL Communications