**3GPP TSG RAN WG1 #100bis-e R1-2002867**

e-Meeting, April 20th – 30th, 2020

Source: NTT DOCOMO, INC.

Title: Summary on Email discussion [100b-e-NR-UEFeatures-NRU-06]

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-06] Email discussion/approval on issues with capability signaling impacts on FGs related to DL+UL operation for NR-U (dates TBD) – Hiroki (DCM)

* Discuss on component(s) of each FG that need to be reported and candidate values for the component(s)
* Discuss on reporting type of each FG
* Discuss on the need of xDD and/or FRx differentiation for each FG of per-UE type
* Note that discussed FGs in this email discussion are derived by outcome of high priority email discussion in FL proposal 3

In the email discussion [100b-e-NR-UEFeatures-NRU-03], following agreements were made.

**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”

**Agreements:**

* Keep 10-18/24/28 as separate FGs

# **10-3: PRB interlace mapping for PUSCH**

Based on agreements and [1], FG10-3 can be defined as below.

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **( 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 10. NR-unlicensed | 10-3 | PRB interlace mapping for PUSCH | 1. PRB interlace frequency domain resource allocation for PUSCH | TBD  Need discussion for licensed use | Yes | N/A |  | Per band | N/A | N/A | N/A | Support of PRB interlace PUSCH | Optional with capability signalling |

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

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Following feedbacks on original FG10-3/3a/3b/3c/12 are provided in contributions for the RAN1#100bis-e meeting.

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| [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 | |

# **10-3a: PRB interlace mapping for PUCCH**

Based on agreements and [1], FG10-3a can be defined as below.

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **( 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 10. NR-unlicensed | 10-3a | PRB interlace mapping for PUCCH | 1. PRB interlace frequency domain resource allocation for PUCCH format 0 and format 1 2. PRB interlace frequency domain resource allocation for PUCCH format 2 3. PRB interlace frequency domain resource allocation for PUCCH format 3 | TBD  Need discussion for licensed use | Yes | N/A |  | Per band | N/A | N/A | N/A | Support of PRB interlace PUCCH format 0/1 | Optional with capability signalling |

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

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

Based on agreements and [1], FG10-13a can be defined as below.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **( 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 10. NR-unlicensed | 10-13a | Extended CP range of more than one symbol for CG-PUSCH | 1. Extended CP range of more than one symbol for CG-PUSCH | TBD  5-19 or 5-20 | Yes | N/A |  | Per band | N/A | N/A | N/A | How long a UE can generate the CP extension beyond 1 symbol for CG-PUSCH | Optional with capability signalling |

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

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

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| [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 | |

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

Based on agreements and [1], FG10-16 can be defined as below.

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **( 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 10. NR-unlicensed | 10-21a | Support using ED threshold given by gNB 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 | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalling |

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

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

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| [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.** |

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

Based on agreements and [1], FG10-18/24/28 can be defined as below.

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(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 |

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

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

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| --- | --- | --- |
| [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. | |

# **Conclusion**

TBD

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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 |
| 10. NR-unlicensed | 10-3 | PRB interlace mapping for PUSCH | 1. PRB interlace frequency domain resource allocation for PUSCH | TBD  Need discussion for licensed use | Yes | N/A |  | Per band | N/A | N/A | N/A | Support of PRB interlace PUSCH | Optional with capability signalling |
| 10. NR-unlicensed | 10-3a | PRB interlace mapping for PUCCH | 1. PRB interlace frequency domain resource allocation for PUCCH format 0 and format 1 2. PRB interlace frequency domain resource allocation for PUCCH format 2 3. PRB interlace frequency domain resource allocation for PUCCH format 3 | TBD  Need discussion for licensed use | Yes | N/A |  | Per band | N/A | N/A | N/A | Support of PRB interlace PUCCH format 0/1 | Optional with capability signalling |
| 10. NR-unlicensed | 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 | TBD  5-19 or 5-20 | Yes | N/A |  | Per band | N/A | N/A | N/A | How long a UE can generate the CP extension beyond 1 symbol for CG-PUSCH | Optional with capability signalling |
| 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 | TBD  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. NR-unlicensed | 10-21a | Support using ED threshold given by gNB 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 | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalling |
| 10. NR-unlicensed | 10-24 | CG-UCI multiplexing with HARQ ACK | 1. Support multiplexing CG-UCI with HARQ ACK | TBD  5-19 or 5-20  Need discussion for licensed use | Yes | N/A |  | Per band | N/A | N/A |  |  | Optional with capability signalling |
| 10. NR-unlicensed | 10-28 | Configured grant with Rel-16 enhanced resource configuration | 1. Support configuration of resources with cg-nrofSlots-r16 and cg-nrofPUSCH-InSlot-r16, | TBD  5-19 or 5-20 | Yes | N/A |  | Per band | N/A | N/A |  |  | Optional with capability signalling |

# **References**

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

[2] R1-2001715 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

[16] R1-2002864 Summary on Email discussion [100b-e-NR-UEFeatures-NRU-03] Moderator (NTT DOCOMO, INC.)