**3GPP TSG RAN WG1 #100bis-e R1-2003198**

**e-Meeting, 20th – 30th April, 2020**

**Agenda item:** 7.2.11.2

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

**Title:** Summary on email discussion [100b-e-NR-UEFeatures-Remaining] NR-unlicensed

**Document for:** Discussion and Decision

1. Introduction

This contribution summarizes the following email discussion in AI 7.2.11 regarding Rel-16 NR UE features.

[100b-e-NR-UEFeatures-Remaining] Email discussion/approval of remaining issues (especially the one identified as low priority items in FL’s summaries) starting no earlier than 4/30 till next meeting – Hiroki (DCM)/Ralf (ATT)

Companies are encouraged to check further updates for UE features list based on R1-2003073 shown below and provide feedback if any. Please note that the target of this email discussion is to reflect agreeable updates rather than solving any controversial discussion point. If there is any controversial discussion point, it should be discussed in the next RAN1 meeting.

Based on the email discussion, further updates on UE features list for NR-U were made as shown in section 2.

**The proposal from moderator is to consider the updated UE features list as a baseline for further discussion in next meeting.**

1. NR-unlicensed

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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 | 10-1 | UL channel access for dynamic channel access mode  | 1. Type 1 channel access2. Type 2A channel access3. Type 2B channel access4. Type 2C channel access5. 20MHz LBT bandwidth6. CP extension up to 1 symbol for PUSCH/PUCCH transmission |  | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-1a | UL channel access for semi-static channel access mode | 1. Type 2C channel access2. Single sensing slot of 9us channel access3. 20MHz LBT bandwidth | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-2 | SSB-based RRM [for dynamic channel access mode] | 1. SSB-based RRM with Q [for dynamic channel access mode] | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A | Q indicates the value of RAN1 parameter $N\_{SSB}^{QCL}$ | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-2a | SSB-based RRM [for semi-static channel access mode] | 1. SSB-based RRM with Q [for semi-static channel access mode] | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A | Q indicates the value of RAN1 parameter $N\_{SSB}^{QCL}$ | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-2b | MIB reading on unlicensed cell | 1. MIB reading on unlicensed cell | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-2c | SSB-based RLM [for dynamic channel access mode] | 1. SSB-based RLM with Q [for dynamic channel access mode] | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A | Q indicates the value of RAN1 parameter $N\_{SSB}^{QCL}$ | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-2d | SSB-based RLM [for semi-static channel access mode] | 1. SSB-based RLM with Q [for semi-static channel access mode] | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A | Q indicates the value of RAN1 parameter $N\_{SSB}^{QCL}$ | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-2e | SIB1 reception on unlicensed cell | 1. SIB1 reception on unlicensed cell | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-2f | Support monitoring of extended RAR window | 1. Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_0 | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-7 | UL channel access for 10 MHz SCell  | 1. 10 MHz LBT bandwidth
 | one of {10-1, 10-1a} | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-10 | RSSI and channel occupancy measurement and reporting | 1. RSSI measurement
2. Channel occupancy reporting
 | TBD | Yes | N/A |  | FFS: Per band or Per UE | N/A | N/A | N/A |  | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-11 | SRS starting position at any OFDM symbol in a slot | 1. Support transmitting SRS starting in all symbols (0,…,13) of a slot
 | TBD | Yes | N/A |  | FFS: Per band or Per UE | N/A | N/A | N/A |  | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-20 | Support search space set configuration with freqMonitorLocation-r16 | 1. Support search space set configuration with freqMonitorLocations-r16 | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-20a | Support coreset configuration with rb-Offset | 1. Support coreset configuration with rb-Offset  | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-23 | CGI reading on unlicensed cell [based on off-sync raster SSB] for ANR functionality | 1. Support acquisition of relevant information from a neighbouring NR unlicensed cell in an unlicensed carrier by reading the RMSI of the neighbouring unlicensed cell and reporting the acquired information to the network | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A | Support reading RMSI from an unlicensed cell [with an off-sync raster SSB] for ANR | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-25 | Enable configured UL transmissions when DCI 2\_0 is configured but not detected | 1. Support configuration of enableConfiguredUL-r16 and enable transmission of higher-layer configured UL \*SRS, PUCCH, CG-PUSCH etc) when DCI 2\_0 is configured but not detected | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-27 | Wideband PRACH | 1. Enhanced PRACH design for NR-U by adopting a single long ZC sequence, with ZC sequence = 1151 for 15kHz and ZC sequence = 571 for 30kHz
 | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-29 | Support available RB set indicator field in DCI 2\_0 | 1. Support monitoring DCI 2\_0 to read availableRB-Sets-r16
 | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-30 | Support channel occupancy duration indicator field in DCI 2\_0 | 1. Support monitoring DCI 2\_0 to read COT duration
 | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |
| 10. NR-unlicensed | 10-8 | Type B PDSCH length {3, 5, 6, 8, [9, 10,] 11, 12, 13} without DMRS shift due to CRS collision | 1. Type B PDSCH length {3, 5, 6, 8, [9, 10,] 11, 12, 13} without DMRS shift due to CRS collision
 | 5-6a | Yes | N/A |  | FFS: Per band or Per UE | N/A | N/A | N/A | Note length 9/10 with DMRS shift due to CRS collision are already covered by 14-3 | Optional with capability signalling |
| 10. NR-unlicensed | 10-9 | Search space set group switching with explicit DCI 2\_0 bit field trigger or with implicit PDCCH decoding with DCI 2\_0 monitoring | 1. Two groups of search space sets2. Monitor DCI 2\_0 with a search space set switching field 3. Support switching the search space set group with PDCCH decoding in group 1 4. Support a timer to switch back to original search space set group5. Monitor DCI 2\_0 for channel occupancy time and use the end of channel occupancy time to switch back to the original search space set group | TBD | Yes | N/A |  | FFS: Per UE or per band or per BC | N/A | N/A | N/A | Being configured with two groups of search spaces, and switch between them. Some search space sets can be configured in both groups. | Optional with capability signalling |
| 10. NR-unlicensed | 10-9b | Search space set group switching with implicit PDCCH decoding without DCI 2\_0 monitoring | 1. Two groups of search space sets2. Support switching the search space set group with PDCCH decoding in group 1 3. Support a timer to switch back to original search space set group | TBD | Yes | N/A |  | FFS: Per UE or per band | N/A | N/A | N/A | Being configured with two groups of search spaces, and switch between them. Some search space sets can be configured in both groups. | Optional with capability signalling |
| 10. NR-unlicensed | 10-9c | Joint search space group switching across multiple cells | 1. Configured with a group of cells and switch search space set group jointly over these cells
 | one of {10-9, 10-9b} | Yes | N/A |  | FFS: Per UE or per band or per BC | N/A | N/A | N/A | Without this capability, the UE will switch search space set groups for different cells independently | Optional with capability signalling |
| 10. NR-unlicensed | 10-9d | Support Search space set group switching capability 2 | 1. Search space set group switching Capability-2: P=10/12/22 symbols for µ = 0/1/2 SCS
 | one of {10-9, 10-9b} | Yes | N/A |  | FFS: Per UE or per band | N/A | N/A | N/A | Without this capability, the UE supports search space set group switching capability-1: P=25/25/25 symbols for µ=0/1/2 | Optional with capability signalling |
| 10. NR-unlicensed | 10-14 | Non-numerical PDSCH to HARQ-ACK timing | 1. Support configuration of a value for dl-DataToUL-ACK indicating an inapplicable time to report HARQ ACK
 | TBD | Yes | N/A |  | FFS: Per UE or per band | N/A | N/A | N/A | If non-numerical K1 value is supported | Optional with capability signalling |
| 10. NR-unlicensed | 10-15 | Enhanced dynamic HARQ codebook | 1. Support of bit fields signalling PDSCH HARQ group index and NFI in DCI 1\_1 (configuration of nfi-TotalDAI-Included)2. Support of bit field in DCI 0\_1 for other group total DAI if configured. (configuration of ul-TotalDAI-Included)3. Support the retransmission of HARQ ACK (pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16) | TBD | Yes | N/A |  | FFS: Per UE or per band | N/A | N/A | N/A | Enhanced dynamic HARQ codebook supporting grouping of HARQ ACK and triggering the retransmission of HARQ ACK in each groups | Optional with capability signalling |
| 10. NR-unlicensed | 10-16 | One-shot HARQ ACK feedback | 1. Support feedback of type 3 HARQ-ACK codebook, triggered by a DCI 1\_1 scheduling a PDSCH
2. Support feedback of type 3 HARQ-ACK codebook , triggered by a DCI 1\_1 without scheduling a PDSCH using a reserved FDRA value
 | TBD | Yes | N/A |  | FFS: Per band or Per UE | N/A | N/A | N/A | Upon triggering, UE reports A/N for all HARQ processes and all CCs in a PUCCH group.  | Optional with capability signalling |
| 10. NR-unlicensed | 10-17 | Multi-PUSCH UL grant | 1. Support of scheduling up to 8 PUSCH with a single DCI 0\_1  | TBD | Yes | N/A |  | FFS: Per band or Per UE | N/A | N/A | N/A |  | Optional with capability signalling |
| 10. NR-unlicensed | [10-19a] | [Support DL reception in a carrier with intra-cell guard-bands] | 1. [When DL BWP has multiple RB sets, support using the available RB set bitmap in DCI 2\_0 to validate the periodic CSI-RS transmission if the CSI-RS is over multiple RB-sets] | TBD | Yes | N/A |  | Per band | N/A | N/A |  | Without this capability, UE will assume all RB sets in the DL BWP are all transmitted or none of them are transmitted | Optional with capability signalling |
| 10. NR-unlicensed | [10-19b] | [Support UL transmission with subset of RB sets passing LBT] | 1. [When UL BWP has multiple RB sets, support transmission of UL signal or channels when LBT passes for only the RB sets the UL signals or channels are located] | TBD | Yes | N/A |  | Per band | N/A | N/A |  | Without this capability, UE will transmit UL when all RB sets in the UL BWP pass LBT | Optional with capability signalling |
| 10. NR-unlicensed | 10-26 | CSI-RS based RLM for NR-U | [CSI-RS based RLM for NR-U] | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalling |
| 10. NR-unlicensed | 10-26a | CSI-RS based RRM for NR-U | [CSI-RS based RRM for NR-U] | TBD | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalling |
| 10. NR-unlicensed | [10-31] | [Support of CSI-RS measurements for CSI reporting and tracking without COT duration from DCI 2\_0] | [· Perform CSI measurements for reporting and tracking using CSI-RS resources that are not within a COT duration indicated by DCI 2\_0· Note: This includes the cases when DCI 2\_0 is not configured and when DCI 2\_0 is configured but COT duration is not provided by either CO duration field or SFI.] | TBD | Yes | N/A |  | [Per band] | N/A | N/A |  |  | Optional with capability signaling |
| 10. NR-unlicensed | 10-3 | PRB interlace mapping for PUSCH | 1. PRB interlace frequency domain resource allocation for PUSCH | TBDOne of {10-1, 10-1a} | 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
 | TBDOne of {10-1, 10-1a} | 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 | 10-12 | OCC for PRB interlace mapping for PF2 and PF3 | 1. OCC22. OCC4 | 10-3a | Yes | N/A |  | Per band | N/A | N/A | N/A | UE OCC capability for EPF2/EFP3 | 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
 | TBDOne of {5-19, 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 resources2. Support configured grant retransmission timer3. Support DFI monitoring4. Support CG-UCI in CG-PUSCH | TBDOne of {5-19, 5-20} | Yes | N/A |  | Per band | N/A | 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 DL2. Use ULtoDL-CO-SharingED-Threshold-r16 for cat 4 LBT for CG-PUSCH to share COT with gNB for DL3. Indicate in CG-UCI the COT sharing information | TBD10-1 | 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 | 10-18 | Yes | N/A |  | Per band | N/A | 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, | TBDOne of {5-19, 5-20} | Yes | N/A |  | FFS: Per UE or per band | N/A | N/A | N/A |  | Optional with capability signalling |

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| Company | Comment |
| Ericsson | * Suggest for consistency to update “Per band” to “FFS: Per band or per UE” for FGs 10-9c/14/15/28
* FG-14: Editorial correction in Components field to revise “imapplicable” to  “inapplicable”
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| Qualcomm | * We do prefer to keep 10-2 and 10-2a separate, and keei 10-2c and 10-2d separate, i.e., remove square brackets, consider the SSB transmission patterns are different between LBE and FBE systems at least during the idle period.
* As discussed in the previous round of email discussion, for 10-2a and 10-2c, we would like to only keep SMTC window or DRS window length shorter or equal to the fixed frame period as the component, consider the UE behavior can be different if the SSB burst can be spreaded across multiple FFPs. We can introduce separate capability for SMTC window or DRS window longer than FFP if necessary.
* For 10-9c, consider this is CA related, may need to consider this is “per band” or “per BC”
* For all the features listed as “FFS:Per band or Per UE”, to allow the most flexibility in implementation and IOT testing, we would like to make them “per band”
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| Moderator (NTT DOCOMO) | Based on feedbacks, following further updates were made* “FFS: per band or per BC or per UE” for 10-9c
* “FFS: per band or per UE” for 10-14/15/28
* Editorial correction for 10-14 is applied
* Clarify that “x-x or y-y” in prerequisite FG column means “one of {x-x, y-y}” needs to be supported to support the FG.

Other discussion points should be discussed in next meeting. |
| MediaTek Inc. | 1. About the column of “Mandatory/Optional,” we have the following comments.
2. For FG10-10, remove “*This FG may be a part of basic operation for a particular scenario*” from the column of “Mandatory/Optional.”
	* According to RAN2’s agreements, FG10-10 should be optional.
3. We prefer to remove the text of “*This FG may be a part of basic operation for a particular scenario*” for all the FGs for now until we have further discussion and consensus. Or at least change “This FG may be a part of basic operation for a particular scenario” to “FFS whether and for which scenario(s) this FG could be part of basic operation”
	* Companies have different thoughts about which FGs could be bascic FGs for which deployment scenarios.
	* For example, we do not think FG10-20 and FG10-23 should be basic FGs.
	* On the other hand, we think HARQ enhancements FG10-14 and FG10-15 should be basic FGs for SA/DC scenarios.
4. About the column of “components,” we have the following comments.
5. In FG10-1a, add “FFS: CP extension up to 1 symbol for PUSCH/PUCCH transmission” as one of its components.
6. Add square brackets to the components of FG10-15 which needs some detailed discussion.
7. In FG10-20, add square brackets to the current component and add “FFS: Maximum number of frequency domain locations for a search space set configuration with freqMonitorLocations-r16” to the column of components.
	* How many PDCCH monitoring occasions a UE can process is highly related to UE capability.
8. Some editorial suggestions on the column of “Feature Group”:
9. In FG10-9, we suggest to change from “Search space set group switching with explicit DCI 2\_0 bit field trigger or with implicit PDCCH decoding with DCI 2\_0 monitoring” to “Search space set group switching without DCI 2\_0 monitoring.”
10. In FG10-2f, we suggest to change from “Support of RAR extension from 10ms to [40ms] by decoding of the 2-bit SFN indication in DCI 1\_0” to “Support monitoring of extended RAR window” to be concise and avoid duplicated description of “feature group” and “components.”
11. Finally, for FG 10-23, in the column of “Note,” change from “Support reading RMSI from SCell from an off-sync raster SSB for ANR” to “Support reading RMSI from an unlicensed cell [with an off-sync raster SSB] for ANR” to be aligned the decription in the column of “feature group.”
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| Moderator (NTT DOCOMO) | Only some editorial suggestions are reflected and other issues should be discussed in next meeting. |