**3GPP TSG RAN WG1 #104-e R1-2101589**

**e-Meeting, January 25th – February 5th, 2021**

**Agenda item:** 7.2.11

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

**Title:** Summary on UE features for NR-U

**Document for:** Discussion and Decision

1. Introduction

This contribution summarizes the discussions and proposals in AI 7.2.11 regarding UE features for NR-U.

Based on the discussions summarized in Section 2, followings are parts of the suggested email discussions/approvals for AI 7.2.11.

**FL proposal of email discussion/approval:**

**[104-e-NR-UEFeature-NRU-01] Email discussion/approval on UE features for NR-U (25th Jan – 29th Jan)**

* **Whether or not to ask RAN2 to update the optionality of FG10-2f for UE supporting only FBE in any of scenarios**
* **Whether or not to clarify that a UE indicating no support of FG 10-26a, also indicates that none of Rel-15 FG 1-5/1-5a/1-6/1-7/1-8/1-9 are supported by the UE in unlicensed bands**
* **Whether or not to clarify that Rel-15 FGs 1-4 applies to licensed band operation only**
* **How to reply to RAN4 on RAN1’s understanding on RB set of NR-U**

Companies are encouraged to check above FL proposal and to provide feedback if any in below.

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| Company | Comment |
| Moderator | According to the draft summary on AI 5 from RAN1 chairman, section 2.3 and corresponding discussion point#3 are added. |
| LG Electronics | We are fine to discuss above 4 topics, as Moderator suggested. However, the first sub-bullet needs to be generalized as follows since it comes from a single company proposal.* **Whether or not to ask RAN2 to update the optionality of FG10-2f**
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| Nokia, NSB | * We are not OK to discuss 10-2f, as the issue has already been resolved by RAN2 and no pending action is needed in RAN1 on that. In fact, LS R1-2100019 clearly says that “*RAN2#112-e has further discussed this and agreed that this capability should be optional only for the UEs which do not support non-CA deployment scenarios, corresponding to scenarios B, C, D, or E in Annex B.3 of TS 38.300.*”
* The proposal is a bit unclear, perhaps the intention is to say that a UE indicating no support of FG 10-26a is not assumed to support any of Rel-15 FG 1-5/1-5a/1-6/1-7/1-8/1-9 in unlicensed bands? It is OK to discuss the issue, but we might need to discuss also in which cases the Rel-15 FGs can be assumed to be supported in unlicensed bands, otherwise we have an incomplete framework.
* FG1-4: related to discussion above, OK to discuss it too.
* OK to discuss reply to RAN4
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| Huawei, HiSilicon | We agree with the scope of the email discussion from the moderator, including the discussion on FBE in relation to the optionality of FG10-2f.Regarding FG10-26a, we are unsure why FG1-7 and 1-8 are also listed by the proponent. But this can be discussed once the email discussion starts. |
| Ericsson | * FG10-2f: We would like to discuss this issue.
	+ Regarding Nokia’s comment, we still think that the optionality of FG 10-2f should be further in discussed in RAN1 as RAN2’s decision was based on incomplete information from RAN1. Furthermore, the LS from RAN2 states that ‘RAN2 assumes that this is in line with the RAN1 justification for making the capability optional.’ When RAN1 provided a reply LS, scenario A (LAA CA operation) was given as an example of a scenario where 10-2f should not be mandatory, since extended RAR window is not needed in such a scenario. At the time the reply LS was sent, it was not discussed in RAN1 whether or not an FBE-only scenario is another example where extended RAR window is unnecessary. Based on this, we believe it should be further discussed in RAN1 whether or not UEs that support FBE only are required to also support FG 10-2f. In our view extended RAR window is not needed in such a scenario, so it does not make sense to force a UE vendor implementing an FBE-only device to implement this functionality.
* FG 10-26a: Not sure discussion is needed. At least the intention is not clear.
	+ 10-26a is optional and all the FG listed in Rel-15 FG 1-5/1-5a/1-6/1-7/1-8/1-9 are optional except FG 1-7 that is related to RLM, and not RRM as in 10-26a. Is the issue about reducing capability singalling? In a sense that reporting no support for 10-26a would impliy 1-5/1-5a/1-6/[1-7?]/1-8/1-9 are not supported too and hence, the UE does not need to indicate that?
* FG 1-4: OK to discuss but some clarity is needed.
	+ FG 1-4 and FG 1-7 are both mandatory in Rel-15. Shouldn’t FG1-7 be part of this discussion too? Is the intention that for unlicensed UE is not expected to do any RLM, RRM measurement?
* RAN4 reply: OK to disucss to send reply to RAN4
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1. Discussion on Rel-16 NR UE features for NR-U
	1. Optionality of FG10-2f

Following proposals are made in contributions.

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| [4] | RAN2 has sent an LS to RAN1 [2] regarding the optionality of the UE capability on extended RAR window (FG 10-2f) informing RAN1 of the following:RAN2#112-e has further discussed this and agreed that this capability should be optional only for the UEs which do not support non-CA deployment scenarios, corresponding to scenarios B, C, D, or E in Annex B.3 of TS 38.300. The reason for this decision was that, to configure *ra-ResponseWindow* larger than 10ms, the network needs to know this capability before initial channel access. RAN2 assumes that this is in line with the RAN1 justification for making the capability optional.The RAN2 decision to make 10-2f mandatory for Scenarios B, C, D, or E was based on the RAN1 reply LS [3] in which only one example was provided in which the capability should be optional, namely that it does not make sense that UEs supporting only CA/LAA scenarios (Scenario A) should be required to implement extended RAR window (FG 10-2f) since the RAR is sent on the PCell in licensed spectrum, where LBT is not used.*RAN1 discussed the RAN2 decision conveyed in LS R1-2005204 (R2-2005865) not to define a capability bit for FG10-2f. It is RAN1’s understanding that FG10-2f should be optional because some UEs may not require this capability, e.g. UEs supporting only CA/LAA scenario (scenario A in the NR-U WID). Therefore, RAN1 would like to ask RAN2 to introduce a capability bit for FG10-2f.* We observe that in the RAN1 reply LS, the CA/LAA scenario was identified only as an example. It also does not make sense for UEs supporting only FBE (*ChannelAccessMode-r16 ='semistatic'*) in any of the deployment scenarios to also support extended RAR window. This is because the likelihood of LBT failure preventing the gNB from sending the RAR within 10 ms is extremely low in a controlled environment, thus making extension of the RAR window not useful in such deployments.Based on this, we propose that RAN2 updates TS 38.306 to specify that for UEs only supporting FBE in any of Scenarios A, B, C, D, or E the capability parameter ***extRA-ResponseWindow-r16*** is optional.1. The capability parameter *extRA-ResponseWindow-r16* in TS 38.306 (corresponding to FG 10-2f) should be optional for UEs supporting FBE only (*ChannelAccessMode-r16* ='*semistatic*'), i.e., UEs that do not also support LBE (*ChannelAccessMode-r16* ='*dynamic*'). For UEs supporting only FBE, the capability should be optional for all of Scenarios A, B, C, D, and E listed in Annex B.3 of TS 38.300.
2. Send an LS reply to RAN2 informing RAN2 of the recommendation in Proposal 1
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| [16] | In [1], RAN2 informed RAN1 of the agreement that the capability *extRA-ResponseWindow-r16* (i.e., FG 10-2f in [2]) is mandatory for the UE supporting any of scenarios B, C, D, and E in TS 38.300 Annex B.3, and also informed of TS 38.306 CR capturing that agreement.However, RAN2 agreement is not aligned with RAN1 agreement as follows that was captured in [2] and was made in RAN1#103-e before RAN2 agreement.

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| Agreements:* Following classification of scenarios is used to define basic FGs for NR-U according to TS38.300 B.3
	+ Scenario A: Carrier aggregation between NR in licensed spectrum (PCell) and NR in shared spectrum (SCell);
		- Scenario A.1: SCell is not configured with uplink (DL only).
		- Scenario A.2: SCell is configured with uplink (DL+UL).
	+ Scenario B: Dual connectivity between LTE in licensed spectrum and NR in shared spectrum (PSCell);
	+ Scenario C: NR in shared spectrum (PCell);
	+ Scenario D: NR cell in shared spectrum and uplink in licensed spectrum;
	+ Scenario E: Dual connectivity between NR in licensed spectrum (PCell) and NR in shared spectrum (PSCell).
* Ask RAN2 to consider following TP for TS38.300 B.3

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| TS38.300, Annex B (informative): Deployment ScenariosB.3 NR Operation with Shared SpectrumNR Radio Access operating with shared spectrum channel access can support the following deployment scenarios:- Scenario A: Carrier aggregation between NR in licensed spectrum (PCell) and NR in shared spectrum (SCell);* Scenario A.1: SCell is not configured with uplink (DL only).
* Scenario A.2: SCell is configured with uplink (DL+UL).

- Scenario B: Dual connectivity between LTE in licensed spectrum and NR in shared spectrum (PSCell);- Scenario C: NR in shared spectrum (PCell);- Scenario D: NR cell in shared spectrum and uplink in licensed spectrum;- Scenario E: Dual connectivity between NR in licensed spectrum (PCell) and NR in shared spectrum (PSCell).Carrier aggregation of cells in shared spectrum is applicable to all deployment scenarios. |

* Following FGs are defined as basic FGs for corresponding scenario(s) for NR-U, and associated scenario(s) for the basic FG is clarified in the note column of UE features list
	+ 10-1: A2, B, C, D and E with dynamic channel access mode
	+ 10-1a: A2, B, C, D and E with semi-static channel access mode
	+ 10-2: A1, A2, B, C, D and E with dynamic channel access mode
	+ 10-2a: A1, A2, B, C, D and E with semi-static channel access mode
	+ 10-2b: B, C, D and E
	+ 10-2c: B, C, D and E with dynamic channel access mode
	+ 10-2d: B, C, D and E with semi-static channel access mode
	+ 10-2e: C and D
* The note "This FG may be part of basic operation for a particular scenario" is removed from following FGs.
	+ 10-2f, 10-3, 10-3a, 10-27, 10-29, 10-30, 10-31
* Note: There will be no more discussion on whether/how to capture the classification of scenarios in TR/TS
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As highlighted above, FG 10-2f is clearly optional for all scenarios (different from FG 10-1/1a/2/2a/2b/2c/2d/2e for which UE should support for some scenarios).In addition, it seems that RAN2 misunderstood RAN1’s intention of the following statements in [3] that was sent to RAN2 in RAN1#102-e.

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| * Regarding FG10-2f in UE features list for NR-U

**To RAN2:**RAN1 discussed the RAN2 decision conveyed in LS R1-2005204(R2-2005865) not to define a capability bit for FG10-2f. It is RAN1’s understanding that FG10-2f should be optional because some UEs may not require this capability, e.g. UEs supporting only CA/LAA scenario (scenario A in the NR-U WID). Therefore, RAN1 would like to ask RAN2 to introduce a capability bit for FG10-2f. |

The highlighted part is just one of examples for RAN1 to request RAN2 to make FG 10-2f optional, and RAN1 was discussing another aspects (but not captured in the LS [3]) on whether FG 10-2f needs to be also optional for stand-alone scenarios (e.g., scenario C in TS 38.300 Annex B.3) or not.Furthermore, the rationale behind RAN1 agreement that FG 10-2f is optional for all scenarios was that the UE feature related to RAR window extension is not critical for UE to support NR-U. In other words, if gNB configures RAR window larger than 10 ms by SIB1 but a UE does not support FG 10-2f, the UE cannot access the cell and shall search another cell for which gNB configures RAR window no larger than 10 ms, which is also applicable to FG 10-3/3a (interlaced PUSCH/PUCCH) that is optional for all scenarios even though it can be configured by SIB1.Therefore, we recommend RAN2 to reflect RAN1 agreement in TS 38.306, and suggest the following proposal.**Proposal: Send a reply LS to RAN2 to inform RAN1’s agreement in RAN1#103-e that the capability *extRA-ResponseWindow-r16* (i.e., FG 10-2f) is optional for all scenarios and recommend the following TS 38.306 CR.**

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| **Definitions for parameters** | **Per** | **M** | **FDD-TDD DIFF** | **FR1-FR2 DIFF** |
| ***extRA-ResponseWindow-r16***Indicates whether the UE supports the configuration of maximum length of RAR window with a value larger than 10ms and up to 40ms by decoding of the 2 LSBs of SFN in the DCI format 1\_0 for 4-step RA type. | Band  | No | N/A | N/A |

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Based on the above proposals, following point can be discussed in RAN1#104-e meeting.

### **Discussion point #1**

* **Whether or not to ask RAN2 to update the optionality of FG10-2f for UE supporting only FBE in any of scenarios**
	1. Clarification on NR-U UE features with Rel-15 FG 1-4/5/5a/6/7/8/9

Following proposals are made in contributions.

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| [11] | **Proposal 5: Clarify that a UE indicating no support of FG 10-26a, also indicates that none of Rel-15 FG 1-5/1-5a/1-6/1-7/1-8/1-9 are supported by the UE in unlicensed bands.**

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| 10. NR-unlicensed | 10-26a | CSI-RS based RRM for operation with shared spectrum channel access  | CSI-RS based RRM for operation with shared spectrum channel access  |  | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signalling |

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| 1-5 | CSI-RS based RRM measurement with associated SS-block | 1) CSI-RSRP measurement2) CSI-RSRQ measurement | 1-1, CSI-RS  | Yes | Not support CSI-RSRP and CSI-RSRQ measurement | Type 4 | No need | Yes |  |  | RAN1 |  | Optional with capability signalingNote: This does not discourage RAN4 to complete their workNote: there is expectation that RAN4 will complete the corresponding RRM measurement  |
| 1-5a | CSI-RS based RRM measurement without associated SS-block | 1) CSI-RSRP measurement 2) CSI-RSRQ measurement3) There is SS-block in the target frequency on which the RRM measurement is performed | 1-1, CSI-RS | Yes |  | Type 4 | No need | Yes |  |  | RAN1 |  | Optional with capability signalingNote: This does not discourage RAN4 to complete their workNote: there is expectation that RAN4 will complete the corresponding RRM measurement  |
| 1-6 | CSI-RS based RS-SINR measurement | 1) CSI-SINR measurement | 1-11-5 | Yes | Not support CSI-SINR measurement | Type 4 | No need | Yes |  |  | RAN1 | Optional with capability signaling | Optional with capability signaling |
| 1-7 | CSI-RS based RLM | 1) CSI-RS based RLM | 1-1, CSI-RS | Yes | Not support CSI-RS based RLM | Type 4 | No need | Yes |  |  | RAN1 |  | Mandatory with capability signaling  |
| 1-8 | RLM based on a mix of SS block and CSI-RS signals within active BWP |  | 1-4 and 1-7 | Yes | UE does not support RLM based on a mix of SS block and CSI-RS signals | Type 4 | No need | No need |  |  | RAN1 | [Mandatory /optional with capability signaling] | Optional with capability signaling |
| 1-9 | CSI-RS based contention free RA for HO |  | 1-1CSI-RS1-5 or 1-5a | Yes | UE does not support CSI-RS based contention free RA for HO | Type 4 | No need | No need |  |  | RAN1 | Optional with capability signaling | Optional with capability signaling |

Similar to the above, we suggest clarifying the relationship between Rel-16 FG 10-2c/10-2d “SSB-based RLM” and Rel-15 FG 1-4 “SSB-based RLM”, each of which is copied below. **Proposal 6: Clarify that Rel-15 FG 1-4 applies to licensed band operation only.**

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| 10. NR-unlicensed | 10-2c | SSB-based RLM for dynamic channel access mode | 1. SSB-based RLM with Q for dynamic channel access mode |  | Yes | N/A |  | Per band | N/A | N/A | N/A | Q indicates the value of RAN1 parameter $N\_{SSB}^{QCL}$the signaling is per band but is only expected for a band where shared spectrum channel access must be used | 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, when DRS window is no longer than the fixed frame period |  | Yes | N/A |  | Per band | N/A | N/A | N/A | Q indicates the value of RAN1 parameter $N\_{SSB}^{QCL}$the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signalingThis FG may be a part of basic operation for a particular scenario |

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| 1-4 | SS block based RLM | 1) SS block based RLM | 1-1 | Yes | Not support SS block based RLM | Type 4 | No need | No need |  |  | RAN1 |  | Mandatory with capability signaling which shall be set to ‘1’  |

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Based on the above proposals, following point can be discussed in RAN1#104-e meeting.

### **Discussion point #2**

* **Whether or not to clarify that a UE indicating no support of FG 10-26a, also indicates that none of Rel-15 FG 1-5/1-5a/1-6/1-7/1-8/1-9 are supported by the UE in unlicensed bands**
* **Whether or not to clarify that Rel-15 FGs 1-4 applies to licensed band operation only**
	1. Reply LS on Rel-16 updated RAN4 UE features

Following proposals are made in contributions.

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| [15] | **1. Overall Description:**RAN1 thanks RAN4 for the LS, and would like to provide following feedback:*For FG4-1 and FG4-2 of NR-U, RAN4’s understanding is a RB set corresponds to 20MHz bandwidth on which a channel access procedure is performed in shared spectrum. RAN4 kindly would like to ask RAN1 to check whether RAN4 understanding is correct.*RAN1’s understanding is that a RB set approximately corresponds to 20MHz bandwidth on which a channel access procedure is performed, and the bandwidth corresponding to the RB set can be less than or slightly greater than 20 MHz based on configuration.**2. Actions:****To RAN WG4** **ACTION:** RAN1 respectfully requests RAN4 to take above response into account. |

Based on the above proposals, following point can be discussed in RAN1#104-e meeting.

### **Discussion point #3**

* **How to reply to RAN4 on RAN1’s understanding on RB set of NR-U**

Reference

[1] R1-2009585 Updated RAN1 UE features list for Rel-16 NR Moderators (AT&T, NTT DOCOMO, INC.)

[2] R1-2100094 Discussion on NR Rel-16 UE Features ZTE

[3] R1-2100140 Correction for V2X UE feature list OPPO

[4] R1-2100522 Remaining details of Rel-16 NR UE features Ericsson

[5] R1-2100554 Discussion on NR Rel-16 UE features LG Electronics

[6] R1-2100635 Remaining issue on UE features Intel Corporation

[7] R1-2101184 On NR Rel.16 UE features Samsung

[8] R1-2101249 Updates on NR UE Features Nokia, Nokia Shanghai Bell

[9] R1-2101273 Remaining details of Rel-16 NR UE features Huawei, HiSilicon

[10] R1-2101342 Discussions on NR Rel-16 UE features Apple

[11] R1-2101444 Discussion on NR Rel-16 UE features Qualcomm Incorporated

[12] R1-2101517 Correction on half-DuplexTDD-CA-SameSCS-r16 CATT

[13] R1-2101587 Remaining issues on Rel-16 NR UE features NTT DOCOMO, INC.

[14] R1-2101685 Remaining issues on Rel-16 eMIMO UE features vivo

[15] R1-2100887 Draft reply LS on Rel-16 updated RAN4 UE features lists for LTE and NR LG Electronics

[16] R1-2100889 Discussion on RAN2 LS on capability for extended RAR window monitoring LG Electronics

Appendix: NR UE features list for NR-U in [1]

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****( 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 access and contention window size adjustment2. 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 | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signalingThis FG is a part of basic operation for following scenarios defined in TS38.300* Scenario A2, B, C, D and E with dynamic channel access mode
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| 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 bandwidth4. CP extension up to 1 symbol for PUSCH/PUCCH transmission |  | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signalingThis FG is a part of basic operation for following scenarios defined in TS38.300* Scenario A2, B, C, D and E with semi-static channel access mode
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| 10. NR-unlicensed | 10-2 | SSB-based RRM for dynamic channel access mode | 1. SSB-based RRM with Q for dynamic channel access mode |  | Yes | N/A |  | Per band | N/A | N/A | N/A | Q indicates the value of RAN1 parameter $N\_{SSB}^{QCL}$the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signalingThis FG is a part of basic operation for following scenarios defined in TS38.300* Scenario A1, A2, B, C, D and E with dynamic channel access mode
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| 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, when SMTC window is no longer than the fixed frame period |  | Yes | N/A |  | Per band | N/A | N/A | N/A | Q indicates the value of RAN1 parameter $N\_{SSB}^{QCL}$the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signalingThis FG is a part of basic operation for following scenarios defined in TS38.300* Scenario A1, A2, B, C, D and E with semi-static channel access mode
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| 10. NR-unlicensed | 10-2b | MIB reading on unlicensed cell | 1. MIB reading on unlicensed cell for PCell and PSCell |  | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signalingThis FG is a part of basic operation for following scenarios defined in TS38.300* Scenario B, C, D and E
 |
| 10. NR-unlicensed | 10-2c | SSB-based RLM for dynamic channel access mode | 1. SSB-based RLM with Q for dynamic channel access mode |  | Yes | N/A |  | Per band | N/A | N/A | N/A | Q indicates the value of RAN1 parameter $N\_{SSB}^{QCL}$the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signalingThis FG is a part of basic operation for following scenarios defined in TS38.300* Scenario B, C, D and E with dynamic channel access mode
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| 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, when DRS window is no longer than the fixed frame period |  | Yes | N/A |  | Per band | N/A | N/A | N/A | Q indicates the value of RAN1 parameter $N\_{SSB}^{QCL}$the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signalingThis FG is a part of basic operation for following scenarios defined in TS38.300* Scenario B, C, D and E with semi-static channel access mode
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| 10. NR-unlicensed | 10-2e | SIB1 reception on unlicensed cell | 1. SIB1 reception on unlicensed cell for PCell |  | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signalingThis FG is a part of basic operation for following scenarios defined in TS38.300* Scenario C and D
 |
| 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 |  | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |
| 10. NR-unlicensed | 10-2g | SSB-based BFD/CBD for dynamic channel access mode | SSB-based BFD/CBD with Q for dynamic channel access mode |  | Yes | N/A |  | Per band | N/A | N/A | N/A | Q indicates the value of RAN1 parameter $N\_{SSB}^{QCL}$the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |
| 10. NR-unlicensed | 10-2h | SSB-based BFD/CBD for semi-static channel access mode | SSB-based BFD/CBD with Q for semi-static channel access mode |  | Yes | N/A |  | Per band | N/A | N/A | N/A | Q indicates the value of RAN1 parameter $N\_{SSB}^{QCL}$the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |
| 10. NR-unlicensed | 10-2i | CSI-RS-based BFD/CBD for operation with shared spectrum channel access  | CSI-RS-based BFD/CBD for operation with shared spectrum channel access  |  | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |
| 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 | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |
| 10. NR-unlicensed | 10-10 | RSSI and channel occupancy measurement and reporting | 1. RSSI measurement
2. Channel occupancy reporting
 |  | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |
| 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
 |  | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signaling |
| 10. NR-unlicensed | 10-20 | Support search space set configuration with freqMonitorLocation-r16 | 1. Maximum number of frequency domain locations for a search space set configuration with freqMonitorLocations-r16 |  | Yes | N/A |  | Per band | N/A | N/A | N/A | Candidate values of component 1: {1, 2, ,3, 4, 5}the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |
| 10. NR-unlicensed | 10-20a | Support coreset configuration with rb-Offset | 1. Support coreset configuration with rb-Offset  |  | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signaling |
| 10. NR-unlicensed | 10-23 | CGI reading on unlicensed cell 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 |  | Yes | N/A |  | Per band | N/A | N/A | N/A | Support reading RMSI from an unlicensed cell for ANRthe signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |
| 10. NR-unlicensed | 10-25 | Enable configured UL transmissions when SFI field in DCI 2\_0 is configured but DCI 2\_0 is not detected | 1. Support configuration of enableConfiguredUL-r16 and enable transmission of higher-layer configured UL \*SRS, PUCCH, CG-PUSCH etc) when SFI field in DCI 2\_0 is configured but DCI 2\_0 is not detected |  | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |
| 10. NR-unlicensed | 10-27 | Wideband PRACH | 1. Enhanced PRACH design for operation with shared spectrum channel access by adopting a single long ZC sequence, with ZC sequence = 1151 for 15kHz and ZC sequence = 571 for 30kHz
 |  | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |
| 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
 |  | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |
| 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
 |  | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |
| 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 |  | Per band | N/A | N/A | N/A | Note length 9/10 with DMRS shift due to CRS collision are already covered by 14-2 | Optional with capability signalling |
| 10. NR-unlicensed | 10-9 | Search space set group switching 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 |  | Yes | N/A |  | 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.the signaling is per band but is only expected for a band where shared spectrum channel access must be used | 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 |  | Yes | N/A |  | 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.the signaling is per band but is only expected for a band where shared spectrum channel access must be used | 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 |  | Per BC | N/A | N/A | N/A | Without this capability, the UE will switch search space set groups for different cells independentlythe signaling is per band but is only expected for a band where shared spectrum channel access must be used | 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 |  | 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=0/1/2the signaling is per band but is only expected for a band where shared spectrum channel access must be used | 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
 |  | Yes | N/A |  | Per band | N/A | N/A | N/A | If non-numerical K1 value is supportedthe signaling is per band but is only expected for a band where shared spectrum channel access must be used | 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) |  | Yes | N/A |  | 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 group | 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
 |  | Yes | N/A |  | Per band | 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  |  | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalling |
| 10. NR-unlicensed | [10-19a] |  |  |  |  |  |  |  |  |  |  |  |  |
| 10. NR-unlicensed | [10-19b] |  |  |  |  |  |  |  |  |  |  |  |  |
| 10. NR-unlicensed | [10-19c] |  |  |  |  |  |  |  |  |  |  |  |  |
| 10. NR-unlicensed | [10-19d] |  |  |  |  |  |  |  |  |  |  |  |  |
| 10. NR-unlicensed | [10-19e] |  |  |  |  |  |  |  |  |  |  |  |  |
| 10. NR-unlicensed | [10-19f] |  |  |  |  |  |  |  |  |  |  |  |  |
| 10. NR-unlicensed | 10-26 | CSI-RS based RLM for operation with shared spectrum channel access  | CSI-RS based RLM for operation with shared spectrum channel access  |  | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signalling |
| 10. NR-unlicensed | 10-26a | CSI-RS based RRM for operation with shared spectrum channel access  | CSI-RS based RRM for operation with shared spectrum channel access  |  | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signalling |
| 10. NR-unlicensed | 10-31 | Support of P/SP-CSI-RS reception with CSI-RS-ValidationWith-DCI-r16 configured | 1. Validate P/SP-CSI-RS reception when receiving a DCI granting a PDSCH over the same set of symbols2. Validate P/SP-CSI-RS reception when receiving a DCI triggering a A-CSI-RS over the same set of symbols |  | Yes | N/A |  | Per band | N/A | N/A |  | If UE does not signal capability for FG 10-31, the UE cannot be configured with CSI-RS-ValidationWith-DCI-r16.If none of the RRC parameters CO-DurationPerCell-r16, SlotFormatIndicator, and CSI-RS-ValidationWith-DCI-r16 is configured on a cell with shared spectrum access, and P/SP CSI-RS is configured, for reception/cancellation of SP/P CSI-RS the behavior in 11.1 of TS38.213 applies as per agreement.the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |
| 10. NR-unlicensed | 10-3 | PRB interlace mapping for PUSCH | 1. PRB interlace frequency domain resource allocation for PUSCH |  | Yes | N/A |  | Per band | N/A | N/A | N/A | Support of PRB interlace PUSCHthe signaling is per band but is only expected for a band where shared spectrum channel access must be used | 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
 |  | Yes | N/A |  | Per band | N/A | N/A | N/A | Support of PRB interlace PUCCH format 0/1the signaling is per band but is only expected for a band where shared spectrum channel access must be used | 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/EFP3the signaling is per band but is only expected for a band where shared spectrum channel access must be used | 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
 | One or both 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-PUSCHthe signaling is per band but is only expected for a band where shared spectrum channel access must be used | 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 | One or both of {5-19, 5-20} | Yes | N/A |  | Per band | N/A | N/A | N/A | Support configured grant with retransmission in configured grant resourcethe signaling is per band but is only expected for a band where shared spectrum channel access must be used | 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 Type 1 channel access for scheduled UL to share COT with gNB for DL2. Use ULtoDL-CO-SharingED-Threshold-r16 for Type 1 channel access for CG-PUSCH to share COT with gNB for DL3. Indicate in CG-UCI the COT sharing information | 10-1 | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signalling |
| 10. NR-unlicensed | 10-21b | Support UL to DL COT sharing | 1. Support Type 1 LBT for scheduled UL to share COT with gNB for DL without ULtoDL-CO-SharingED-Threshold-r162. Support Type 1 LBT for CG-PUSCH to share COT with gNB for DL without ULtoDL-CO-SharingED-Threshold-r163. Indicate in CG-UCI the COT sharing information | 10-1 | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signaling |
| 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 | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | 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, | One or both of {5-19, 5-20} | Yes | N/A |  | Per band | N/A | N/A | N/A | the signaling is per band but is only expected for a band where shared spectrum channel access must be used | Optional with capability signalling |