**3GPP TSG RAN WG1 #106bis-e R1-2109913**

**e-Meeting, October 11th – 19th, 2021**

**Agenda Item: 8.17.2**

**Source: Moderator (AT&T)**

**Title: Summary of UE features for supporting NR from 52.6 GHz to 71 GHz**

**Document for:** **Discussion/Decision**

# Introduction

This document presents the summary of email discussion/approval [106bis-e-R17-UE-features-60GHz-01] during RAN1 #106bis-e. According to the Chairman’s Notes:

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| [106bis-e-R17-UE-features-60GHz-01] Email discussion UE features for supporting NR from 52.6 GHz to 71 GHz – Ralf (AT&T)* 1st check point: October 14
* Final check point: October 19
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The following was discussed and/or agreed during RAN1 #106bis-e within the scope of [106bis-e-R17-UE-features-60GHz-01]. All proposals are based on the latest RAN1 UE features list for Rel-17 NR in [1].

# Summary of Contributions Submitted to RAN1 #106bis-e

The following is the moderator’s summary of contributions submitted to RAN1 #106bis-e in this agenda item.

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|  24. NR\_ext\_to\_71GHz | 24-1 | General FR2-2 support | 1. Support 120KHz SCS transmission and reception2. Support multi-RB PUCCH format 0/1/43. PRACH with 120KHz SCS and length 139/571/1151 |  |  |  |  |  |  |  |  |  |  |

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| Company | Summary |
| FUTUREWEI [2] | Change the Feature group 24-1 title from “General” to “Basic” given that this feature will be pre-requisite for all other features, and is mandatory when FR2-2 is supported

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|  24. NR\_ext\_to\_71GHz | 24-1 | ~~General~~ BasicFR2-2 support | 1. Support 120KHz SCS transmission and reception2. Support multi-RB PUCCH format 0/1/43. PRACH with 120KHz SCS and length 139/571/11514. Support 120 kHz SSB for initial access |  |  |  | FR2-2 is not supported | Per UE |  |  |  |  | Optional with capability signalingThis feature is the basic feature for the support of FR2-2 |

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| ZTE/Sanechips [3] |  |
| Vivo [4] | On 24-1, it should be a minimum set of features as long as a UE supports operation from 52.6-71GHz. As indicated in WID, NR/NR-U operation in the 52.6GHz to 71GHz can be in stand-alone or aggregated via CA or DC with an anchor carrier. For a UE supporting non-standalone case (e.g. CA) operation in the 52.6GHz to 71GHz, there will be no need to support multi-RB PUCCH and PRACH transmission. Besides, according to current WID [2], a design target says ‘support enhancement for PUCCH format 0/1/4 to increase the number of RBs under PSD limitation in shared spectrum operation’. This also means multi-RB PUCCH should not be a basic feature for general FR2-2 support.

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| **Index** | **Feature group** | **Components** | **Prerequisite feature groups** |
| 24-1 | General FR2-2 support | 1. Support 120KHz SCS transmission and reception2. Support multi-RB PUCCH format 0/1/43. PRACH with 120KHz SCS and length 139/571/1151 |  |

Proposal: Remove ‘multi-RB PUCCH format 0/1/4’ and ‘PRACH with 120KHz SCS and length 139/571/1151’ from general FR2-2 support and list them as independent UE feature.  |
| Huawei/HiSilicon [5] | The component of enhanced PUCCH format 0/1/4 with multi-RB should be a separated FG because it is also supported for 480 kHz and 960 kHz SCS. In addition, the support of enhanced PUCCH format 0/1/4 is only applicable to unlicensed band operation due to limitation on PSD in regulation. At maximum 16 RB are supported for all numerologies according to the agreement in RAN1#106. In NR-U Rel-16, enhanced PUCCH format 0/1/2/3 with PRB interlace resource mapping is set as a separate FG10-3a.The component of wideband PRACH for 120 kHz SCS with sequence length of 571 and 1171 should be a separate FG because it is only applicable for unlicensed band. If wideband PRACH with length of 571 is also supported for 480 kHz SCS, it can be listed as one of the component. Similar method is adopted in NRU that wideband PRACH is set as a separate FG10-27.

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|  24. NR\_ext\_to\_71GHz | 24-1 | General FR2-2 support | 1. Support 120KHz SCS transmission and reception
2. 120kHz for SSB monitoring
3. PRACH with 120kHz and length 139
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| Ericsson [6] | To be consistent with FG's 24-2/3/4/5, an additional component should be added on "Support 120 kHz for SSB monitoring."**Proposal: Add the following new component to FG 24-1: Support 120 kHz for SSB monitoring**Additionally, component #2 should clarify multi-RB PUCCH for 120 kHz.**Proposal: Clarify component #2 of FG 24-1 as follows: Support multi-RB PUCCH format 0/1/4 for 120 kHz** |
| Samsung [7] | RAN and RAN1 have agreed to support 120 kHz SCS as the default numerology for supporting NR from 52.6 GHz to 71 GHz, and support 480 kHz and 960 kHz as optional numerologies subject to UE’s capability. Based on this principle, general support for NR from 52.6 GHz to 71 GHz with 120 kHz SCS transmission and reception should be a mandatory UE feature, with the type of the UE feature as per band. Meanwhile, only basic transmission and reception of 120 kHz SCS should be considered as components of the general support, and enhancement features including the support of multi-RB PUCCH formats and PRACH with 120 kHz should be separated out as new features with FG 24-1 as the prerequisite feature group. **Proposal: For FG 24-1:****• Only keep “support 120 kHz SCS transmission and reception” as the component, and separate out others as new feature groups with FG 24-1 as the prerequisite feature group;****• “Type” of the FG is “per band”;****• This FG is “mandatory”.** |
| MediaTek Inc. [8] | We view this FG as basic UE feature for operating in FR2-2 and we suggest to split into UL and DL basic features to enable operation in a cell not configured with uplink. For the components, we suggest to include specific types of channels/signals instead of transmission and reception in the description to avoid ambiguity. We also suggest to separate the multi-RB PUCCH feature and wideband PRACH feature into other FGs as optional enhancements.

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| Features | Index | Feature group | Components | Note | Mandatory/Optional |
|  ~~24. NR\_ext\_to\_71GHz~~ | ~~24-1~~ | ~~General FR2-2 support~~ | ~~1. Support 120KHz SCS transmission and reception~~~~2. Support multi-RB PUCCH format 0/1/4~~~~3. PRACH with 120KHz SCS and length 139/571/1151~~ |  |  |
| 24. NR\_ext\_to\_71GHz | 24-1-1 | General FR2-2 support for DL | 1. Support 120kHz subcarrier spacing for DL data and control channels and reference signals in FR2-2
 |  | Optional with capability signalingThis FG is a part of basic DL operation in FR2-2  |
| 24. NR\_ext\_to\_71GHz | 24-1-2 | General FR2-2 support for UL | 1. Support 120kHz subcarrier spacing for UL data and control channels and reference signals in FR2-2
2. Support PRACH with 120KHz subcarrier spacing and length 139 in FR2-2
 |  | Optional with capability signalingThis FG is a part of basic UL operation in FR2-2 |

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| Intel Corporation [9] |  |
| NTT DOCOMO, INC. [10][11] | Since a number of discussions are still on-going in RAN1, only a few UE features are captured in the list now. In general, we believe most of the discussion points regarding UE features need to wait for RAN1 progress a bit more. However, even in the current situation, we think an important UE features to be clearly supported in this WI is missing in the list; that is, the ones for supporting multi-PDSCH/PUSCH scheduling. As the support of this functionality had already been agreed in RAN1, there would be no reason not to capture it even now. Given that only 120 kHz SCS is to be mandatory for UEs supporting NR in 52.6 – 71 GHz, whether to support multi-PDSCH/PUSCH scheduling in 52.6 – 71 GHz should be reported per SCS that the UE supports.

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|  24. NR\_ext\_to\_71GHz | 24-1 | General FR2-2 support | 1. Support 120KHz SCS transmission and reception2. Support multi-RB PUCCH format 0/1/43. PRACH with 120KHz SCS and length 139/571/11514. Support multi-PUSCH[/PDSCH] scheduling by single DCI for the operation with 120 kHz SCS |  |  |  |  |  |  |  |  |  |  |

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| LG Electronics [12] |  |
| Apple [13] | Remove “Support multi-RB PUCCH format 0/1/4” or “PRACH with 120KHz SCS and length 139/571/1151” in the General FR2-2 support UE feature (24-1). PUCCH and PRACH should be separate FGs |
| Nokia/Nokia Shanghai Bell [14] | SSB support for non-initial access should be mentioned in this FG as well |

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|  24. NR\_ext\_to\_71GHz | 24-2 | 120KHz SSB based stand-alone support | 1. Support 480KHz SSB for initial access | 24-1 |  |  |  |  |  |  |  |  |  |

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| Company | Summary |
| FUTUREWEI [2] | Move Feature 24-2 into Feature 24-1. We consider the support 120 kHz SSB for initial access as basic, because 120kHz SCS is mandatory (per WID) if FR2-2 is supported. While the initial version suggests that this should be mandatory only in stand alone deployment, we note that the other SCS (480kHz, 960 kHz) are both optional, therefore no necessary supported for NSA deployment.

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|  ~~24. NR\_ext\_to\_71GHz~~ | ~~24-2~~ | ~~120KHz SSB based stand-alone support~~ | ~~1. Support 480KHz 120 kHz SSB for initial access~~ | ~~24-1~~ |  |  |  |  |  |  |  |  |  |

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| ZTE/Sanechips [3] | For “FG 24-2 120KHz SSB based stand-alone support” [1], the existing description of Component 1 is “Support 480KHz SSB for initial access”. This may be an editorial error. The correct description should be "Support 120KHz SSB for initial access". In addition, we do not think FG 24-2 is necessary. According to the WID and the agreement reached in RAN#92-e, supporting 120KHz for initial access should be a basic feature, which can be listed as a component of “FG 24-1 General FR2-2 support”.From WID:* In addition to 120kHz, support 480 kHz SSB for initial access with support of CORESET#0/Type0-PDCCH configuration in the MIB with following constraints:
	+ Note: 480 kHz is an optional SSB numerology for initial access for the UE. A UE supporting a band in 52.6-71 GHz must at least support 120 kHz SCS (for initial access and after initial access)

Agreement in RAN#92-e, June 14-18, 2021In addition to 120kHz, support **480** kHz SSB for initial access with support of CORESET0/Type0-PDCCH configuration in the MIB with following constraints:* Limited sync raster entry numbers
	+ It is assumed that RAN4 supports a channelization design which results in the total number of synchronization raster entries considering both licensed and unlicensed operation in a 52.6 – 71 GHz band no larger than **665** (Note: the total number of synchronization raster entries in FR2 for band n259 + n257 is 599). If the assumption cannot be satisfied, it’s up to RAN4 to decide its applicability to bands in 52.6 – 71 GHz.
* only 480kHz CORESTE#0/Type0-PDCCH SCS supported for 480 kHz SSB SCS.
* SSB time domain candidate resource pattern (within a slot or pair of slots) for 480 and 960kHz SSB are identical
* Prioritize support SSB-CORESET0 multiplexing pattern 1. Other patterns discussed on a best effort basis.
* 960 kHz numerology for the SSB is not supported by the UE for initial access in Rel-17.

Note: Strive to minimize specification impact by reusing tables for CORESET#0 and type0-PDCCH CSS set configuration defined for FR2 in Rel-15, as much as possibleNote: 480 kHz is an optional SSB numerology for initial access for the UE. A UE supporting a band in 52.6-71 GHz must at least support 120 kHz SCS (for initial access and after initial access)Note: Dependency or lack thereof for a UE supporting 480kHz and/or 960kHz numerology for data and control to also support 480kHz SSB numerology for initial access is to be tackled as part of UE capability discussion.**Proposal: The existing description “Support 480KHz SSB for initial access” of Component 1 in FG 24-2 has an editorial error. The correct description should be "Support 120KHz SSB for initial access".** **Proposal: FG 24-2 is not necessary, which can be listed as a component of “FG 24-1 General FR2-2 support”.** |
| Vivo [4] | On 24-2, the component should be ‘Support 120KHz SSB for initial access’ to be aligned with the feature group name.

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| **Index** | **Feature group** | **Components** | **Prerequisite feature groups** |
| 24-2 | 120KHz SSB based stand-alone support | 1. Support 480KHz SSB for initial access | 24-1 |

**Proposal: Correct the component of 24-2 to be ‘Support 120KHz SSB for initial access’.** |
| Huawei/HiSilicon [5] | There is a typo in the component description, “1. Support 480KHz SSB for initial access” -> “1. Support 120KHz SSB for initial access”

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|  24. NR\_ext\_to\_71GHz | 24-2 | 120KHz SSB based stand-alone support | 1. Support 120KHz SSB for initial access | 24-1 |  |  |  |  |  |  |  |  |  |

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| Ericsson [6] | Correct the typo in the component description for FG 24-2 as follows: Support 120 480 KHz SSB for initial access |
| Samsung [7] |  |
| MediaTek Inc. [8] | For FG24-2, the component should be “support 120kHz SSB for initial access” and we suggest to add FR2-2 notion to differentiate the support of 120kHz SSB in FR2-1.

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| Features | Index | Feature group | Components | Note | Mandatory/Optional |
|  24. NR\_ext\_to\_71GHz | 24-2 | 120KHz SSB based stand-alone support in FR2-2 | 1. Support ~~480~~120KHz SSB for initial access in FR2-2 |  | Optional |

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| Intel Corporation [9] | While the rest of the feature list seem ok. We think feature 24-2, 120kHz SSB based stand-along support, needs to be included to the baseline feature 24-1 and should not be separated as a separate feature. Supporting CA/DC operation such that carrier operating in FR2-2 is an Scell seems to be even more complex operation compared to a standalone operation. The stand-along support for 120kHz should be mandatory feature in case UE support bands in FR2-2.**Proposal: Merge feature 24-2 into feature 24-1 as a subcomponent of 24-1 and void out feature 24-2 from the initial feature list provided in R1-2102108679.** |
| NTT DOCOMO, INC. [10][11] |  |
| LG Electronics [12] |

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| 24-2 | 120KHz SSB based stand-alone support | 1. Support 120KHz SSB for initial access | 24-1 |

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| Apple [13] | Fix Typo in 24-2 description i.e 240 kHz in description and 120 kHz in title |
| Nokia/Nokia Shanghai Bell [14] | o Component description should be 120kHzo FG name mentions stand-alone support, but the functionality is relevat to PSCell operation as well. It would be better to merge this FG with FG 24-1. |

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|  24. NR\_ext\_to\_71GHz | 24-3 | 480KHz SSB based stand-alone support | 1. Support 480KHz SSB for initial access | 24-1, 24-2, 24-4 |  |  |  |  |  |  |  | From WID:* In addition to 120kHz, support 480 kHz SSB for initial access with support of CORESET#0/Type0-PDCCH configuration in the MIB with following constraints:
	+ Note: 480 kHz is an optional SSB numerology for initial access for the UE. A UE supporting a band in 52.6-71 GHz must at least support 120 kHz SCS (for initial access and after initial access)
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| Company | Summary |
| FUTUREWEI [2] |

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|  24. NR\_ext\_to\_71GHz | ~~24-3~~24-2 | 480KHz SSB based stand-alone support | 1. Support 480KHz SSB for initial access | 24-1, 24-3 ~~24-2,~~ ~~24-4~~ | Yes |  |  | Per UE |  |  |  | From WID:* In addition to 120kHz, support 480 kHz SSB for initial access with support of CORESET#0/Type0-PDCCH configuration in the MIB with following constraints:
	+ Note: 480 kHz is an optional SSB numerology for initial access for the UE. A UE supporting a band in 52.6-71 GHz must at least support 120 kHz SCS (for initial access and after initial access)
 | Optional with capability signaling |

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| ZTE/Sanechips [3] | So far, dependency or lack thereof for a UE supporting 480kHz numerology for data and control to also support 480kHz SSB numerology for initial access has not been decided. Thus, RAN1 should first agree that a UE supporting 480kHz numerology for data and control should also support 480kHz SSB numerology for initial access, then FG 24-4 can be used as a prerequisite feature group for FG 24-3.**Observation: No agreements/conclusions to support that FG 24-4 can be used as a prerequisite feature group for FG 24-3.****Proposal” RAN1 should agree that a UE supporting 480kHz numerology for data and control supports 480kHz SSB numerology for initial access.** |
| Vivo [4] |  |
| Huawei/HiSilicon [5] |  |
| Ericsson [6] |  |
| Samsung [7] | Similarly, FG 24-4 and FG 24-5 should only include basic transmission and reception operations for 480 kHz and 960 kHz SCS, respectively, and enhancements regarding the SSB monitoring, multi-slot PDCCH monitoring, and PRACH should be separated out as new feature groups. It also needs to be clarified that FG 24-3, FG 24-4 and FG 24-5 are per band, and optional. Meanwhile, the FGs for SSB reception and data reception should be separated and may not need to be prerequisite from each other. **Proposal: For FG 24-3, FG 24-4 and FG 24-5:****• Separate out “SSB monitoring”, “multi-slot PDCCH monitoring”, and “PRACH” from FG 24-4 and FG 24-5 as new feature groups;****• These FGs are “per band”;****• These FGs are “optional”;****• FG 24-3 doesn’t require FG 24-4 (after the separation) as perquisite FG.** |
| MediaTek Inc. [8] | In the note of FG 24-3, it captures that 480 kHz is an optional SSB numerology for initial access. We suggest to add following description in the note based on one related sub-bullet in WID:* only 480kHz CORESET#0/Type0-PDCCH SCS is supported for 480 kHz SSB SCS.

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| Features | Index | Feature group | Components | Note | Mandatory/Optional |
|  24. NR\_ext\_to\_71GHz | 24-3 | 480KHz SSB based stand-alone support in FR2-2 | 1. Support 480 KHz SSB for initial access in FR2-2 | From WID:- In addition to 120kHz, support 480 kHz SSB for initial access with support of CORESET#0/Type0-PDCCH configuration in the MIB with following constraints:* only 480kHz CORESET#0/Type0-PDCCH SCS supported for 480 kHz SSB SCS.

o Note: 480 kHz is an optional SSB numerology for initial access for the UE. A UE supporting a band in 52.6-71 GHz must at least support 120 kHz SCS (for initial access and after initial access) | Optional |

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| Intel Corporation [9] |  |
| NTT DOCOMO, INC. [10][11] |  |
| LG Electronics [12] |  |
| Apple [13] |  |
| Nokia/Nokia Shanghai Bell [14] | Similar comment as above, this is relevant to PSCell as well, not only stand-alone. It would be better to merge this FG with FG 24-4. |

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|  24. NR\_ext\_to\_71GHz | 24-4 | 480KHz SCS support | 1. 480KHz SCS for UL transmission2. 480KH SCS for DL reception3. 480KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 480KHz with X=45. PRACH with 480KHz and length 139/[571] |  |  |  |  |  |  |  |  | From WID:In addition to 120kHz SCS, specify new SCS, 480kHz and 960kHz, and define maximum bandwidth(s), for operation in this frequency range for data and control channels and reference signals, only NCP supported.  |  |

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| Company | Summary |
| FUTUREWEI [2] |

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|  24. NR\_ext\_to\_71GHz | ~~24-4~~24-3 | 480KHz SCS support | 1. 480KHz SCS for UL transmission2. 480KH SCS for DL reception3. 480KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 480KHz with X=45. PRACH with 480KHz and length 139/[571] | 24-1 | Yes |  |  | Per UE |  |  |  | From WID:In addition to 120kHz SCS, specify new SCS, 480kHz and 960kHz, and define maximum bandwidth(s), for operation in this frequency range for data and control channels and reference signals, only NCP supported. Agreement:A UE supporting 480 kHz SCS supports multi-slot PDCCH monitoring for 480 kHz SCS.Agreement:Do not support PRACH length L=571, 1151 for 960kHz PRACH and at least L =1151 for 480kHz PRACH. | Optional with capability signaling |

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| ZTE/Sanechips [3] |  |
| Vivo [4] | PRACH support may not be needed for certain non-standalone scenario similar with the discussion for 24-1. Thus, PRACH part should be listed as independent UE feature.

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| **Index** | **Feature group** | **Components** | **Prerequisite feature groups** |
| 24-4 | 480KHz SCS support | 1. 480KHz SCS for UL transmission2. 480KH SCS for DL reception3. 480KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 480KHz with X=45. PRACH with 480KHz and length 139/[571] |  |

**Proposal: List PRACH part in 24-4 as independent UE feature.**On 24-4 and 24-5, SSB-based monitoring needs further clarification on what to be included in this bullet, e.g. SSB-based RLM, RRM, BFD and etc. It is better to make it clear using spec language.**Proposal: Further clarification of SSB-based monitoring in 24-4 is needed.**Beside the already listed UE features, it seems that certain issues are missing here, e.g. multi-PDSCH/PUSCH support, directional LBT, receiver-assisted LBT and etc. The details of these features may be still discussed currently but they should be considered after they are complete. |
| Huawei/HiSilicon [5] |

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|  24. NR\_ext\_to\_71GHz | 24-4 | 480KHz SCS support | 1. 480KHz SCS for UL transmission2. 480KH SCS for DL reception3. 480KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 480KHz with X=45. PRACH with 480KHz and length 139 |  |  |  |  |  |  |  |  | From WID:In addition to 120kHz SCS, specify new SCS, 480kHz and 960kHz, and define maximum bandwidth(s), for operation in this frequency range for data and control channels and reference signals, only NCP supported.  |  24. NR\_ext\_to\_71GHz |

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| Ericsson [6] | Consistent with FG 24-1, a component for support for multi-RB PUCCH format 0/1/4 for 480 kHz should be addedProposal: Add the following new component to FG 24-3 as follows: Support multi-RB PUCCH format 0/1/4 for 480 kHzComponent #4 on multi-slot monitoring is not defined well enough, e.g., it says nothing about the value Y that is currently being discussed as part of the multi-slot monitoring capability definition. In contrast, for PDCCH monitoring in Rel-15 (FG 3-5b) and in Rel-16 (FG 11-2), the description includes a definition of the monitoring span Y. We understand that the discussions have not concluded in RAN1 yet, hence the component can be rewritten as follows until those discussions are completeProposal: Modify the description of Component #4 of FG 24-3 as follows until RAN1 completes the design of multi-slot monitoring capability:Multiple-slot PDCCH monitoring for 480KHz with X=4 [FFS: Component description to be updated once further details of multi-slot monitoring capability are known, e.g., definition of Y] |
| Samsung [7] | Similarly, FG 24-4 and FG 24-5 should only include basic transmission and reception operations for 480 kHz and 960 kHz SCS, respectively, and enhancements regarding the SSB monitoring, multi-slot PDCCH monitoring, and PRACH should be separated out as new feature groups. It also needs to be clarified that FG 24-3, FG 24-4 and FG 24-5 are per band, and optional. Meanwhile, the FGs for SSB reception and data reception should be separated and may not need to be prerequisite from each other. **Proposal: For FG 24-3, FG 24-4 and FG 24-5:****• Separate out “SSB monitoring”, “multi-slot PDCCH monitoring”, and “PRACH” from FG 24-4 and FG 24-5 as new feature groups;****• These FGs are “per band”;****• These FGs are “optional”;****• FG 24-3 doesn’t require FG 24-4 (after the separation) as perquisite FG.** |
| MediaTek Inc. [8] | We view this optional FG as basic UE feature for operation in FR2-2 if UE supports 480kHz subcarrier spacing. Similar to FG 24-1, we suggest to split the components into UL and DL basic features to enable operation in a cell not configured with uplink. We also suggest to separate multi-slot PDCCH monitoring and wideband PRACH into other FGs as optional enhancements.

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| Features | Index | Feature group | Components | Note | Mandatory/Optional |
|  ~~24. NR\_ext\_to\_71GHz~~ | ~~24-4~~ | ~~480KHz SCS support~~ | ~~1. 480KHz SCS for UL transmission~~~~2. 480KH SCS for DL reception~~~~3. 480KHz for SSB monitoring~~~~4. Multiple-slot PDCCH monitoring for 480KHz with X=4~~~~5. PRACH with 480KHz and length 139/[571]~~ |  |  |
| 24. NR\_ext\_to\_71GHz | 24-4-1 | 480kHz SCS support for DL in FR2-2 | 1. Support 480kHz subcarrier spacing for DL data and control channels and reference signals in FR2-2
 |  | Optional |
| 24. NR\_ext\_to\_71GHz | 24-4-2 | 480kHz SCS support for UL in FR2-2 | 1. Support 480kHz subcarrier spacing for UL data and control channels and reference signals in FR2-2
2. Support PRACH with 480KHz subcarrier spacing and length 139 in FR2-2
 |  | Optional |

 |
| Intel Corporation [9] | RAN 1 doesn’t complete the down selection between Alt 1 and Alt 2 for multi-slot PDCCH decoding capability yet. However, both Alt 1 and Alt 2 are defined based on a combination of values (X, Y). For value X, it is agreed to support X=4 slots for SCS 480 kHz and X=8 slots for SCS 960 kHz. Other X value(s) are still under discussion. Regarding value Y, it is agreed that 1<=Y<=X/2 (both in units of slot) when X>1 for Alt 1. Similar situation exists for value Y of Alt 2 too. Since a larger Y value is beneficial for the flexibility of PDCCH transmission and a smaller Y value may be favorite from power saving point of view, it is expected multiple Y values can be supported by UE for different use cases. In summary, for each of the SCS 480kHz and 960kHz, UE may support multiple combinations (X, Y) for the multi-slot PDCCH monitoring capability. A first issue is whether the support of multi-slot PDCCH monitoring capability should be captured in the baseline capability FG 24-1. Since multi-slot PDCCH monitoring capability is not introduced for SCS 120kHz, it is fine that multi-slot PDCCH monitoring capability is not a part of FG 24-1. A second issue is whether separate FG(s) should be introduced for the multi-slot PDCCH monitoring capability. With the agreement that a UE supporting SCS 480kHz or 960kHz supports multi-slot PDCCH monitoring for SCS 480kHz or 960kHz, it would be fine to make the support of multi-slot PDCCH monitoring capability a part of FG 24-4. However, the current description in FG 24-4 doesn’t well reflect the status of RAN1 discussion. Therefore, we propose to add FFS for additional X value and the values of Y.

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| 24-4 | 480KHz SCS support | 1. 480KHz SCS for UL transmission2. 480KH SCS for DL reception3. 480KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 480KHz with X=4. FFS other value(s) of X. FFS value(s) of Y. 5. PRACH with 480KHz and length 139/[571] |  |

 |
| NTT DOCOMO, INC. [10][11] | Since a number of discussions are still on-going in RAN1, only a few UE features are captured in the list now. In general, we believe most of the discussion points regarding UE features need to wait for RAN1 progress a bit more. However, even in the current situation, we think an important UE features to be clearly supported in this WI is missing in the list; that is, the ones for supporting multi-PDSCH/PUSCH scheduling. As the support of this functionality had already been agreed in RAN1, there would be no reason not to capture it even now. Given that only 120 kHz SCS is to be mandatory for UEs supporting NR in 52.6 – 71 GHz, whether to support multi-PDSCH/PUSCH scheduling in 52.6 – 71 GHz should be reported per SCS that the UE supports.

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|  24. NR\_ext\_to\_71GHz | 24-4 | 480KHz SCS support | 1. 480KHz SCS for UL transmission2. 480KH SCS for DL reception3. 480KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 480KHz with X=45. PRACH with 480KHz and length 139/[571]6. Multi-PUSCH/PDSCH scheduling by single DCI for the operation with 480 kHz SCS |  |  |  |  |  |  |  |  | From WID:In addition to 120kHz SCS, specify new SCS, 480kHz and 960kHz, and define maximum bandwidth(s), for operation in this frequency range for data and control channels and reference signals, only NCP supported.  |  |

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| LG Electronics [12] |

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| 24-4 | 480KHz SCS support | 1. 480KHz SCS for UL transmission2. 480KHz SCS for DL reception3. 480KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 480KHz with X=45. PRACH with 480KHz and length 139/[571] | 24-1 |

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| Apple [13] |  |
| Nokia/Nokia Shanghai Bell [14] |  |

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|  24. NR\_ext\_to\_71GHz | 24-5 | 960KHz SCS support | 1. 960KHz SCS for UL transmission2. 960KH SCS for DL reception3. 960KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 960KHz with X=85. PRACH with 960KHz and length 139 |  |  |  |  |  |  |  |  | From WID* In addition to 120kHz SCS, specify new SCS, 480kHz and 960kHz, and define maximum bandwidth(s), for operation in this frequency range for data and control channels and reference signals, only NCP supported.
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| Company | Summary |
| FUTUREWEI [2] |

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|  24. NR\_ext\_to\_71GHz | ~~24-5~~24-4 | 960KHz SCS support | 1. 960KHz SCS for UL transmission2. 960KH SCS for DL reception3. 960KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 960KHz with X=85. PRACH with 960KHz and length 139 | 24-1 | Yes |  |  | Per UE |  |  |  | From WIDIn addition to 120kHz SCS, specify new SCS, 480kHz and 960kHz, and define maximum bandwidth(s), for operation in this frequency range for data and control channels and reference signals, only NCP supportedAgreement:A UE supporting 960 kHz SCS supports multi-slot PDCCH monitoring for 960 kHz SCS.Agreement:Do not support PRACH length L=571, 1151 for 960kHz PRACH and at least L =1151 for 480kHz PRACH. | Optional with capability signaling |

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| ZTE/Sanechips [3] |  |
| Vivo [4] | PRACH support may not be needed for certain non-standalone scenario similar with the discussion for 24-1. Thus, PRACH part should be listed as independent UE feature.

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| **Index** | **Feature group** | **Components** | **Prerequisite feature groups** |
| 24-5 | 960KHz SCS support | 1. 960KHz SCS for UL transmission2. 960KH SCS for DL reception3. 960KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 960KHz with X=85. PRACH with 960KHz and length 139 |  |

**Proposal: List PRACH part in 24-5 as independent UE feature.**On 24-4 and 24-5, SSB-based monitoring needs further clarification on what to be included in this bullet, e.g. SSB-based RLM, RRM, BFD and etc. It is better to make it clear using spec language.**Proposal: Further clarification of SSB-based monitoring in 24-5 is needed.**Beside the already listed UE features, it seems that certain issues are missing here, e.g. multi-PDSCH/PUSCH support, directional LBT, receiver-assisted LBT and etc. The details of these features may be still discussed currently but they should be considered after they are complete. |
| Huawei/HiSilicon [5] |  |
| Ericsson [6] | Consistent with FG 24-1, a component for support for multi-RB PUCCH format 0/1/4 for 960 kHz should be addedProposal: Add the following new component to FG 24-4 as follows: Support multi-RB PUCCH format 0/1/4 for 960 kHzComponent #4 on multi-slot monitoring is not defined well enough, e.g., it says nothing about the value Y that is currently being discussed as part of the multi-slot monitoring capability definition. In contrast, for PDCCH monitoring in Rel-15 (FG 3-5b) and in Rel-16 (FG 11-2), the description includes a definition of the monitoring span Y. We understand that the discussions have not concluded in RAN1 yet, hence the component can be rewritten as follows until those discussions are completeProposal: Modify the description of Component #4 of FG 24-4 as follows until RAN1 completes the design of multi-slot monitoring capability:Multiple-slot PDCCH monitoring for 960KHz with X=8 [FFS: Component description to be updated once further details of multi-slot monitoring capability are known, e.g., definition of Y] |
| Samsung [7] | Similarly, FG 24-4 and FG 24-5 should only include basic transmission and reception operations for 480 kHz and 960 kHz SCS, respectively, and enhancements regarding the SSB monitoring, multi-slot PDCCH monitoring, and PRACH should be separated out as new feature groups. It also needs to be clarified that FG 24-3, FG 24-4 and FG 24-5 are per band, and optional. Meanwhile, the FGs for SSB reception and data reception should be separated and may not need to be prerequisite from each other. **Proposal: For FG 24-3, FG 24-4 and FG 24-5:****• Separate out “SSB monitoring”, “multi-slot PDCCH monitoring”, and “PRACH” from FG 24-4 and FG 24-5 as new feature groups;****• These FGs are “per band”;****• These FGs are “optional”;****• FG 24-3 doesn’t require FG 24-4 (after the separation) as perquisite FG.** |
| MediaTek Inc. [8] | Similar to our comment for FG 24-4, our proposal for FG 24-5 is as follows

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| Features | Index | Feature group | Components | Note | Mandatory/Optional |
|  ~~24. NR\_ext\_to\_71GHz~~ | ~~24-5~~ | ~~960KHz SCS support~~ | ~~1. 960KHz SCS for UL transmission~~~~2. 960KH SCS for DL reception~~~~3. 960KHz for SSB monitoring~~~~4. Multiple-slot PDCCH monitoring for 960KHz with X=8~~~~5. PRACH with 960KHz and length 139~~ |  |  |
| 24. NR\_ext\_to\_71GHz | 24-5-1 | 960kHz SCS support for DL in FR2-2 | 1. Support 960kHz subcarrier spacing for DL data and control channels and reference signals in FR2-2
 |  | Optional |
| 24. NR\_ext\_to\_71GHz | 24-5-2 | 960kHz SCS support for UL in FR2-2 | 1. Support 960kHz subcarrier spacing for UL data and control channels and reference signals in FR2-2
2. Support PRACH with 960KHz SCS and length 139 in FR2-2
 |  | Optional |

 |
| Intel Corporation [9] | RAN 1 doesn’t complete the down selection between Alt 1 and Alt 2 for multi-slot PDCCH decoding capability yet. However, both Alt 1 and Alt 2 are defined based on a combination of values (X, Y). For value X, it is agreed to support X=4 slots for SCS 480 kHz and X=8 slots for SCS 960 kHz. Other X value(s) are still under discussion. Regarding value Y, it is agreed that 1<=Y<=X/2 (both in units of slot) when X>1 for Alt 1. Similar situation exists for value Y of Alt 2 too. Since a larger Y value is beneficial for the flexibility of PDCCH transmission and a smaller Y value may be favorite from power saving point of view, it is expected multiple Y values can be supported by UE for different use cases. In summary, for each of the SCS 480kHz and 960kHz, UE may support multiple combinations (X, Y) for the multi-slot PDCCH monitoring capability. A first issue is whether the support of multi-slot PDCCH monitoring capability should be captured in the baseline capability FG 24-1. Since multi-slot PDCCH monitoring capability is not introduced for SCS 120kHz, it is fine that multi-slot PDCCH monitoring capability is not a part of FG 24-1. A second issue is whether separate FG(s) should be introduced for the multi-slot PDCCH monitoring capability. With the agreement that a UE supporting SCS 480kHz or 960kHz supports multi-slot PDCCH monitoring for SCS 480kHz or 960kHz, it would be fine to make the support of multi-slot PDCCH monitoring capability a part of FG 24-5. However, the current description in FG 24-5 doesn’t well reflect the status of RAN1 discussion. Therefore, we propose to add FFS for additional X value and the values of Y.

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| 24-5 | 960KHz SCS support | 1. 960KHz SCS for UL transmission2. 960KH SCS for DL reception3. 960KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 960KHz with X=8. FFS other value(s) of X. FFS value(s) of Y5. PRACH with 960KHz and length 139 |  |

 |
| NTT DOCOMO, INC. [10][11] | Since a number of discussions are still on-going in RAN1, only a few UE features are captured in the list now. In general, we believe most of the discussion points regarding UE features need to wait for RAN1 progress a bit more. However, even in the current situation, we think an important UE features to be clearly supported in this WI is missing in the list; that is, the ones for supporting multi-PDSCH/PUSCH scheduling. As the support of this functionality had already been agreed in RAN1, there would be no reason not to capture it even now. Given that only 120 kHz SCS is to be mandatory for UEs supporting NR in 52.6 – 71 GHz, whether to support multi-PDSCH/PUSCH scheduling in 52.6 – 71 GHz should be reported per SCS that the UE supports.

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|  24. NR\_ext\_to\_71GHz | 24-5 | 960KHz SCS support | 1. 960KHz SCS for UL transmission2. 960KH SCS for DL reception3. 960KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 960KHz with X=85. PRACH with 960KHz and length 1396. Multi-PUSCH/PDSCH scheduling by single DCI for the operation with 960 kHz SCS |  |  |  |  |  |  |  |  | 1. From WID
* In addition to 120kHz SCS, specify new SCS, 480kHz and 960kHz, and define maximum bandwidth(s), for operation in this frequency range for data and control channels and reference signals, only NCP supported.
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| LG Electronics [12] |

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| 24-5 | 960KHz SCS support | 1. 960KHz SCS for UL transmission2. 960KHz SCS for DL reception3. 960KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 960KHz with X=85. PRACH with 960KHz and length 139 | 24-1 |

 |
| Apple [13] |  |
| Nokia/Nokia Shanghai Bell [14] |  |

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|  24. NR\_ext\_to\_71GHz | 24-? | Cat 3 or Cat 4 LBT support for FR2-2 unlicensed operation | 1. Cat 3 or 4 LBT support (not agreed yet if CW is supported, so it can be either Cat 3 or Cat 4 LBT for now. Will update when we have agreement) | 24-1 |  |  |  |  |  |  |  |  |  |

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| Company | Summary |
| FUTUREWEI [2] |

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|  24. NR\_ext\_to\_71GHz | 24-? | Cat 3 or Cat 4 LBT support for FR2-2 unlicensed operation | 1. Cat 3 or 4 LBT support (not agreed yet if CW is supported, so it can be either Cat 3 or Cat 4 LBT for now. Will update when we have agreement) | 24-1 |  |  |  | Per band/ Per cell  |  |  |  |  | Optional with capability signalingThis feature is a basic feature for FR2-2 support where required by the regulators  |

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| ZTE/Sanechips [3] |  |
| Vivo [4] |  |
| Huawei/HiSilicon [5] | Cat 3 or Cat 4 LBT support for FR2-2 unlicensed operation* UE feature should reflect the capability at UE side. As for channel access, it only corresponds to UL channel access procedure. So the name of FG should be changed to “Uplink channel access procedure for FR2-2 unlicensed operation”.
* A new component should be added for the LBT bandwidth according to the following agreement in RAN1#106-e.

*Agreement:** *For LBT for single carrier transmission, gNB/UE performs LBT over the channel bandwidth (or BWP bandwidth) (Alt SC.1. in earlier agreements)*
* *For LBT for multi-carrier transmission in intra-band CA, gNB/UE performs multiple LBT, one for each channel bandwidth separately (Alt CA.1. in earlier agreements)*
	+ *FFS: Additional support of performing single LBT over all CCs (Alt CA.2. in earlier agreements)*

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|  24. NR\_ext\_to\_71GHz | 24-? | Unlink channel access procedure for FR2-2 unlicensed operation | 1. Cat 3 or 4 LBT support (not agreed yet if CW is supported, so it can be either Cat 3 or Cat 4 LBT for now. Will update when we have agreement)
2. Support LBT performed per carrier/BWP bandwidth
 | 24-1 |  |  |  |  |  |  |  |  |  |

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| Ericsson [6] | We observe that Cat 4 LBT is not yet agreed, and if agreed, it is not clear that this should be included in the same feature group as Cat 3 or a separate one. Hence for now we propose to remove Cat 4 from the name and description of the FG.Proposal: Modify the name and description of FG 24-? to remove Cat 4 LBT until RAN1 concludes on Cat 4 support

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| Cat 3 ~~or Cat 4 LBT~~ support for FR2-2 unlicensed operation | 1. Cat 3 ~~or 4 LBT~~ support ~~(not agreed yet if CW is supported, so it can be either Cat 3 or Cat 4 LBT for now. Will update when we have agreement)~~ |

 |
| Samsung [7] |  |
| MediaTek Inc. [8] |  |
| Intel Corporation [9] |  |
| NTT DOCOMO, INC. [10][11] |  |
| LG Electronics [12] |  |
| Apple [13] |  |
| Nokia/Nokia Shanghai Bell [14] | FG on Cat 3 or Cat 4 LBT support for FR2-2 unlicensed operation: Agree that more clarity is needed before defining the details of the FG |

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|  24. NR\_ext\_to\_71GHz | 24-? | Cat 2 LBT support for FR2-2 unlicensed operation | 1. Support Cat 2 LBT | 24-1 |  |  |  |  |  |  |  |  |  |

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| Company | Summary |
| FUTUREWEI [2] |

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|  24. NR\_ext\_to\_71GHz | 24-? | Cat 2 LBT support for FR2-2 unlicensed operation | 1. Support Cat 2 LBT | 24-1 |  |  |  |  |  |  |  |  | Optional with capability signalingThis feature is a basic feature for FR2-2 support where required by the regulators   |

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| ZTE/Sanechips [3] |  |
| Vivo [4] |  |
| Huawei/HiSilicon [5] |  |
| Ericsson [6] |  |
| Samsung [7] |  |
| MediaTek Inc. [8] | Up to RAN1 #106e meeting, COT sharing is the only agreed scenario for Cat2 LBT application and it is desirable to support such feature in additional to the support of Cat3 to Cat 4 LBT. Therefore, we suggest to include the support of Cat3 or Cat4 LBT as the prerequisite features for the Cat2 LBT support.

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| Features | Index | Feature group | Components | Prerequisite feature groups | Note | Mandatory/Optional |
|  24. NR\_ext\_to\_71GHz | 24-? | Cat 2 LBT support for FR2-2 unlicensed operation | 1. Support Cat 2 LBT | [Cat 3 or Cat 4 LBT support for FR2-2 unlicensed operation] |  | Optional |

 |
| Intel Corporation [9] |  |
| NTT DOCOMO, INC. [10][11] |  |
| LG Electronics [12] |  |
| Apple [13] |  |
| Nokia/Nokia Shanghai Bell [14] |  |

**General Comments**

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| Company | Summary |
| FUTUREWEI [2] |  |
| ZTE/Sanechips [3] | For Rel -16, UE feature of multiPUSCH-UL-grant-r16 is introduced after introducing multi-PUSCH in NR-U. For Rel-17, the following agreement was achieved and multi-PUSCH/PDSCH has approved for SCS of 120, 480 and 960 kHz in RAN1 #106-e.Agreement:* The maximum number of PDSCHs/PUSCHs that can be scheduled with a single DCI in Rel-17 is 8 for SCS of 120, 480 and 960 kHz.
* FFS: Whether UE capability is introduced for restricting the maximum number of PDSCHs or PUSCHs that can be scheduled with a single DCI

Therefore, similar with UE feature of *multiPUSCH-UL-grant-r16* for multi-PUSCH for NR-U in Rel-16, UE feature for multi-PUSCH/PDSCH should be introduced for FR2-2 in Rel-17. For example, the UE feature may be *multiPUSCH-UL-grant-r17* and *multiPDSCH-DL-grant-r17* correspond to multi-PUSCH and multi-PDSCH for FR2-2 in Rel-17, respectively.**Proposal: UE feature for multi-PUSCH and multi-PDSCH should be introduced for FR2-2 in Rel-17.**In the preliminary RAN1 UE features list, we can observe that Cat2 LBT and Cat3/4 LBT has been reflected in Rel-17 above 52.6GHz UE feature, but there is no see a feature for No LBT. According to the agreement of RAN1 #102 e-meeting, we can see that both channel access with LBT mechanism(s) and a channel access mechanism without LBT has been supported for Rel-17 above 52.6GHz. Therefore, it is necessary to capture the feature for No LBT in Rel-17 above 52.6GHz UE feature list.Agreement:* For gNB/UE to initiate a channel occupancy, both channel access with LBT mechanism(s) and a channel access mechanism without LBT are supported
* FFS: LBT mechanisms such as Omni-directional LBT, directional LBT and receiver assisted LBT type of schemes when channel access with LBT is used.
* FFS: If operation restrictions for channel access without LBT are needed, e.g. compliance with regulations, and/or in presence of ATPC, DFS, long term sensing, or other interference mitigation mechanisms
* FFS: The mechanism and condition(s) to switch between channel access with LBT and channel access without LBT (if local regulation allows)

**Proposal: The feature for No LBT should be captured in Rel-17 above 52.6GHz UE feature list.**In the RAN1 #103 and #105 e-meeting, it has agreed that contention-exempt short control signalling transmission is supported in 60Ghz band for regions where LBT is required and no LBT is allowed for short control signalling, including msg1 for the 4 step RACH and MsgA for the 2-step RACH. The related conclusions are copied as below:Agreement:(RAN1 #103 e-meeting)* Support of contention-exempt short control signalling transmission in 60GHz band for regions where LBT is required and short control signaling without LBT is allowed.
	+ Note: If regulations do not allow short control signaling exemption in a region when operating with LBT, operation with LBT for these short control signals should be supported
* Restrictions to the transmission, such as, on duty cycle (airtime measured over a relatively long period of time), content, TX power, etc. can be discussed when specifications are developed.

Agreement:(RAN1 #105 e-meeting)* Contention Exempt Short Control Signalling rules apply to the transmission of msg1 for the 4 step RACH and MsgA for the 2-step RACH for all supported SCS.
	+ Note restriction for short control signalling transmissions apply (10% over any 100ms intervals)
	+ Alt 1: The 10% over any 100ms interval restriction is applicable to all available msg1/msgA resources configured (not limited to the resources actually used) in a cell
	+ Alt 2: The 10% over any 100ms interval restriction is applicable to the msg1/msgA transmission from one UE perspective
* FFS: Other UL signals/channels can be transmitted with Contention Exempt Short Control Signalling rule, such as msg3, SRS, PUCCH, PUSCH without user plain data, etc

According to the above agreement, we can see that short control signalling is supported only to the given region. Therefore, we think that the feature on contention-exempt short control signalling transmission should be captured in UE feature list.**Proposal: The feature for contention-exempt short control signalling transmission should be captured in Rel-17 above 52.6GHz UE feature list.** |
| Vivo [4] | First, the organization structure of the UE features should consider different deployment scenarios as listed in TS 38.300 for operation with shared spectrum access:- Scenario A: Carrier aggregation between NR in licensed spectrum (SpCell) 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).For NRU UE features, the basic features are defined for different scenarios, i.e. different deployment scenario may have different basic UE features. Similarly, the design framework could be reused for NR operation from 52.6GHz to 71GHz.**Proposal: Reuse NRU UE feature design framework, i.e. different deployment scenario corresponding to different basic UE features.**Second, in current listed UE features, DL reception and UL transmission are always bundled together in the same feature group. Actually, in Scenario A.1 listed above, there is no need to support UL transmission. Thus, separating DL reception and UL transmission into different feature groups is preferred.**Proposal: Separate DL reception and UL transmission into different feature groups.**Third, since 52.6-71GHz may involve both licensed and unlicensed operation, the application band type for each feature group should be determined, i.e. licensed band only, unlicensed band only or both licensed and unlicensed band.**Proposal: The applicable band type (licensed or unlicensed) for each feature group should be determined.** |
| Huawei/HiSilicon [5] | In the WID, it is identified that the proximity of the frequency range of 52.6-71GHz to the original FR2 (24.25-52.6GHz) and the similar commercial opportunities for high data rate communications makes it possible to maximize the leverage of FR2 based implementation in Rel-15/16. During the discussion on FR definition, it is also agreed and reflected in the WID that FR2 is extended to cover the frequency range from 24.25GHz to 71GHz with FR2-1 and the frequency range from 52.6GHz to 71GHz with FR2-2. The commonality in specification between FR2-1 and FR2-2 at least in RAN1 and RAN2 is the main reason to define 52.6-71GHz as a frequency sub-range instead of a new frequency range. Although it is noted in the WID that “The related UE capabilities and their applicability to the frequency range 52.6 to 71 GHz will have to be analyzed on a case by case basis”, we observed that at least for 120 kHz SCS and licensed band operation, it is common understanding among companies to reuse the existing design in FR2-1. So in order to reduce the workload for UE feature discussion we have the following proposal. **Proposal: The R15/16 feature groups for FR2-1 should be supported by default at least for 120 kHz SCS and licensed band operation, except for those explicitly identified**In FR2-2, in addition to 120 kHz SCS with NCP, 480 kHz and 960 kHz SCS are optionally supported. Many of UE features agreed so far are either numerology agnostic or having trivial difference in parameters. For example, the support of channel access procedures, basic data/control channels and reference signals transmission/reception and multi PDSCH/PUSCH scheduling by single DCI are numerology agnostic. The capability of beam management may only differ in the values related to timeline. There are also UE features only supported by specific numerologies. For example, 120 kHz SSB for initial access will be supported for all UE while 480 kHz SSB is only optionally supported for initial access and 960 kHz SSB is not supported for initial access. In order to leave the flexibility while maintaining reasonable amount of UE capability report, we have the following proposal. **Proposal: The feature groups defined in Rel-17 for FR2-2 should be supported for all numerologies, except for those explicitly identified.** In NR-U Rel-16, it had been agreed that the feature groups designed for unlicensed band operation should be discussed case by case whether they are applicable to licensed band operation. Finally, there are several features also adopted by licensed band operation in Rel-16, such as PDSCH mapping Type B other than 2,4,7 OS, enhanced type 2 and type 3 HARQ codebook, SRS location other than last 6 OS and multiple PUSCH scheduling by single DCI. At same time, most of feature groups design for FR1 licensed band in NR Rel-15 is directly inherited. We meet a similar situation in Rel-17 for the feature groups for FR2-2. For example, multiple PDSCH scheduling and multi-slot PDCCH monitoring will be applied to both licensed and unlicensed band operation. While wideband PRACH and channel access procedure will only be valid for unlicensed band operation. Thus, we have the following proposal. **Proposal: It should be studied case by case for each feature group defined in Rel-17 for FR2-2 whether it can be applied only in unlicensed band or both unlicensed and licensed band operation. The feature group applicable to licensed or unlicensed band(s) should be explicitly captured in the table.**It is noted in WID after frequency sub-range FR2-2 is agreed that “The application of any of the UE feature introduced for 52.6-71 GHz to existing FR1/FR2 should be discussed case by case.” Most of feature group may only be used in FR2-2, e.g. the enhancements corresponding to the new SCS. On the other side, we do observe feature group can be applicable to FR2-1 or even FR1, such as multiple PDSCH scheduling by single DCI. **Proposal: It should be studied case by case for each feature group defined in Rel-17 for FR2-2 whether it can be extended to FR2-1. The applicable FR should be explicitly captured in the table.**The following features has been agreed but not reflected in the table, which includes* **FG24-?: Multi-PDSCH/PUSCH scheduling by single DCI**

It is identified as one of the objective in WID that * + *“Support enhancements for multi-PDSCH/PUSCH scheduling and HARQ support with a single DCI.”*

The feature of multi-PUSCH scheduling by single DCI is introduced in FG10-17 in NR-U Rel-16 in order to reduced LBT overhead in unlicensed band. Up to 8 PUSCH can be scheduled with DCI 0-1. Although it is extended to licensed band and even FR2-1 for 120 kHz SCS, there is still restriction that the scheduled PUSCH should be contiguous in time domain.In Rel-17, multi-PUSCH scheduling by single DCI has been further extended in FR2-2 for 480 kHz and 960 kHz SCS. The restriction of contiguous resource allocation in time domain is also removed. Moreover, Up to 8 PDSCH scheduled DCI 1-1 is added, which results enhancement of type 1 and type 2 HARQ codebook generation. So we think Multi-PDSCH/PUSCH scheduling by single DCI can be a separate FG with the difference in Rel-17 discussed above as components in the feature group.* **FG24-?: Support 32 HARQ processes for 480/960kHz SCS**

 In RAN1#106-e, it is agreed that *Agreement:* *For NR FR2-2 at least for 480/960 kHz SCS, support 32 as the maximum number of HARQ processes for DL and UL, subject to UE capability.** *Note: Up to 32 maximal supported HARQ process number is already agreed in Rel-17 NTN WI.*
* *Working assumption: The same solution to support up to 32 HARQ process number in Rel-17 NTN WI is reused for NR FR2-2.*

According to the agreement, the support of such feature depends on UE capability. Considering NTN may only support FR1, it should be set a separate FG for FR2-2 with support 480 kHz and 960 kHz as prerequisite. **Proposal: The following new feature groups should be added.** * **Wideband PRACH**
* **PUCCH format 0/1/4 with multi RB**
* **Multiple-PDSCH/PUSCH scheduling by single DCI**
* **32 HARQ processes for 480kHz and 960kHz**

There are some feature groups already existing in Rel-15. The values are extended for 480 kHz and 960 kHz SCS in FR2-2. These features includes:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups | Field name in TS 38.331 [2] |
| 2-2 | PDSCH beam switching | 1) Time duration (definition follows clause 5.1.5 in TS 38.214), Xi, to determine and apply spatial QCL information for corresponding PDSCH reception.Time duration is defined counting from end of last symbol of PDCCH to beginning of the first symbol of PDSCH.Xi is the number of OFDM symbols, i is the index of SCS, l=1,2, corresponding to 60,120 kHz SCS. | 2-1 | *timeDurationForQCL* |
| 2-25 | Beam reporting timing | The number of symbols, Xi, between the last symbol of SSB/CSI-RS and the first symbol of the transmission channel containing beam report is at least RBi, wherei is the index of SCS, i=1,2,3,4 corresponding to 15,30,60,120 kHz SCS. | 2-24 | *beamReportTiming* |
| 2-27 | Beam switching | Maximum number of Tx + Rx beam changes a UE can conduct during a slot across the whole band CC B\_(B\_Total,). This number is defined as per SCS | 2-24 | *maxNumberRxTxBeamSwitchDL* |
| 2-28 | A-CSI-RS beam switching timing | Minimum time between the DCI triggering of AP-CSI-RS and aperiodic CSI-RS transmission shall be at least KBi symbols. (Symbols measured from last symbol containing the indication to first symbol of CSI-RS), wherei is the index of SCS, l=1,2 corresponding to 60,120 kHz SCS. |  | *beamSwitchTiming* |

It should be discussed whether new feature groups should be added for 480 kHz SCS and 960 kHz SCS or simply add additional values in the existing FGs. As RAN2 will design the UE capability signaling, guidance from RAN2 might be helpful.**RAN2’s guidance is necessary to decide whether to introduce new FGs or modify existing FG to capture the new values introduced for 480 kHz and 960 kHz.**

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|  24. NR\_ext\_to\_71GHz | 24-? | Wideband PRACH | Enhanced PRACH design for operation with shared spectrum channel access by adopting a single long ZC sequence, with ZC sequence = 1151 for 120kHz and ZC sequence = 571 for 120kHz /[480kHz].  | 24-1, [24-4]  |  |  |  |  |  |  |  | Agreement:* For initial access and non-initial access use cases, support 120kHz PRACH SCS with sequence length L=571, 1151 (in addition to L=139) for PRACH Formats A1~A3, B1~B4, C0, and C2.

…Agreement:Do not support PRACH length L=571, 1151 for 960kHz PRACH and at least L =1151 for 480kHz PRACH.  |  |
|  24. NR\_ext\_to\_71GHz | 24-? | PUCCH format 0/1/4 with multi RB | 1. Support [2,…, 16] RB for PUCCH format 0 and format 1 for 120kHz/480kHz/960kHz
2. Support [2,…, 16] RB for PUCCH format 4 for 120kHz/480kHz/960kHz
 | 24-1, 24-4, 24-5 |  |  |  |  |  |  |  | Agreement:The maximum configured number of RBs, N\_RB, for enhanced PF 0/1/4 is given by 16 RBs for 120 kHz SCSAgreement:The maximum configured number of RBs, N\_RB, for enhanced PF 0/1/4 is given by 16 RBs for 480 and 960 kHz SCS (same as for 120 kHz SCS). |  |
|  24. NR\_ext\_to\_71GHz | 24-? | Multiple PDSCH/PUSCH scheduling by single DCI | 1. Support scheduling up to 8 PDSCH by DCI 1-1
2. Support scheduling up to 8 PUSCH by DCI 0-1
3. Support non-contiguous time domain resource allocation
4. Support enhanced Type1 HARQ codebook for multiple PDSCH scheduling by single DCI
5. Support enhanced type 2 HARQ codebook for multiple PDSCH scheduling by single DCI
 | 24-1, 24-4, 24-5 |  |  |  |  |  |  |  | Agreement:* The maximum number of PDSCHs/ PUSCHs that can be scheduled with a single DCI in Rel-17 is 8 for SCS of 120, 480 and 960 kHz.

FFS: Whether UE capability is introduced for restricting the maximum number of PDSCHs or PUSCHs that can be scheduled with a single DCI.Agreement:* Do not use fallback DCI (i.e., DCI formats 0\_0 and 1\_0) for multi-PDSCH/PUSCH scheduling.
* Use DCI format 0\_1 to schedule multiple PUSCHs with a single DCI.
* Use DCI format 1\_1 to schedule multiple PDSCHs with a single DCI.

Agreement:For TDRA in a DCI that can schedule multiple PDSCHs (or PUSCHs),* A row of the TDRA table can indicate PDSCHs (or PUSCHs) that are in consecutive or non-consecutive slots, by configuring {SLIV, mapping type, scheduling offset K0 (or K2)} for each PDSCH (or PUSCH) in the row of TDRA table.
* Note: Whether and how to reduce RRC overhead is left to RAN2.
 |  |
|  24. NR\_ext\_to\_71GHz | 24-? | Support of 32 HARQ processes  | 1. Support 32 HARQ processes
 | [24-1], 24-4, 24-5 |  |  |  |  |  |  |  | Agreement: For NR FR2-2 at least for 480/960 kHz SCS, support 32 as the maximum number of HARQ processes for DL and UL, subject to UE capability.* Note: Up to 32 maximal supported HARQ process number is already agreed in Rel-17 NTN WI.

Working assumption: The same solution to support up to 32 HARQ process number in Rel-17 NTN WI is reused for NR FR2-2. |  |

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| Ericsson [6] | As a general principle, feature group A should be listed as a pre-requisite for feature group B only if feature group B cannot functionally operate without feature group A. Hence, in order to apply this principle, it is first necessary to have stable, clear definitions for each feature group before deciding which FG is a pre-requisite for another. For example, as we discuss below, FG 24-2 (120 kHz standalone support) does not strictly require multi-RB PUCCH and long sequence PRACH listed as components of FG 24-1, so it is not clear that 24-1 should be a pre-requisite for 24-2 given the current definition of 24-1. The components of 24-1 should be discussed first.**Proposal: Defer discussion on which FGs should be pre-requisites of other FGs until there are stable, clear definitions for each FG with agreements on which components should be included. For now, the pre-requisite column of the UE features table should be left blank to avoid complicating the UE feature discussion.** The first priority is to focus on defining clear descriptions of each feature group and agree on which components should be included. After that, then the signaling granularity (per UE, per band, etc.) and the optionality can be decided. In our view, unless there is a strong motivation to define the signaling granularity other than per-UE, the starting point is that a feature should be per-UE. As agreed in RAN, discussions on whether or not there is a need to differentiate between FR2-1 and FR2-2 is handled on a case-by-case (i.e., per FG) basis.**Proposal: Defer discussion on signaling type (Per UE, Per Band, etc.), optional/mandatory support, and potential FR2-1/2-2 differentiation until there are stable, clear definitions for each FG with agreements on which components should be included.**In Rel-17, new candidate values for the following 4 existing UE capability parameters has been discussed:* *timeDurationForQCL*
	+ Rel-15 FG 2-2 in [2]
* *beamSwitchTiming*
	+ Rel-15 FG 2-28 in [2]
	+ Rel-16 FG 14-7 in [2]
* *beamReportTiming*
	+ Rel-15 FG 2-25 in [2]
* *maxNumberRxTxBeamSwitchDL*
	+ Rel-15 FG 2-27 in [2]

The agreements below show the new candidate values that are supported for the larger subcarrier spacings (480 and 960 kHz) introduced in Rel-17. Hence these values need to be accounted for in the UE feature list update for Rel-17. Proposal: Include the new candidate values agreed for the capability parameters timeDurationForQCL, beamSwitchTiming, beamReporTiming, and maxNumberRxTxBeamSwitchDL in the UE feature list for Rel-17.Agreement:For timeDurationForQCL, beamSwitchTiming and beamReportTiming,* Following candidate values of FR2 are reused for 120 kHz:
	+ timeDurationForQCL: 14 and 28 symbols
	+ beamSwitchTiming: 14, 28, 48, 224 and 336 symbols
	+ beamReportTiming: 14, 28 and 56 symbols
* For 480 kHz
	+ Support at least the candidate values for 120 kHz scaled by 4x
	+ FFS: Support for additional candidate value(s)
* For 960 kHz
	+ Support at least the candidate values for 120 kHz scaled by 8x
	+ FFS: Support for additional candidate values(s)
* FFS: UE capability signaling details
* Note: The scaled values 224 and 336 symbols for beamSwitchTiming are used as in Rel-16 (defined in Rel-15 with updates in Rel-16).

Agreement:For candidate values of timeDurationForQCL, beamSwitchTiming and beamReportTiming, * Support one of the following alternatives
	+ Alt-1: No additional candidate values are supported for 120 kHz, 480 kHz and 960 kHz
	+ Alt-2: 28 and 56 symbols are supported as additional candidate values for 480 kHz and 960 kHz, respectively
* For UE capability signaling, UE reports one value of the candidate values in OFDM symbols per each SCS

Agreement:For maxNumberRxTxBeamSwitchDL,* Support at least 2 and 4 as candidate values for 480 kHz
	+ FFS: 7
* Support at least 2 as a candidate value for 960 kHz
	+ FFS: Support for additional candidate value(s) including 4

Agreement:For maxNumberRxTxBeamSwitchDL,* For 480 kHz, support 7 as a candidate value for 480 kHz in addition to the agreed candidate values 2 and 4
* For 960 kHz, support one of the following alternatives
	+ Alt-1: Support 1, 4 and [7] as candidate values for 960 kHz in addition to the agreed candidate values 2
	+ Alt-2: Support 4 as a candidate value for 960 kHz in addition to the agreed candidate values 2
* No additional candidate values are supported

Agreement:For the threshold values 48 or 48+ $d∙2^{μ\_{CSIRS}}/2^{μ\_{PDCCH}}$ mentioned in Clauses 5.2.1.5.1 and 5.2.1.5.1a of 38.214, scale 48 to 4\*48 for 480 kHz and 8\*48 for 960 kHz. |
| Samsung [7] | The current list in R1-2108679 is not exhausted, and there are agreed features subject to UE capabilities not captured in the list. We observed at least the following feature groups should be added. **Proposal: Add the following FGs requiring capability signalling:****• 2 codeword transmission for PDSCH, per band;****• Multiple PDSCH scheduled in a slot for 120 kHz SCS and single TRP operation, per band;****• Multiple PUSCH scheduled in a slot for 120 kHz SCS and single TRP operation, per band;****• 32 maximum number of HARQ processes for DL, per FSPC;****• 32 maximum number of HARQ processes for UL, per FSPC.**For the 60 GHz unlicensed band, many features from Rel-16 NR-U for resisting the impact from LBT should be carried over by default, as captured in the TR. Additional FGs should be added to current list in R1-2108679 [1], using Rel-16 NR-U FGs as a baseline. **Proposal: For 60 GHz unlicensed band, add more FGs carried over from Rel-16 NR-U.** |
| MediaTek Inc. [8] | Based on the conclusion made in RAN #92, indication of the UE features for FR2-2 only should be included in UE capability reporting, which is not allowed based on the current UE feature list structure. One way to address the issue could be to include the notion of “FR2-2” in the naming or components of the FG applied for FR2-2 only. Another way could be to include a column in the UE feature list table to indicate “FR1-FR2-1-FR2-2 differentiation” for FGs to allow UE to support different functionalities between FR1, FR2-1, and FR2-2. Proposal: How to report UE features applied to only FR2-1 or FR2-2 should be further discussed.

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| Introduce FR2-1 for 24.25 – 52.6 GHz, and FR2-2 for 52.6 – 71 GHz,* The above two ranges to be introduced under the FR2 common range.

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|  | Option A |
| Frequency range designation | Corresponding frequency range  |
| FR1 | 410 MHz – 7125 MHz |
| FR2 |  FR2-1: 24250 MHz – 52600 MHz |
| FR2-2: 52600 MHz – 71000 MHz |
| NOTE: Whenever the FR2 is referred, both FR2-1 and FR2-2 frequency sub-ranges shall be considered in this release, unless otherwise stated.NOTE: The designations FR2-1 and FR2-2 should only be used when needed. |

* The related UE capabilities and their applicability to the frequency range 52.6 to 71 GHz will have to be analysed on a case by case basis
* The application of any of the UE feature introduced for 52.6-71 GHz to existing FR1/FR2 should be discussed case by case.

TSG RAN specifications shall make it very clear (to readers) that frequency bands in the 52.6-71GHz range are only Release-independent from Rel-17 onwards, to ensure that there is clear industry understanding about which FR2 features are applicable for operation in 52.6-71GHz range. |

 FG for wideband PRACH enhancementFor wideband PRACH enhancement, we suggest to introduce an FG to capture the agreement made in RAN1 #104e meetingAgreement:* For initial access and non-initial access use cases, support 120kHz PRACH SCS with sequence length L=571, 1151 (in addition to L=139) for PRACH Formats A1~A3, B1~B4, C0, and C2.

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| Features | Index | Feature group | Components | Note | Mandatory/Optional |
| 24. NR\_ext\_to\_71GHz | 24-X | Wideband PRACH for 120kHz SCS in FR2-2 unlicensed operation | 1. Enhanced PRACH design for operation with shared spectrum channel access by adopting a single long ZC sequence, with ZC sequence = 571/1151 for 120kHz |  | Optional |

FG for multi-slot PDCCH monitoringAlthough the multi-slot PDCCH monitoring feature details are still under discussion, we suggest to reserve FGs for the feature and revise the components with more details when the functionality is mature.

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| Features | Index | Feature group | Components | Note | Mandatory/Optional |
| 24. NR\_ext\_to\_71GHz | 24-Y-1 | Multi-slot PDCCH monitoring for 480kHz | 1. Support multi-slot PDCCH monitoring for 480KHz with X=4
 |  | Optional |
| 24. NR\_ext\_to\_71GHz | 24-Y-2 | Multi-slot PDCCH monitoring for 960kHz | 1. Support multi-slot PDCCH monitoring for 960KHz with X=8
 |  | Optional |

FG for multi-RB PUCCH format 0/1/4Based on our comments on FG 24-1, we suggest to introduce FGs for multi-RB PUCCH format 0/1/4 enhancements based on the following agreements:Agreement:The maximum configured number of RBs, N\_RB, for enhanced PF 0/1/4 is given by 16 RBs for 120 kHz SCS.Agreement:The maximum configured number of RBs, N\_RB, for enhanced PF 0/1/4 is given by 16 RBs for 480 and 960 kHz SCS (same as for 120 kHz SCS).

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| Features | Index | Feature group | Components | Note | Mandatory/Optional |
| 24. NR\_ext\_to\_71GHz | 24-Z-1 | 120kHz multi-RB PUCCH format 0/1/4 for FR2-2 unlicensed operation | 1. Support multi-RB PUCCH format 0/1 enhancements with configured integer number of RB in the range [1,… ,16]
2. Support multi-RB PUCCH format 4 enhancements with configured integer number of RB in the range [1,… ,16] that fulfil the requirement $2^{α\_{2}}∙3^{α\_{3}}∙5^{α\_{5}}$ where $α\_{2},α\_{3},α\_{5}$ is a set of non-negative integers
 |  | Optional |
| 24. NR\_ext\_to\_71GHz | 24-Z-2 | 480kHz multi-RB PUCCH format 0/1/4 for FR2-2 unlicensed operation | 1. Support multi-RB PUCCH format 0/1 enhancements with configured integer number of RB in the range [1,… ,16]
2. Support multi-RB PUCCH format 4 enhancements with configured integer number of RB in the range [1,… ,16] that fulfil the requirement $2^{α\_{2}}∙3^{α\_{3}}∙5^{α\_{5}}$ where $α\_{2},α\_{3},α\_{5}$ is a set of non-negative integers
 |  | Optional |
| 24. NR\_ext\_to\_71GHz | 24-Z-3 | 960kHz multi-RB PUCCH format 0/1/4 for FR2-2 unlicensed operation | 1. Support multi-RB PUCCH format 0/1 enhancements with configured integer number of RB in the range [1,… ,16]
2. Support multi-RB PUCCH format 4 enhancements with configured integer number of RB in the range [1,… ,16] that fulfil the requirement $2^{α\_{2}}∙3^{α\_{3}}∙5^{α\_{5}}$ where $α\_{2},α\_{3},α\_{5}$ is a set of non-negative integers
 |  | Optional |

FG for multi-PDSCH DL grantWe suggest to add FGs for the enhancements of both multi-PDSCH and multi-PUSCH scheduled by single DCI. We also suggest to add the notion of FR2-2 in this FG such that it can be differentiated from the existing multi-PUSCH feature introduced for Rel-16 NR-U and for FR2-1.

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| Features | Index | Feature group | Components | Note | Mandatory/Optional |
| 24. NR\_ext\_to\_71GHz | 24-S-1 | multi-PDSCH DL grant for 120 kHz SCS in FR2-2 | 1. Support of scheduling up to 8 PDSCHs with a single DCI 1\_1 for 120kHz SCS in FR2-2
 |  | Optional |
| 24. NR\_ext\_to\_71GHz | 24-S-2 | multi-PDSCH DL grant for 480kHz SCS in FR2-2 | 1. Support of scheduling up to 8 PDSCHs with a single DCI 1\_1 for 480kHz SCS in FR2-2
 |  | Optional |
| 24. NR\_ext\_to\_71GHz | 24-S-3 | multi-PDSCH DL grant for 960kHz SCS in FR2-2 | 1. Support of scheduling up to 8 PDSCHs with a single DCI 1\_1 for 960kHz SCS in FR2-2
 |  | Optional |

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| Features | Index | Feature group | Components | Note | Mandatory/Optional |
| 24. NR\_ext\_to\_71GHz | 24-T-1 | multi-PUSCH UL grant for 120 kHz SCS in FR2-2 | 1. Support of scheduling up to 8 PUSCHs with a single DCI 0\_1 for 120kHz in FR2-2
 |  | Optional |
| 24. NR\_ext\_to\_71GHz | 24-T-2 | multi-PUSCH UL grant for 480kHz SCS in FR2-2 | 1. Support of scheduling up to 8 PUSCHs with a single DCI 0\_1 for 480kHz in FR2-2
 |  | Optional |
| 24. NR\_ext\_to\_71GHz | 24-T-3 | multi-PUSCH UL grant for 960kHz SCS in FR2-2 | 1. Support of scheduling up to 8 PUSCHs with a single DCI 0\_1 for 960kHz in FR2-2
 |  | Optional |

 Based on the WID, both LBT and No-LBT related procedures can be supported in FR2-2 unlicensed spectrum. Therefore, we suggest to introduce a FG for UE to indicate support of only No-LBT mode transmission.

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| Features | Index | Feature group | Components | Note | Mandatory/Optional |
| 24. NR\_ext\_to\_71GHz | 24-W | No-LBT mode transmission for FR2-2 unlicensed operation | 1. Support only No-LBT mode transmission for FR2-2 unlicensed operation |  | Optional |

 |
| Intel Corporation [9] | Max number of Rx/Tx Beam switchingRAN1 has agreed to added 2, 4 and 7 as candidate numbers of Rx Tx beam switch for downlink value for 480kHz and at least 2 for 960kHz. We propose to add 1, 4 and 7 for 960kHz. Given that this is a capability that UE reports, we strong believe frequent values should be supported by the specification so that more advanced UE can indicate support of such frequent beam switching. From our understanding supporting additional values should not negatively impact UE implementation nor gNB implementation, as UE will have freedom to report any of the valid values as capability, and gNB can control how DL and UL transmission are conducted.* **Propose to add/amend the maxNumberRxTxBeamSwitchDL capability to support:**
	+ **{2,4,7} for 480kHz**
	+ **{1, 2,4,7} for 960kHz**

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| --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups |
| 24-A | maxNumberRxTxBeamSwitchDL | For existing capability maxNumberRxTxBeamSwitchDL add the following options.Optionally indicate {2,4,7} values for 480kHz SCS.Optionally indicate {1, 2,4,7} values for 960kHz SCS. | 24-4, 24-5 (depending on indicated SCS) |

timeDurationQCL, beamReportTiming and beamSwitchTimingIn RAN1 #104-bis-e meeting the values for parameters corresponding to timing relationships associated with beam management operations were agreed. For larger SCS of 480 kHz/960 kHz, the main principle is to scale the parameter values of NR FR2 reused in NR extension from 52.6 GHz up to 71 GHz for SCS 120 kHz. However, the simple scaling means no speed up in beam management operations for the new NR UE devices, which are intended to work on these frequencies, comparing with current UE devices operating in NR FR2. Therefore, it seems necessary to provide UE capabilities for faster beam switching and beam reporting assuming some reasonable progress in signal processing of UE devices for NR extension from 52.6 GHz up to 71 GHz. In particular, it’s proposed to support an additional candidate value of 28 OFDM symbols for SCS 480 kHz and a candidate value of 56 OFDM symbols for SCS 960 kHz for each of the parameters: *timeDurationQCL*, *beamReportTiming* and *beamSwitchTiming*. The added values would in addition to 4x and 8x scaled values of 120kHz agreed for 480kHz and 960kHz, respectively.* **For timeDurationForQCL, beamSwitchTiming and beamReportTiming,**
	+ **Following candidate values of FR2 are reused for 120 kHz:**
		- **timeDurationForQCL: 14 and 28 symbols**
		- **beamSwitchTiming: 14, 28, 48, 224 and 336 symbols**
		- **beamReportTiming: 14, 28 and 56 symbols**
	+ **For 480 kHz**
		- **Support at least the candidate values for 120 kHz scaled by 4x**
		- **Additionally support 28**
	+ **For 960 kHz**
		- **Support at least the candidate values for 120 kHz scaled by 8x**
		- **Additionally support 56**

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| --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups |
| 24-B | timeDurationQCL | For existing capability timeDurationQCL add the following options.Support {28, 56 (=4\*14), 112 (=4\*28)} for 480kHz.Support {56, 112 (=8\*14), 224 (=8\*28)} for 960kHz. |  |
| 24-C | beamReportTiming | For existing capability beamReportTiming add the following options.Support {28, 56 (=4\*14), 112 (=4\*28), 224 (=4\*48), 896 (=4\*224), 1344 (=4\*336)} for 480kHzSupport {56, 112 (=8\*14), 224 (=8\*28), 384 (=8\*48), 1792 (=8\*224), 2688 (=8\*336)} for 960kHz |  |
| 24-D | beamSwitchTiming | For existing capability beamSwitchTiming add the following options.Support {28, 56 (=4\*14), 112 (=4\*28), 224 (=4\*56)} for 480kHzSupport {56, 112 (=8\*14), 224 (=8\*28), 448 (=8\*56)} for 960kHz |  |

With the de-prioritization of enhancement of NR operation above 52.6 GHz for Release 18, it is now even more important to make sure capability support for advanced UEs are standardized in Release 17. While it is difficult to assess what advanced UEs could be supported in the future, several companies have provided projection numbers for advance processing capability. We believe those values are good place to start. For N1 and N3 values, 34 ~ 41 symbols for 480kHz and 46 ~ 54 symbols for 960kHz should be something that could be achieved by future implementations. These values roughly correspond to 75 ~ 92 µsec and 51 ~ 60 µsec, respectively. Please note that IEEE 802.11ad/ay system can perform much faster processing in the order of few µsec. Therefore, the support of 50 ~ 80 µsec downlink data processing does not seem to be something that is unachievable.Similarly, we think 85 ~ 95 symbols for 480 kHz and 112 ~ 160 symbols with 960 kHz for N2 are feasible values. These roughly correspond to 190 ~ 212 µsec and 125 ~ 178 µsec preparation time for PUSCH, respectively.For CSI processing, unlike data it is difficult to scale down the channel estimation process by putting more hardware components. However, for devices that are able to support 1.6GHz or 2GHz of channel bandwidth, we expect these devices are have quite advanced processing capabilities and should be able to process the channel estimation results to generate the required CSI feedback. Therefore, instead of 4x and 8x scaling from 120kHz, we think 2x and 4x scaling compared with 120kHz could be feasible.**Proposal:** * **Support the following advanced N1, N2, and N3 processing times as optional capability.**
	+ **N1 = N3 = [36], N2 = [90] for 480 kHz**
	+ **N1 = N3 = [49], N2 = [144] for 960 kHz**
* **Support the following advance Z1,Z2,and Z1 processing times for CSI as optional capability**

|  |  |  |  |
| --- | --- | --- | --- |
| *µ* | ***Z1* [symbols]** | ***Z2* [symbols]** | ***Z3* [symbols]** |
| *Z1* | *Z'1* | *Z2* | *Z'2* | *Z3* | *Z'3* |
| 5 | [194] | [170] | [304] | [280] | [min([194], *X*5+ KB3)] | [*X*5] |
| 6 | [388] | [340] | [608] | [560] | [min([388], *X*6+ KB4)] | [*X*6] |

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| --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups |
| 24-W | Advanced data processing capability | Indicate that UE supports smaller PDSCH processing time (N1), PUSCH preparation time (N2), and HARQ-ACK multiplexing timeline (N3).If indicated to be supported, UE shall support N1 = N3 = [36], N2 = [90] for 480 kHz N1 = N3 = [49], N2 = [144] for 960 kHz |  |
| 24-V | Advance CSI processing capability | Indicates that UE supports smaller CSI processing Z1, Z2, and Z3.If indicated to be supported, UE shall supportFor 480kHz:Z1 = [194] Z’1 = [170]Z2 = [304] Z’2 = [280]Z3 = min([194], X5 + KB3)For 960kHz:Z1 = [388] Z’1 = [340] Z2 = [608] Z’2 = [560] Z3 = min([388], X6 + KB4) |  |

It is evident that UE may not be able to support beyond specific MCS for a specific rank due to excessive phase noise, even with the most advanced phase noise compensation techniques that may be utilized by the UE. The support of advance phase noise compensation techniques should not be considered a norm for all UE. Therefore, the supported maximum MCS and for each transmission rank may need to indicate as capability signaling.It should be noted that existing capability signal does support indication of max number of MIMO layers, and supported modulation order for DL. However, gNB is allows to indicate higher modulator order than the reported values as long the maximum peak throughput is not exceeded. The following is the description for supportedModulationOrderDL.

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| --- |
| ***supportedModulationOrderDL*** Indicates the maximum supported modulation order to be applied for downlink in the carrier in the max data rate calculation as defined in 4.1.2. If included, the network may use a modulation order on this serving cell which is higher than the value indicated in this field as long as UE supports the modulation of higher value for downlink. If not included: - for FR1, the network uses the modulation order signalled in *pdsch-256QAM-FR1*. - for FR2, the network uses the modulation order signalled per band i.e. *pdsch-256QAM-FR2* if signalled. If not signalled in a given band, the network shall use the modulation order 64QAM. In all the cases, it shall be ensured that the data rate does not exceed the max data rate (*DataRate*) and max data rate per CC (*DataRateCC*) according to TS 38.214.  |

**Proposal: Support capability signaling to indicate the maximum MCS support for each transmission rank (among supported number of transmission layers). The actual minimum max-MCS value for each transmission rank (values in bracket) is FFS.**

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| --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups |
| 24-X | Supported maximum MCS in DL | Indicates the maximum MCS for DL supported by the UE for each transmission rank supported by the UE. Note that UE shall support MCS 29, 30, 31 of MCS table 1 and 3 regardless of indicated value.Values are indicated for each supported subcarrier spacing and each rank supported by the UE operating in FR2-2. [Note: numbers in brackets are FFS]For 120kHz:* For rank 1: max MCS of {[16], …, 28} of MCS table 1, max MCS of {[20], …, 28} of MCS table 3
* For rank 2: max MCS of {[9], …, 28} of MCS table 1, max MCS of {[15], …, 28} of MCS table 3
* For rank 3~8: max MCS of {[9], …, 28} of MCS table 1, max MCS of {[15], …, 28} of MCS table 3

For 480kHz:* For rank 1: max MCS of {[16], …, 28} of MCS table 1, max MCS of {[20], …, 28} of MCS table 3
* For rank 2: max MCS of {[9], …, 28} of MCS table 1, max MCS of {[15], …, 28} of MCS table 3
* For rank 3~8: max MCS of {[9], …, 28} of MCS table 1, max MCS of {[15], …, 28} of MCS table 3

For 960kHz:* For rank 1: max MCS of {[16], …, 28} of MCS table 1, max MCS of {[20], …, 28} of MCS table 3
* For rank 2: max MCS of {[9], …, 28} of MCS table 1, max MCS of {[15], …, 28} of MCS table 3
* For rank 3~8: max MCS of {[9], …, 28} of MCS table 1, max MCS of {[15], …, 28} of MCS table 3
 |  |

**UE beam correspondence**In general, companies generally agree that LBT beams should have some correspondence (or strong correlation) with the Tx beams that are planned to be after successful LBT operation. In order for this operation to properly work beam correspondence at the UE is needed. Currently beam correspondence is mandatory UE capability with capability signaling. We suggest to change this such that for FR2-2, beam correspondence must be mandatorily supported.Proposal: For UEs supporting bands in FR2-2, beamCorrespondenceWithoutUL-BeamSweeping must be supported.

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| --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups |
| 24-E | beamCorrespondenceWithoutUL-BeamSweeping | For existing capability beamCorrespondenceWithoutUL-BeamSweeping add the following text:For UEs supporting operation in FR2-2 band(s), UE shall indicate support of beamCorrespondenceWithoutUL-BeamSweeping for those band(s).  |  |

**Rx assisted LBT**Among the four candidate schemes identified by RAN1 to support a receiver-aided LBT procedure so that to provide to the gNB a better assessment of the channel occupancy status of the UE, only scheme 1, which is based on L1-RSSI assistance, and scheme 2, which is based on CCA (a.k.a. CAT-2 LBT) or eCCA (a.k.a, Cat-4 LBT) based assistance, may be actually beneficial from a system level perspective, and may be feasible from a standardization point of view considering the amount of time left to work out the details. The benefits of scheme 1 are strictly correlated with the timeline for L1-RSSI reporting, and they become more evident as this timeline is tightened. For this matter, while we believe this scheme may be beneficial and should be supported, it may need to be used only when the UE’s processing time for the L1-RSSI is tightened, therefore UE’s capability signaling is needed for this matter.**Proposal: Support capability signaling to indicate whether or not a UE could support L1-RSSI based receiver assistance (scheme 1)**As for scheme 2, in order to reduce the LBT overhead, which otherwise would detrimentally impact the benefit of this scheme, only a CCA based receiver assistance should be supported. In this matter, given that Cat-2 is based on UE’s capability, and this scheme is based on the assumption that a UE can perform Cat-2, then this scheme could be only used up to UE’s capability. In this sense, we suggest to add a note into the CAT-2 capability signaling indicating that this signaling would also support the CCA based receiver assistance scheme.**Proposal: CCA based receiver assistance scheme (scheme 2) is supported based on CAT-2 capability signaling.**

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| --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups |
| 24-F | L1-RSSI based receiver assistance | UE is able to perform L1-RSSI measurement and report as part of AP-CSI |  |
| 24-? | Cat 2 LBT support for FR2-2 unlicensed operation | 1. Support Cat 2 LBT
2. Support CCA based receiver assistance
 | 24-1 |

 |
| NTT DOCOMO, INC. [10][11] | A general issue would be how to consider FR-related differentiation. In this WI, companies discuss on various types of new features and enhancements of the existing NR functionalities to extend NR to 52.6 – 71 GHz frequency range. Any UE feature to be supported in this WI will then be applicable at least for 52.6 – 71 GHz. However, companies may or may not argue that some of the UE features to be specified in this WI could be technically beneficial even in another frequency range, and then desire to discuss whether/how to expand the applicability of such UE features to other frequency ranges. It may consume quite a lot of time in RAN1 to discuss the range of applicability one by one. Note that 52.6 – 71 GHz frequency range at least include unlicensed bands, while licensed bands may also be identified in the future. The WI also target the support for both licensed and unlicensed band in this frequency range. This fact may also make the discussion more complex. Also, frequency range notation itself should be carefully considered. In the latest WID for supporting NR from 52.6 GHz to 71 GHz [2], two important aspects on frequency range definition regarding beyond 24 GHz are captured; one is to extend the definition of FR2 up to 71GHz, and the other is to introduce new FR sub-labels, FR2-1 and FR2-2, to be used for differentiating 24.25 – 52.6 GHz and 52.6 – 71 GHz if needed. Therefore, as well as FR1/2 differentiation, FR2-1/2-2 differentiation may also need to be considered. With the consideration above, how to have FR-related differentiation would depend on each UE feature in our view. We see the following alternatives at this stage.* One potential approach to easily solve this issue could be to define all the UE features to be specified in this WI per-band (or per BC). With this, UE can report its capability regarding functionalities for 52.6 – 71 GHz operation per band that the UE supports, which means vendors have a freedom for its own implementation. However, it may increase the overhead for UE capability signalling depending on the number of bands/band combinations to be specified.
* For UE features which can be applied regardless of licensed or unlicensed band, extending per-FR capability signalling may be another possibility. For example, by enabling per-FR capability signalling to differentiate FR2-1 and FR2-2, it would be possible to indicate a certain UE feature is applicable for FR2-2 only if needed. Or, if a UE feature is applicable to both FR2-1 and FR2-2 without any difference, just to use the existing per-FR capability signalling would also be possible. By defining in this manner, vendors still have a freedom to implement a certain feature for a certain frequency range, while overhead for capability signalling can be suppressed.
* To decrease signalling overhead more, per-UE signalling with some Notes can also be considered. This approach, however, may be applicable to particular UE features only, for which the targeted FR is crystal clear. For example, if a UE feature is clearly applicable for FR2-2 unlicensed band only, it could be possible to define it as a UE feature with per-UE capability signalling with a Note saying i.e., “this is applicable only for unlicensed band in FR2-2”. While this approach achieves much less overhead on UE capability signalling, an issue may be less implementation flexibility.

|  |  |  |
| --- | --- | --- |
| FR differentiation | Flexibility for implementation  | UE capability signalling overhead |
| Per-band  | Very flexible | Heavy  |
| Per FR | Less flexible  | Relatively light |
| Per UE | Much less flexible | Light  |

**Proposal: For the discussion on Rel-17 UE features at least regarding 52.6 – 71 GHz WI, the following alternatives can be considered in case-by-case manner, in terms of FR differentiation.** * **Alt 1: define as per-band**
* **Alt 2: define as per-FR**
	+ **Differentiation of FR2-1/2-2 may or may not be needed**
* **Alt 3: define as per-UE**
	+ **A fixed limitation (e.g., as a Note) on applicable frequency range may be needed**

3GPP is working on WI for extending current NR operation to 71 GHz in Rel-17, where a new frequency range from 52.6 GHz to 71 GHz is to be supported. In the relevant WID, the following is described regarding FR notation:

|  |
| --- |
| Note 5: FR2 is extended to cover 24.25GHz to 71GHz with FR2-1 for 24.25-52.6GHz and FR2-2 for 52.6-71GHz. * + The related UE capabilities and their applicability to the frequency range 52.6 to 71 GHz will have to be analysed on a case by case basis
	+ The application of any of the UE feature introduced for 52.6-71 GHz to existing FR1/FR2 should be discussed case by case.
	+ TSG RAN specifications shall make it very clear (to readers) that frequency bands in the 52.6-71GHz range are only Release-independent from Rel-17 onwards, to ensure that there is clear industry understanding about which FR2 features are applicable for operation in 52.6-71GHz range.

NOTE 5a: Whenever the FR2 is referred, both FR2-1 and FR2-2 frequency sub-ranges shall be considered in this release, unless otherwise stated.NOTE 5b: The designations FR2-1 and FR2-2 should only be used when needed. |

According to the Note 5 above, 1) FR2 is extended to cover 24.25 GHz to 71 GHz, while two new FR notations are introduced, that is, FR2-1 and FR2-2 for 24.25 – 52.6 GHz and 52.6 – 71 GHz, respectively. Also, as in the 1st sub-bullet in Note 5, the related UE capabilities (e.g., Rel-15/16 UE features applicable to FR2) and their applicability to the frequency range from 52.6 to 71 GHz will have to be analysed on a case-by-case basis. We show a brief set of analysis regarding Rel-15/16 UE features in terms of applicability to 52.6 – 71 GHz frequency range, based on the UE features specified in 38.211, where we have focused with the principles below: * Check mandatory UE features in Rel-15/16 if it is applicable to 52.6 – 71 GHz frequency range
* Check UE features with per-UE signalling if it is applicable to 52.6 – 71 GHz frequency range when it is reported applicable to FR2
* For UE features with per-FR capability signalling, we have not analysed yet since it may be straightforward that per-FR signalling will indicate sub-FR level applicability, although it needs further discussions
* For UE features with per-band or per-BC capability signalling, we have not analysed yet since per-band/BC capability signalling is finer granularity than FR-level differentiation

 On mandatory UE featuresSome UE features are defined as mandatory for NR in Rel-15. It has to be supported even for UEs supporting Rel-17 functionalities. However, they didn’t consider the operation in 52.6 – 71 GHz when specified, especially with larger SCSs. Therefore, some UE features, even the ones defined as mandatory in Rel-15/16, may or may not be feasible in case of the operation in 52.6 – 71 GHz frequency range. One potential issue among the mandatory features is related to FG3-1 on basic DL control channel, with the following components:

|  |
| --- |
| 1) One configured CORESET per BWP per cell in addition to CORESET0* CORESET resource allocation of 6RB bit-map and duration of 1 – 3 OFDM symbols for FR1
* For type 1 CSS without dedicated RRC configuration and for type 0, 0A, and 2 CSSs, CORESET resource allocation of 6RB bit-map and duration 1-3 OFDM symbols for FR2
* For type 1 CSS with dedicated RRC configuration and for type 3 CSS, UE specific SS, CORESET resource allocation of 6RB bit-map and duration 1-2 OFDM symbols for FR2
* REG-bundle sizes of 2/3 RBs or 6 RBs
* Interleaved and non-interleaved CCE-to-REG mapping
* Precoder-granularity of REG-bundle size
* PDCCH DMRS scrambling determination
* TCI state(s) for a CORESET configuration

2) CSS and UE-SS configurations for unicast PDCCH transmission per BWP per cell* PDCCH aggregation levels 1, 2, 4, 8, 16
* UP to 3 search space sets in a slot for a scheduled SCell per BWP
* This search space limit is before applying all dropping rules.
* For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot
* For type 1 CSS without dedicated RRC configuration and for type 0, 0A, and 2 CSS, the monitoring occasion can be any OFDM symbol(s) of a slot, with the monitoring occasions for any of Type 1- CSS without dedicated RRC configuration, or Types 0, 0A, or 2 CSS configurations within a single span of three consecutive OFDM symbols within a slot

3) Monitoring DCI formats 0\_0, 1\_0, 0\_1, 1\_14) Number of PDCCH blind decodes per slot with a given SCS follows Case 1-1 table5) Processing one unicast DCI scheduling DL and one unicast DCI scheduling UL per slot per scheduled CC for FDD6) Processing one unicast DCI scheduling DL and 2 unicast DCI scheduling UL per slot per scheduled CC for TDD |

For UEs supporting NR from 52.6 GHz to 71 GHz, at least the operation with 120 kHz SCS is to be supported. As 120 kHz SCS is the one which was supported in Rel-15/16 NR already, it does not cause any issue to support the existing UE features, including the ones specified as mandatory, e.g., FR3-1. However, the UEs supporting NR in 52.6 – 71 GHz may support larger SCS(s), i.e., 480 and/or 960 kHz SCS, as well in order to achieve the operation with larger absolute bandwidth per CBW. Since symbol duration is scaled based on SCS in the same manner as in FR1 and FR2, and definition of slot is same as in Rel-15/16 NR, the operation with 480/960 kHz SCS automatically means the one with shortened duration of a slot. When operating with shortened duration of a slot by supporting 480 and/or 960 kHz SCS, some components supported as mandatory in FG3-1 may not be feasible. For example, in the second component, up to 3 search space sets in a slot for a scheduled SCell per BWP is supported. Since NR in 52.6 – 71 GHz will be operated with SCS of 120 kHz or larger, whether up to 3 SS sets in a slot is always possible may not be clear. Moreover, in the sixth component, per-slot and per-CC maximum limitation of DCI processing is described, where one unicast DCI scheduling DL and 2 unicast DCI scheduling UL are supported. The feasibility of this may also be affected by shortened duration of a slot, e.g., only smaller number of DCIs may be possible for UE to process per slot with shortened time duration. Given above, we propose to discuss on how to interpret FG3-1 for the operation with SCS of 480 and/or 960 kHz. We see some alternatives to deal with the situation can be considered; one is to add a Note in a new UE feature to support 480 and 960 kHz SCS in 52.6 – 71 GHz frequency range such as “[a certain components of] FG 3-1 is not applicable to the SCS supported by this FG”. **Proposal: For UEs supporting NR in 52.6 – 71 GHz frequency range, how to treat a mandatory UE feature, FG 3-1, should be discussed at least when the UE supports the operation with 480 and/or 960 kHz SCS** On UE features with per-UE capability signallingAs well as mandatory UE features, UE features with per-UE capability signalling also need to be checked in terms of their applicability to the operation in 52.6 – 71 GHz. When UEs report their support of a certain UE feature with per-UE capability signalling, NW will understand that the UE supports the feature regardless of the operating band, frequency range (or even duplex). However, it may not always the case that UE features with per-UE capability signalling are applicable to 52.6 – 71 GHz when it is applicable to the existing frequency ranges. Our brief analysis is shown on the 6th column on the tables in Appendix. We generally believe most of the UE features with per-UE capability signalling are also applicable to FR2-2 as well. On the other hand, to support such UE features in practice in 52.6 – 71 GHz frequency range, some maintenances in the specifications will be needed, especially in terms of SCS. For example, FG 12-6 is a UE feature with per-UE capability signalling to report whether the UE supports DL SPS with the periodicity shorter than 10 ms. In Rel-16, an RRC parameter *periodicityExt-r16* is supported for configuring DL SPS periodicity shorter than 10 ms. However, how to use the value configured via *periodicityExt-r16* has not been defined in case that larger SCS than 120 kHz is configured. In other words, even if the UE feature reporting is supported for NR in 52.6 – 71 GHz as it is, when larger SCS than 120 kHz is used, this functionality (i.e., DL SPS with shorter than 10 ms periodicity) cannot be configured in practice. **Observation: While most of Rel-15/16 UE features with per-UE capability signalling can be reused as they are for UE to report their support for NR in 52.6 – 71 GHz, some maintenances will be required in the specifications to support the functionalities in practice.** **Proposal 2: For Rel-15/16 UE features with per-UE capability signalling, whether to be applicable to FR2-2 when they are reported as applicable should be analysed a case-by-case manner** On UE features with per-FR/band/BC capability signallingThere would be other types of UE features in NR in terms of FR differentiation, that is, UE features with per-FR/band/BC capability signalling. For the ones with per band/BC capability signalling, we do not see the need to check their validity since per-band/BC signalling naturally differentiate FR2-2 as well as the other FRs. Thus we do not incorporate them with the table in Appendix. On the other hand, some UE features with per-band/BC signalling include a Note associated with FR and/or whether it is licensed or unlicensed. For example, FG22-6/7 on PUCCH grouping, there are the descriptions on carrier type, which differentiate between the existing FRs and licensed/unlicensed band for FR1. Here, whether “FR2” can include 52.6 – 71 GHz or not is unclear at this stage. Moreover, as 52.6 – 71 GHz includes unlicensed bands, differentiation between licensed/unlicensed band may be required even if the wording “FR2” is kept as it is. **Proposal: For Rel-15/16 UE features with per-FR capability signalling,** * **If FR-related description is included in e.g., component, whether/how to consider 52.6 – 71 GHz may need to be discussed.**
* **Otherwise, as it can naturally differentiate FR2-2 from other FRs, there is no need to discuss in terms on FR2-2**

The ones with per-FR capability signalling may not have any issue either since Rel-15/16 defines FR2 as a frequency range between 24.25 – 52.6 GHz. Also, even if FR2-2 is additionally considered, as well as FR1/2-1 differentiation which has already been done via per-FR capability signalling, FR2-2 will need to be differentiated from the other FRs in many cases. Given that, we have not analysed yet on the ones with per-FR capability signalling on the tables in Appendix.An issue which may be lying on the ones with per-FR capability signalling would be whether to be applicable when they are reported as applicable to FR2 if no differentiation between FR2-1 and FR2-2 is considered. Some could be applicable to FR2-2 in the same manner as to FR2-1, while some others may not. This issue may also need to be checked in a case-by-case basis. We think it should also be discussed in RAN1 in the future. **Proposal: For Rel-15/16 UE features with per-FR capability signalling, how to treat when it is reported as applicable to FR2 should be discussed*** **Option 1: Differentiation between FR2-1 and FR2-2 is introduced**
* **Option 2: All the UE features are treated as applicable or inapplicable to FR2-2 as well as FR2-1 when it is reported for FR2, while the ones for which such treatment cannot be appropriate are defined as exceptional cases via e.g., adding Note**
 |
| LG Electronics [12] | Based on past agreements and working assumption, we need to introduce UE capability signalling to indicate whether multi-PDSCH and/or multi-PUSCH scheduling is supported or not. In detail, two approaches can be considered as follows.* Approach 1: Add new UE feature groups where one is for multi-PDSCH DL assignment that can schedules up to 8 PDSCHs with a single DCI format 1\_1 for 120/480/960 kHz, and the other is multi-PUSCH UL grant that can schedules up to 8 PUSCHs with a single DCI format 0\_1 for 120/480/960 kHz.

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| **Index** | **Feature group** | **Components** | **Prerequisite feature groups** |
| 24-1 | General FR2-2 support | 1. Support 120KHz SCS transmission and reception2. Support multi-RB PUCCH format 0/1/43. PRACH with 120KHz SCS and length 139/571/1151 |  |
| 24-2 | 120KHz SSB based stand-alone support | 1. Support 120KHz SSB for initial access | 24-1 |
| 24-3 | 480KHz SSB based stand-alone support | 1. Support 480KHz SSB for initial access | 24-1, 24-2, 24-4 |
| 24-4 | 480KHz SCS support | 1. 480KHz SCS for UL transmission2. 480KHz SCS for DL reception3. 480KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 480KHz with X=45. PRACH with 480KHz and length 139/[571] | 24-1 |
| 24-5 | 960KHz SCS support | 1. 960KHz SCS for UL transmission2. 960KHz SCS for DL reception3. 960KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 960KHz with X=85. PRACH with 960KHz and length 139 | 24-1 |
| 24-? | Multi-PDSCH DL assignment | 1. Support of scheduling up to 8 PDSCHs with a single DCI 1\_1 for 120/480/960 kHz |  |
| 24-? | Multi-PUSCH UL grant | 1. Support of scheduling up to 8 PUSCHs with a single DCI 0\_1 for 120/480/960 kHz |  |

* Approach 2: For 120 kHz, add new UE feature groups for multi-PDSCH DL assignment and multi-PUSCH UL grant. For 480 and 960 kHz, add components for multi-PDSCH DL assignment and multi-PUSCH UL grant, in FG 24-4 and FG 24-5, respectively.

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| **Index** | **Feature group** | **Components** | **Prerequisite feature groups** |
| 24-1 | General FR2-2 support | 1. Support 120KHz SCS transmission and reception2. Support multi-RB PUCCH format 0/1/43. PRACH with 120KHz SCS and length 139/571/1151 |  |
| 24-2 | 120KHz SSB based stand-alone support | 1. Support 120KHz SSB for initial access | 24-1 |
| 24-3 | 480KHz SSB based stand-alone support | 1. Support 480KHz SSB for initial access | 24-1, 24-2, 24-4 |
| 24-4 | 480KHz SCS support | 1. 480KHz SCS for UL transmission2. 480KHz SCS for DL reception3. 480KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 480KHz with X=45. PRACH with 480KHz and length 139/[571]6. Support of scheduling up to 8 PDSCHs with a single DCI 1\_17. Support of scheduling up to 8 PUSCHs with a single DCI 0\_1 | 24-1 |
| 24-5 | 960KHz SCS support | 1. 960KHz SCS for UL transmission2. 960KHz SCS for DL reception3. 960KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 960KHz with X=85. PRACH with 960KHz and length 1396. Support of scheduling up to 8 PDSCHs with a single DCI 1\_17. Support of scheduling up to 8 PUSCHs with a single DCI 0\_1 | 24-1 |
| 24-? | Multi-PDSCH DL assignment | 1. Support of scheduling up to 8 PDSCHs with a single DCI 1\_1 for 120 kHz |  |
| 24-? | Multi-PUSCH UL grant | 1. Support of scheduling up to 8 PUSCHs with a single DCI 0\_1 for 120 kHz |  |

 |
| Apple [13] | The current framework focuses on the possible SCSs that the UE can support. However, when we look at the use cases that a UE may support, the framework breaks down. For example, in the case of a non-standalone UE with both uplink and downlink on an unlicensed band, there is no need for MIB acquisition on the unlicencensed band or in the case of a non-standalone downlink-only UE with UL on licensed, there is no need for “Support multi-RB PUCCH format 0/1/4” or “PRACH with 120KHz SCS and length 139/571/1151” in the General FR2-2 support UE feature (24-1). As such, there is a need to :* + Identify all the use cases and the corresponding UE features needed
	+ Idenitfy the common UE features for all the use cases and have these as standalone features
	+ Discuss how to support the different SCSs for each of these features. These could be (a) separate features (b) separate items for SCS under each feature or (c) rules on how indication of support for a specific SCS determines the features that the UE indicates that it supports.

Possible Use Cases for discussion include the following:* + Standalone: Needs most of the features
	+ Non-standalone DL-only unlicensed (UL on licensed) : Implies no need for MIB acquisition, channel access, PUCCH and PRACH.
	+ Non-standalone DL+ UL on unlicensed : Implies no need for MIB acquisition but needs channel access
	+ The table below details the different features needed for each of these use cases:
	+ NOTE: Common FGs can be placed in FG 24-1 while Separate FGs are standalone.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Features |   | Standalone | Non-standalone DL-only (UL on licensed) | Non-standalone DL+ UL on unlicensed |
| Initial Access   | MIB acquisition | Y | N  | N  |
| PRACH(Separate) | Y | {NOTE: N if licensed on the legacy band , Y if lieensed is on 52.6 GHz band} | ?{Depends on if CA or DC} |
| multi-RB PUCCH before RRC connection (Separate) | Y | N | ?{Depends on if CA or DC} |
| SSB monitoring (Separate) | RRM/RLM measurement | Y | Y | Y |
| PDCCH monitoring (Separate) | MSM (size of X,Y) | Y | Y | Y |
| PUCCH(Separate) |  multi-RB PUCCH after RRC connection: Do we need to send NRB ? | Y | N | ?{Depends on if CA or DC} |
| Beam Management (Separate) | Separate feature | Y | Y | Y |
| Timing/UE processing (Common/Separate) | in general support if only one set of #s agreed | Y | Y | Y |
| Multi-PDSCH/PUSCH(Common/Separate) | mandatory or optional ? | Y | Y | Y |
| Channel Access(Separate) | 24-?-1, 24-?-? | Y | N | Y |

**Proposal: For the framework of the FGs for NR operating between 52.6 GHz and 71 GHz, RAN 1 should:*** **Identify valid use cases and the corresponding UE features needed**
* **Idenitfy the common UE features for all the use cases and have these as standalone features**
* **Discuss the effect of SCS on each of these features.**

**Proposal: RAN1 to discuss a common or separate FG for timing/UE processing and Multi-PDSCH/PUSCH when the design is finalized****Proposal: Separate FG for Multi-PDCCH monitoring when the design finalzied** |
| Nokia/Nokia Shanghai Bell [14] | Regardless of the eventual FG type decision, it should be noted which FGs are exclusively applicable to FR2-2 bands. |

# Discussion/Approval Items during RAN1 #106bis-e

After review of contributions submitted to RAN1 #106bis-e in this agenda item, the following topics were identified by the moderator for discussion/approval during RAN1 #106bis-e. Companies submitted the following views on the moderator’s proposals.

# FG 24-1: General FR2-2 support

The preliminary RAN1 NR UE feature list in [1] was submitted to RAN1 #106-e for information only. It is important that during RAN1 #106bis-e, we agree a formal baseline for RAN1 #107-e. The focus of this meeting is thus to agree on the number of rows/FGs whereas the details of each row/FG can further be discussed at RAN1 #107-e. There seems to be consensus that this FG is needed. Regarding the FFS points, only those should be discussed during RAN1 #106bis-e whose resolution may result in the introduction of new feature groups.

**Proposal:**

**Alt. 1: Agree the following feature group incl. any changes highlighted in red as baseline for further discussions during RAN1 #107-e**

* **FFS points whose resolution may result in the introduction of new feature groups can be discussed during RAN1 #106bis-e**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  24. NR\_ext\_to\_71GHz | 24-1 | ~~General~~ Basic FR2-2 support | 1. Support 120KHz SCS transmission and reception2. Support multi-RB PUCCH format 0/1/4 for 120 kHz3. PRACH with 120KHz SCS and length 139[/571/1151][4. Support 120 kHz SSB for initial/non-initial access][5. Support 120kHz subcarrier spacing for DL data and control channels and reference signals in FR2-2][6. Support 120kHz subcarrier spacing for UL data and control channels and reference signals in FR2-2][7. Support multi-PUSCH[/PDSCH] scheduling by single DCI for the operation with 120 kHz SCS] |  |  |  | FR2-2 is not supported | [per UE][per band] |  |  |  |  | Optional with capability signalling[A UE that supports FR2-2 must indicate this FG is supported] |

* **Alt. 2: Agree the following three feature groups incl. any changes highlighted in red as baseline for further discussions during RAN1 #107-e**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  24. NR\_ext\_to\_71GHz | 24-1 | ~~General~~ Basic FR2-2 DL support | 1. Support 120KHz SCS transmission and reception[2. Support 120 kHz SSB for initial/non-initial access][3. Support 120kHz subcarrier spacing for DL data and control channels and reference signals in FR2-2] |  |  |  | FR2-2 is not supported | [per UE][per band] |  |  |  |  | Optional with capability signalling[A UE that supports FR2-2 must indicate this FG is supported] |
|  24. NR\_ext\_to\_71GHz | 24-1a | FR2-2 PRACH support | 1. PRACH with 120KHz SCS and length 139[/571/1151] | 24-1 |  |  |  | [per UE][per band] |  |  |  |  | Optional with capability signalling |
|  24. NR\_ext\_to\_71GHz | 24-1b | Basic FR2-2 UL support | 1. Support multi-RB PUCCH format 0/1/4 for 120 kHz[2. Support 120kHz subcarrier spacing for UL data and control channels and reference signals in FR2-2] | 24-1 |  |  |  | [per UE][per band] |  |  |  |  | Optional with capability signalling |
|  24. NR\_ext\_to\_71GHz | 24-1c | Multi-PDSCH scheduling | 1. Support multi-PDSCH scheduling by single DCI for the operation with 120 kHz SCS |  |  |  |  | [per UE][per band] |  |  |  |  | Optional with capability signalling |
|  24. NR\_ext\_to\_71GHz | 24-1d | Multi-PUSCH scheduling | 1. Support multi-PUSCH scheduling by single DCI for the operation with 120 kHz SCS | 24-1 |  |  |  | [per UE][per band] |  |  |  |  | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Intel | WE are ok with Alt 1.For Alt 2, while our preference is Alt1, we are ok to go in Alternative 2 approach. For Alt 2,:* FG 24-1a, L=571 and L=1151 should be part of this feature.
* It might be better to merge FG24-1a and 24-1b together.
 |
| LG Electronics | We prefer Alt 2. Similar to NR-U, basic FG can be different depending on deployment scenario. For example, for LAA DL case, FG 24-1 could be a basic FG while FG 24-1/1a/1b could be basic FGs for stand-alone PCell case.We can discuss further for detailed description of components, but one editorial comment: pre-requisite of FG 24-1c is omitted, is this intended or not? |
| Samsung | The basic FGs should be the minimum set of features to support common implementation for FR2-2, so we support Alt 2 with the following additional comments: * In FG 24-1, 120 kHz SSB should be a separated UE FG, since not all the development scenarios require implementation of SSB. Also, SSB for initial access and non-initial access should also be two separated FGs.
* In FG 24-1, bullet 3 seems having overlapped content with bullet 1. If FG 24-1 is only for basic DL operation, then bullet 1 is not needed.
* In FG 24-1b, the supporting of multi-RB PUCCH format should be a separate FG, and may not have to be combined with basic FR2-2 UL support.
* In FG 24-1b, the supporting of basic UL operation may not have the supporting of basic DL operation as prerequisite FG
* In FG 24-1c, the supporting of multi-PDSCH scheduling by single DCI should have FG 24-1 as prerequisite FG
* In FG 24-1d, the supporting of multi-PUSCH scheduling by single DCI should have FG 24-1b as prerequisite FG, not FG 24-1
 |

# FG 24-2: 120KHz SSB based stand-alone support

The preliminary RAN1 NR UE feature list in [1] was submitted to RAN1 #106-e for information only. It is important that during RAN1 #106bis-e, we agree a formal baseline for RAN1 #107-e. The focus of this meeting is thus to agree on the number of rows/FGs whereas the details of each row/FG can further be discussed at RAN1 #107-e. There seems to be consensus that this FG is needed. Regarding the FFS points, only those should be discussed during RAN1 #106bis-e whose resolution may result in the introduction of new feature groups.

**Proposal:**

**Alt. 1: Agree the following feature group incl. any changes highlighted in red as baseline for further discussions during RAN1 #107-e**

* **FFS points whose resolution may result in the introduction of new feature groups can be discussed during RAN1 #106bis-e**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  24. NR\_ext\_to\_71GHz | 24-2 | 120KHz SSB based stand-alone support in FR2-2 | 1. Support ~~480~~120KHz SSB for initial access in FR2-2 | 24-1 |  |  |  |  |  |  |  |  | Optional with capability signaling |

* **Alt. 2: Delete FG 24-2 and merge the components with FG 24-1**

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Intel | We are ok with the FG as a separate FG with the understanding that if support of 120kHz initial access is no longer a mandatory feature for UEs that support this band, then supporting 480kHz for initial access does not necessarily need to mandate support of 120kHz initial access. |
| LG Electronics | We prefer Alt 1 to differentiate basic FGs corresponding to each deployment scenario. However, it should be clarified that FG 24-2 is also a basic FG for stand-alone deployment scenario in FR2-2. We have a different opinion with Intel in that any UE operating in FR2-2 with SA mode should be capable of FG 24-2. |
| Samsung | We support Alt 1 to list the SSB operation for standalone operation as a separate FG, to be aligned with the development scenarios supported in FR2-2. It may also need to clarify what operations are intended to be included for “standalone support”. Is it only for initial cell search or more?  |

# FG 24-3: 480KHz SSB based stand-alone support

The preliminary RAN1 NR UE feature list in [1] was submitted to RAN1 #106-e for information only. It is important that during RAN1 #106bis-e, we agree a formal baseline for RAN1 #107-e. The focus of this meeting is thus to agree on the number of rows/FGs whereas the details of each row/FG can further be discussed at RAN1 #107-e. There seems to be consensus that this FG is needed, although two companies prefer to either delete the FG or spilt it into multiple ones. Regarding the FFS points, only those should be discussed during RAN1 #106bis-e whose resolution may result in the introduction of new feature groups.

**Proposal:**

**Alt. 1: Agree the following feature group incl. any changes highlighted in red as baseline for further discussions during RAN1 #107-e**

* **FFS points whose resolution may result in the introduction of new feature groups can be discussed during RAN1 #106bis-e**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  24. NR\_ext\_to\_71GHz | 24-3 | 480KHz SSB based stand-alone support in FR2-2 | 1. Support 480KHz SSB for initial access in FR2-2 | 24-1[, 24-2, 24-3, 24-4] | Yes |  |  | [Per UE/band] |  |  |  | From WID:* In addition to 120kHz, support 480 kHz SSB for initial access with support of CORESET#0/Type0-PDCCH configuration in the MIB with following constraints:
	+ Note: 480 kHz is an optional SSB numerology for initial access for the UE. A UE supporting a band in 52.6-71 GHz must at least support 120 kHz SCS (for initial access and after initial access)
	+ [only 480kHz CORESET#0/Type0-PDCCH SCS supported for 480 kHz SSB SCS]
 | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Intel | We are ok with the FG. As for dependency of FG24-2 as a prerequisite FG, if 24-2 is going to be a separate FG, then there doesn’t seem to be a technical reason why 24-3 needs to have 24-2 as a prerequisite.Therefore, if 24-2 is a separate FG, then we suggest to remove 24-2 from prerequisite of 24-3.Also remove 24-3 from prerequisite field as it becomes circular referencing.  |
| LG Electronics | We are fine with this proposal. For pre-requisite column, we support 24-1, 24-2, and 24-4 (BTW, 24-3 can be a pre-requisite of 24-3 itself? If not, 24-3 should be removed.). |
| Samsung | We are ok with this proposal, and would like to further comment that the supporting of 480 kHz SSB does not have to be coupled with 480 kHz data reception, so 24-3 may not have to use 24-4 as a prerequisite feature group.  |

# FG 24-4: 480KHz SCS support

The preliminary RAN1 NR UE feature list in [1] was submitted to RAN1 #106-e for information only. It is important that during RAN1 #106bis-e, we agree a formal baseline for RAN1 #107-e. The focus of this meeting is thus to agree on the number of rows/FGs whereas the details of each row/FG can further be discussed at RAN1 #107-e. There seems to be consensus that this FG is needed, although four companies prefer to spilt it into multiple ones, each with a different partitioning of components. Regarding the FFS points, only those should be discussed during RAN1 #106bis-e whose resolution may result in the introduction of new feature groups.

**Proposal:**

* **Resolve the issues of wideband PRACH, multi-RB PUCCH format 0/1/4, and multi-PUSCH/PDSCH scheduling by single DCI, i.e., whether to have components of a single FG or separate FGs, for 120 kHz first, then use the same structure for 480 kHz**
* **Resolve the issue of having separate capabilities for DL and UL (data and control channels as well as reference signals) for 120 kHz first, then use the same structure for 480 kHz**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  24. NR\_ext\_to\_71GHz | 24-4 | 480KHz SCS support | 1. 480KHz SCS for UL data and control channels and reference signal transmission in FR2-22. 480KH SCS for DL data and control channels and reference signal reception in FR2-23. 480KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 480KHz with X=[4] [FFS: Component description to be updated once further details of multi-slot monitoring capability are known, e.g., definition of Y]5. PRACH with 480KHz and length 139/[571]FFS: 6. Support multi-RB PUCCH format 0/1/4 for 480 kHzFFS: 7. Multi-PUSCH/PDSCH scheduling by single DCI for the operation with 480 kHz SCS | 24-1 | Yes |  |  | [Per UE/band] |  |  |  | From WID:In addition to 120kHz SCS, specify new SCS, 480kHz and 960kHz, and define maximum bandwidth(s), for operation in this frequency range for data and control channels and reference signals, only NCP supported. [Agreement:A UE supporting 480 kHz SCS supports multi-slot PDCCH monitoring for 480 kHz SCS.Agreement:Do not support PRACH length L=571, 1151 for 960kHz PRACH and at least L =1151 for 480kHz PRACH] | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Intel | Generally ok with updates. |
| LG Electronics | One general question: Can UE indicate its capability per each component? Or should UE indicate its capability per each FG? |
| Samsung | We agree with moderator’s comment that same structure can be used for 120 kHz SCS, and we can discuss FG 24-4 later.  |

# FG 24-5: 960KHz SCS support

The preliminary RAN1 NR UE feature list in [1] was submitted to RAN1 #106-e for information only. It is important that during RAN1 #106bis-e, we agree a formal baseline for RAN1 #107-e. The focus of this meeting is thus to agree on the number of rows/FGs whereas the details of each row/FG can further be discussed at RAN1 #107-e. There seems to be consensus that this FG is needed, although four companies prefer to spilt it into multiple ones, each with a different partitioning of components. Regarding the FFS points, only those should be discussed during RAN1 #106bis-e whose resolution may result in the introduction of new feature groups.

**Proposal:**

* **Resolve the issues of multi-RB PUCCH format 0/1/4 and multi-PUSCH/PDSCH scheduling by single DCI, i.e., whether to have components of a single FG or separate FGs, for 120 kHz first, then use the same structure for 960 kHz**
* **Resolve the issue of having separate capabilities for DL and UL (data and control channels as well as reference signals) for 120 kHz first, then use the same structure for 960 kHz**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  24. NR\_ext\_to\_71GHz | 24-5 | 960KHz SCS support | 1. 960KHz SCS for UL data and control channels and reference signal transmission in FR2-22. 960KH SCS for DL data and control channels and reference signal reception in FR2-23. 960KHz for SSB monitoring4. Multiple-slot PDCCH monitoring for 960KHz with X=[8] [FFS: Component description to be updated once further details of multi-slot monitoring capability are known, e.g., definition of Y]5. PRACH with 960KHz and length 139FFS: 6. Support multi-RB PUCCH format 0/1/4 for 960 kHzFFS: 7. Multi-PUSCH/PDSCH scheduling by single DCI for the operation with 960 kHz SCS | 24-1 | Yes |  |  | [Per UE/band] |  |  |  | From WID* In addition to 120kHz SCS, specify new SCS, 480kHz and 960kHz, and define maximum bandwidth(s), for operation in this frequency range for data and control channels and reference signals, only NCP supported.

[Agreement:A UE supporting 960 kHz SCS supports multi-slot PDCCH monitoring for 960 kHz SCS.Agreement:Do not support PRACH length L=571, 1151 for 960kHz PRACH and at least L =1151 for 480kHz PRACH] | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Intel | Generally ok with updates |
| Samsung | We agree with moderator’s comment that same structure can be used for 120 kHz SCS, and we can discuss FG 24-4 later.  |

# FG 24-?: Cat 3 or Cat 4 LBT support

The preliminary RAN1 NR UE feature list in [1] was submitted to RAN1 #106-e for information only. It is important that during RAN1 #106bis-e, we agree a formal baseline for RAN1 #107-e. The focus of this meeting is thus to agree on the number of rows/FGs whereas the details of each row/FG can further be discussed at RAN1 #107-e. There seems to be consensus that this FG is needed. Regarding the FFS points, only those should be discussed during RAN1 #106bis-e whose resolution may result in the introduction of new feature groups.

**Proposal: Agree the following feature group incl. any changes highlighted in red as baseline for further discussions during RAN1 #107-e**

* **FFS points whose resolution may result in the introduction of new feature groups can be discussed during RAN1 #106bis-e**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  24. NR\_ext\_to\_71GHz | 24-? | ~~Cat 3 or Cat 4 LBT support~~ Unlink channel access procedure for FR2-2 unlicensed operation | 1. Cat 3 [or 4] LBT support [(not agreed yet if CW is supported, so it can be either Cat 3 or Cat 4 LBT for now. Will update when we have agreement)]
2. [Support LBT performed per carrier/BWP bandwidth]
 | 24-1 |  |  |  | [Per band] |  |  |  |  | Optional with capability signalling[A UE that supports FR2-2 must indicate this FG is supported when required by regulation] |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Intel | Ok with updates |
| LG Electronics | One typo: Uplink channel access procedure for FR2-2 unlicensed operation. But, we may need to keep “cat 3 or cat 4 LBT” to distinguish this FG from FG 24-? (for cat2 LBT) in Section 3.7. |
| Samsung | We are ok with the proposal.  |

# FG 24-?: Cat 2 LBT support for FR2-2 unlicensed operation

The preliminary RAN1 NR UE feature list in [1] was submitted to RAN1 #106-e for information only. It is important that during RAN1 #106bis-e, we agree a formal baseline for RAN1 #107-e. The focus of this meeting is thus to agree on the number of rows/FGs whereas the details of each row/FG can further be discussed at RAN1 #107-e. There seems to be consensus that this FG is needed. Regarding the FFS points, only those should be discussed during RAN1 #106bis-e whose resolution may result in the introduction of new feature groups.

**Proposal: Agree the following feature group incl. any changes highlighted in red as baseline for further discussions during RAN1 #107-e**

* **FFS points whose resolution may result in the introduction of new feature groups can be discussed during RAN1 #106bis-e**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  24. NR\_ext\_to\_71GHz | 24-? | Cat 2 LBT support for FR2-2 unlicensed operation | 1. Support Cat 2 LBT | 24-1[,Cat 3 or Cat 4 LBT support for FR2-2 unlicensed operation] |  |  |  |  |  |  |  |  | Optional with capability signalling[A UE that supports FR2-2 must indicate this FG is supported when required by regulation] |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Intel | Ok with updates. |
| Samsung | We are ok with the proposal.  |

# Additional feature groups in the 24-x family of FR2-2 features

The following new feature group in the 24-x family of FR2-2 features was proposed by one or more companies during RAN1 #106bis-e. Please indicate in the table below whether you agree with the introduction of such a new row/FG.

***At this point, it is not important whether you agree with the exact details of the proposed new FG. Rather you should indicate whether you see the need for introducing such a feature group in principle.***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  24. NR\_ext\_to\_71GHz | 24-? | Contention-exempt short control signalling transmission |  |  |  |  |  |  |  |  |  |  |  |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Intel | We think gNB should have control over how UE exercises short control signal exemption. The 10% duty cycle will be determined by the UE, and due to this some channels/signals may use LBT and some may not. Therefore, it could be beneficial for the gNB to have control over which channels/signals UE can exercise short control signal exemption rules. |
| Samsung | We are ok with having this new FG.  |

The following new feature group in the 24-x family of FR2-2 features was proposed by one or more companies during RAN1 #106bis-e. Please indicate in the table below whether you agree with the introduction of such a new row/FG.

***At this point, it is not important whether you agree with the exact details of the proposed new FG. Rather you should indicate whether you see the need for introducing such a feature group in principle.***

* **Alt. 1**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  24. NR\_ext\_to\_71GHz | 24-? | 32 HARQ processes  | 1. Support 32 HARQ processes
 |  |  |  |  |  |  |  |  |  |  |

* **Alt. 2**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 24. NR\_ext\_to\_71GHz | 24-? | 32 DL HARQ processes  | 1. Support 32 HARQ processes in DL
 |  |  |  |  |  |  |  |  |  |  |
| 24. NR\_ext\_to\_71GHz | 24-? | 32 UL HARQ processes  | 1. Support 32 HARQ processes in UL
 |  |  |  |  |  |  |  |  |  |  |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Intel | If FG24-4 or FG24-5 each contains both DL and UL, then Alt 1 seems to be the correct approach.If FG24-4 or FG24-5 is split for DL and UL separately, then Alt 2 seems to be the correct approach. |
| LG Electronics | Alt 2 is preferred. One thing to be noted is that this feature is originally introduced for NTN WI. If we will have separate FG in 60 GHz from FG in NTN, we should describe that this FG is only for 480/960 kHz in FR2-2. |
| Samsung | We are ok with having this new FG, and we support Alt 2, since the operation support 32 DL and UL should be separated.  |

The following new feature group in the 24-x family of FR2-2 features was proposed by one or more companies during RAN1 #106bis-e. Please indicate in the table below whether you agree with the introduction of such a new row/FG.

***At this point, it is not important whether you agree with the exact details of the proposed new FG. Rather you should indicate whether you see the need for introducing such a feature group in principle.***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  24. NR\_ext\_to\_71GHz | 24-? | 2 codeword transmission for PDSCH | 1. Support of 2 codeword transmission for PDSCH
 |  |  |  |  |  |  |  |  |  |  |

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| --- | --- |
| Company | Comments/Questions/Suggestions |
| Intel | Not sure if this FG is needed. UE already reports “maxNumberMIMO-LayersPDSCH”, “maxNumberMIMO-LayersCB-PUSCH”, and “maxNumberMIMO-LayersNonCB-PUSCH” as UE capability.Having a second configuration for supporting 2 CW seems reduandant.So suggest not to agree to this entry. |
| LG Electronics | Agree with Intel. We can reuse “maxNumberMIMO-LayersPDSCH” (FG 2-3) to indicate 2-CW UE capability. |
| Samsung | FR2-2 should support the capability signaling for supporting reception of 2 CW transmission for PDSCH, based on current agreement. Whether it reuses existing FG or a new one could be further discussed.  |

The following new feature group in the 24-x family of FR2-2 features was proposed by one or more companies during RAN1 #106bis-e. Please indicate in the table below whether you agree with the introduction of such a new row/FG.

***At this point, it is not important whether you agree with the exact details of the proposed new FG. Rather you should indicate whether you see the need for introducing such a feature group in principle.***

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| 24. NR\_ext\_to\_71GHz | 24-? | No-LBT mode transmission for FR2-2 unlicensed operation | 1. Support only No-LBT mode transmission for FR2-2 unlicensed operation |  |  |  |  |  |  |  |  |  |  |

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| Company | Comments/Questions/Suggestions |
| Intel | Not sure, not performing LBT is a capability. This seems to be more like “incapability” indiciation. In general, UE capability should not specify incapability.Our suggestion is to not have a separate FG for no-LBT but include it as part of basic FG sets. |
| Samsung | We are ok with having this new FG in general, but would like to clarify why the description of this FG is “only No-LBT mode transmission”.  |

The following new feature group in the 24-x family of FR2-2 features was proposed by one or more companies during RAN1 #106bis-e. Please indicate in the table below whether you agree with the introduction of such a new row/FG.

***At this point, it is not important whether you agree with the exact details of the proposed new FG. Rather you should indicate whether you see the need for introducing such a feature group in principle.***

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| 24. NR\_ext\_to\_71GHz | 24-? | maxNumberRxTxBeamSwitchDL | For existing capability maxNumberRxTxBeamSwitchDL add the following options.Optionally indicate {2,4,7} values for 480kHz SCS.Optionally indicate {1, 2,4,7} values for 960kHz SCS. |  |  |  |  |  |  |  |  |  |  |
| 24. NR\_ext\_to\_71GHz | 24-? | timeDurationQCL | For existing capability timeDurationQCL add the following options.Support {28, 56 (=4\*14), 112 (=4\*28)} for 480kHz.Support {56, 112 (=8\*14), 224 (=8\*28)} for 960kHz. |  |  |  |  |  |  |  |  |  |  |
| 24. NR\_ext\_to\_71GHz | 24-? | beamReportTiming | For existing capability beamReportTiming add the following options.Support {28, 56 (=4\*14), 112 (=4\*28), 224 (=4\*48), 896 (=4\*224), 1344 (=4\*336)} for 480kHzSupport {56, 112 (=8\*14), 224 (=8\*28), 384 (=8\*48), 1792 (=8\*224), 2688 (=8\*336)} for 960kHz |  |  |  |  |  |  |  |  |  |  |
| 24. NR\_ext\_to\_71GHz | 24-? | beamSwitchTiming | For existing capability beamSwitchTiming add the following options.Support {28, 56 (=4\*14), 112 (=4\*28), 224 (=4\*56)} for 480kHzSupport {56, 112 (=8\*14), 224 (=8\*28), 448 (=8\*56)} for 960kHz |  |  |  |  |  |  |  |  |  |  |

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| Company | Comments/Questions/Suggestions |
| Intel | We agree with the contents.Not sure if these need to be categorized as new FGs, as they are requesting for changes to existing FG. |
| LG Electronics | Similar view with Intel. We can reuse FG 2-2 (for *timeDurationForQCL*), FG 2-25 (for *beamReportTiming*), FG 2-27 (for *maxNumberRxTxBeamSwitchDL*), and FG 2-28 (for *beamSwitchTiming*). |
| Samsung | We believe we need a general method on treating adding new values corresponding to 480/960 kHz SCS for the existing FGs, and coordination with RAN2 may be needed.  |

The following new feature group in the 24-x family of FR2-2 features was proposed by one or more companies during RAN1 #106bis-e. Please indicate in the table below whether you agree with the introduction of such a new row/FG.

***At this point, it is not important whether you agree with the exact details of the proposed new FG. Rather you should indicate whether you see the need for introducing such a feature group in principle.***

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| 24. NR\_ext\_to\_71GHz | 24-? | Advanced data processing capability | Indicate that UE supports smaller PDSCH processing time (N1), PUSCH preparation time (N2), and HARQ-ACK multiplexing timeline (N3).If indicated to be supported, UE shall support N1 = N3 = [36], N2 = [90] for 480 kHz N1 = N3 = [49], N2 = [144] for 960 kHz |  |  |  |  |  |  |  |  |  |  |
| 24. NR\_ext\_to\_71GHz | 24-? | Advance CSI processing capability | Indicates that UE supports smaller CSI processing Z1, Z2, and Z3.If indicated to be supported, UE shall supportFor 480kHz:Z1 = [194] Z’1 = [170]Z2 = [304] Z’2 = [280]Z3 = min([194], X5 + KB3)For 960kHz:Z1 = [388] Z’1 = [340] Z2 = [608] Z’2 = [560] Z3 = min([388], X6 + KB4) |  |  |  |  |  |  |  |  |  |  |

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| --- | --- |
| Company | Comments/Questions/Suggestions |
| Intel | Supportive of the FG entries. |
| LG Electronics | Not support to have above FGs until RAN1 agree advanced processing capabilities. |
| Samsung | We don’t support advanced data processing and CSI processing capabilities, and there is no agreement so far supporting these FGs.  |

The following new feature group in the 24-x family of FR2-2 features was proposed by one or more companies during RAN1 #106bis-e. Please indicate in the table below whether you agree with the introduction of such a new row/FG.

***At this point, it is not important whether you agree with the exact details of the proposed new FG. Rather you should indicate whether you see the need for introducing such a feature group in principle.***

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| 24. NR\_ext\_to\_71GHz | 24-? | Supported maximum MCS in DL | Indicates the maximum MCS for DL supported by the UE for each transmission rank supported by the UE. Note that UE shall support MCS 29, 30, 31 of MCS table 1 and 3 regardless of indicated value.Values are indicated for each supported subcarrier spacing and each rank supported by the UE operating in FR2-2. [Note: numbers in brackets are FFS]For 120kHz:* For rank 1: max MCS of {[16], …, 28} of MCS table 1, max MCS of {[20], …, 28} of MCS table 3
* For rank 2: max MCS of {[9], …, 28} of MCS table 1, max MCS of {[15], …, 28} of MCS table 3
* For rank 3~8: max MCS of {[9], …, 28} of MCS table 1, max MCS of {[15], …, 28} of MCS table 3

For 480kHz:* For rank 1: max MCS of {[16], …, 28} of MCS table 1, max MCS of {[20], …, 28} of MCS table 3
* For rank 2: max MCS of {[9], …, 28} of MCS table 1, max MCS of {[15], …, 28} of MCS table 3
* For rank 3~8: max MCS of {[9], …, 28} of MCS table 1, max MCS of {[15], …, 28} of MCS table 3

For 960kHz:* For rank 1: max MCS of {[16], …, 28} of MCS table 1, max MCS of {[20], …, 28} of MCS table 3
* For rank 2: max MCS of {[9], …, 28} of MCS table 1, max MCS of {[15], …, 28} of MCS table 3
* For rank 3~8: max MCS of {[9], …, 28} of MCS table 1, max MCS of {[15], …, 28} of MCS table 3
 |  |  |  |  |  |  |  |  |  |  |

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| Company | Comments/Questions/Suggestions |
| Intel | Supportive of the FG entries. |
| Samsung | Further discussion on this FG is needed.  |

The following new feature group in the 24-x family of FR2-2 features was proposed by one or more companies during RAN1 #106bis-e. Please indicate in the table below whether you agree with the introduction of such a new row/FG.

***At this point, it is not important whether you agree with the exact details of the proposed new FG. Rather you should indicate whether you see the need for introducing such a feature group in principle.***

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| 24. NR\_ext\_to\_71GHz | 24-? | beamCorrespondenceWithoutUL-BeamSweeping | For existing capability beamCorrespondenceWithoutUL-BeamSweeping add the following text:For UEs supporting operation in FR2-2 band(s), UE shall indicate support of beamCorrespondenceWithoutUL-BeamSweeping for those band(s).  |  |  |  |  |  |  |  |  |  |  |

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| Company | Comments/Questions/Suggestions |
| Intel | We agree with the contents.Not sure if these need to be categorized as new FGs, as they are requesting for changes to existing FG. |
| LG Electronics | We can reuse FG 2-20 (Beam correspondence). |
| Samsung | Further discussion on this FG may be needed.  |

The following new feature group in the 24-x family of FR2-2 features was proposed by one or more companies during RAN1 #106bis-e. Please indicate in the table below whether you agree with the introduction of such a new row/FG.

***At this point, it is not important whether you agree with the exact details of the proposed new FG. Rather you should indicate whether you see the need for introducing such a feature group in principle.***

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| 24. NR\_ext\_to\_71GHz | 24-? | L1-RSSI based receiver assistance | UE is able to perform L1-RSSI measurement and report as part of AP-CSI |  |  |  |  |  |  |  |  |  |  |
| 24. NR\_ext\_to\_71GHz | 24-? | Cat 2 LBT support for FR2-2 unlicensed operation | 1. Support Cat 2 LBT
2. Support CCA based receiver assistance
 |  |  |  |  |  |  |  |  |  |  |

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| --- | --- |
| Company | Comments/Questions/Suggestions |
| Intel | Agree with FG entries. |
| LG Electronics | Not support FG corresponding to L1-RRS based receiver assistance until RAN1 agree to adopt it.The second FG seems duplicated with FG in Section 3.7. |
| Samsung | Further agreements are needed to support these FGs.  |

# Conclusion

After further discussion on the RAN1 email reflector the following was agreed as part of this email discussion:

# References

1. R1-2108679, Preliminary RAN1 UE features list for Rel-17 NR, Moderators (AT&T, NTT DOCOMO, INC.)
2. R1-2108834, UE features for supporting NR from 52.6 GHz to 71 GHz, FUTUREWEI
3. R1-2108941, Discussion on UE features for 52.6 to 71GHz, ZTE/Sanechips
4. R1-2109014, Discussions on UE features for NR operation from 52.6GHz to 71GHz, vivo
5. R1-2109144, Rel-17 UE features for extension to 71 GHz, Huawei/HiSilicon
6. R1-2109441, UE features for extending current NR operation to 71 GHz, Ericsson
7. R1-2109525, UE features for supporting NR from 52.6 GHz to 71 GHz, Samsung
8. R1-2109563, Views on UE features for supporting NR from 52.6 GHz to 71 GHz, MediaTek Inc.
9. R1-2109643, Discussion on UE capability for extending NR up to 71 GHz, Intel Corporation
10. R1-2109707, Views on Rel-17 UE features for supporting NR from 52.6 GHz to 71 GHz, NTT DOCOMO, INC.
11. R1-2109719, Views on applicability of Rel-15/16 NR UE features to FR2-2, NTT DOCOMO, INC.
12. R1-2109969, Discussion on UE features for NR above 52.6 GHz, LG Electronics
13. R1-2110066, Views on UE features for supporting NR from 52.6 GHz to 71 GHz, Apple
14. R1-2110265, On UE features for supporting NR from 52.6 GHz to 71 GHz, Nokia/Nokia Shanghai Bell