**3GPP TSG RAN WG1 #108-e R1-2nnnnn**

**e-Meeting, February 21st – March 3rd, 2022**

**Agenda Item: 8.16**

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

**Title: Summary of UE features for 32 HARQ processes**

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

# Introduction

This document presents the summary of email discussion/approval [108-e-R17-UE-features-32HARQ] during RAN1 #108-e. According to the Chairman’s Notes:

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| [108-e-R17-UE-features-32HARQ] Email discussion on UE features for 32 HARQ processes – Ralf (AT&T)* Check point on February 23
	+ If there is no consensus at the Feb 23 check point, email thread will be closed
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The following was discussed and/or agreed during RAN1 #108-e within the scope of [108-e-R17-UE-features-32HARQ]. All proposals are based on the latest RAN1 UE features list for Rel-17 NR in [1].

# Summary of Contributions Submitted to RAN1 #108-e

The following is the moderator’s summary of contributions submitted to RAN1 #108-e in this agenda item.

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| Company | Summary |
| Huawei/HiSilicon [2] | For NR NTN, the following FG was agreed on the support of 32 HARQ processes **Agreement: Adopt the following changes highlighted in chromatic formatting**

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| 26. NR\_NTN\_solutions | 26-5 | Increasing the number of HARQ processes | 1. The maximal supported HARQ process number is X~~32~~ for ~~both~~ UL and Y DL
2. ~~FFS: Support on the maximal HARQ process number is up to UE capability~~
3. ~~FFS: separate features for DL and UL~~
 |  | Yes | No | ~~[Increasing the number of HARQ processes avoids HARQ stalling]~~ Increased number of HARQ processes is not supported  | ~~FFS [~~Per band or per FSPC or per UE] | No | No | ~~[support mixture of FDD/TDD (for HAPS and/or STG) and/or FR1/FR]~~ | ~~FFS: whether this FG gets merged with FG 26-1 if the note “For UE supports NR [NTN/ satellite/HAPS/ATG], UE must indicate this FG is supported” is confirmed in the positive~~Candidate component values for (X,Y): {(16,32),(32,16),(32,32)}~~Candidate component values for Y: {16,32}~~ | Optional with capability signalling~~[For UE supports NR [NTN/ satellite/HAPS/ATG], UE must indicate this FG is supported]~~[Note: This UE feature group is applicable only for NR NTN cell and ATG cell, for terrestrial cell except for ATG cell this feature is not supported] |

For above 52.6GHz, the following two FGs were agreed on the support of 32 HARQ processes in RAN1#107-e and one more relevant agreement achieved in RAN1#107b-e:**Agreement:** (from RAN1#107-e)* **Confirm FGs 24-8 and 24-9 as separate rows**
* **Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting as shown**
* **Discuss FR1 and FR2-1 support in NR NTN as part of FG 26-5 and update this FG if needed based on the outcome in NR NTN**

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| 24. NR\_ext\_to\_71GHz | 24-8 | 32 DL HARQ processes ~~[~~for FR 2-2~~]~~ | Support 32 HARQ processes in DL ~~[~~for 480/960 kHz~~]~~ |  |  |  |  | [Per UE/per FSPC/per band] |  |  |  | FFS: 120 kHz | Optional with capability signalling |
| 24. NR\_ext\_to\_71GHz | 24-9 | 32 UL HARQ processes ~~[~~for FR 2-2~~]~~ | Support 32 HARQ processes in UL ~~[~~for 480/960 kHz~~]~~ |  |  |  |  | [Per UE/per FSPC/per band] |  |  |  | FFS: 120 kHz | Optional with capability signalling |

**Agreement** (from RAN1#107b-e)* In NR FR2-2, a UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL (or for UL) shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL (or UL), subject to UE capability.

For MBS, one conclusion was reached in RAN1#107bis-e meeting that UE is not expected to support hardware for more HARQ processes for receiving broadcast in Rel-17 in addition to the maximum number of HARQ processes supported for receiving unicast in Rel-16, i.e. the HARQ process resources are shared between broadcast, unicast and multicast. However, if UE supports 32 HARQ process for unicast in Rel-17, the 32 HARQ processes can be shared as well by multicast/broadcast and there is no reason to precdule such sharing given the conclusion from NR MBS. It was also ackowleged that coordination between above 52.6GHz or NTN are needed on the definition of support of 32 HARQ processes. Our views on how to handle this UE feature in Rel-17 in a generic manner are provided below* Comment 1: There is no need to define duplicated FGs in different WIs.
	+ The support of 32 HARQ processes can be defined separately without tying it to other capabilitie such as above 52.6GHz, NTN or MBS.
	+ The reporting type of this FG can be defined as per band or per FSBC.
		- As an example, for a UE support 52.6 GHz or NTN, it will anyway need to report the supported band/band combinitions. As a result, the support of 52.6GHz or NTN and the support of 32 HARQ processes can be naturally coupled together.
	+ One addtional benefit by doing so is that the support of 32 HARQ processes can be extended for licensed terrestrial bands.
* Comment 2: In NTN and above 52.6GHz, the support of 32 HARQ processes are defined differently. In NTN, there is only one FG defined for both ULand DL while in above 52.6GHz two FGs are defined separately for UL and DL. Even though there may be no pratical difference between the two kinds of definitions, it seems clearer to define separate FGs into UL and DL.

Based on the above consideration, we propose the following FGs for the support of 32 HARQ processes

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| 39 | 39-1 | 32 DL HARQ processes | HARQ process operation with configurable number of DL HARQ processes of up to 32 |  |  |  |  | [per FSPC/per band] |  |  |  |  | Optional with capability signalling |
| 39 | 39-2 | 32 UL HARQ processes | HARQ process operation with configurable number of UL HARQ processes of up to 32 |  |  |  |  | [per FSPC/per band] |  |  |  |  | Optional with capability signalling |

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The following is the moderator’s summary of contributions submitted to RAN1 #108-e in agenda item 8.16.2 on the same topic.

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| 24. NR\_ext\_to\_71GHz | 24-8 | 32 DL HARQ processes for FR 2-2 | Support 32 HARQ processes in DL for 480/960 kHz |  |  |  |  | [Per UE/per FSPC/per band] |  |  |  | FFS: 120 kHz | Optional with capability signalling |

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| Company | Summary |
| Huawei/HiSilicon [3] | In RAN1#107bis-e, the following agreement is achieved on the support of 32 HARQ processes for 120kHz SCS. Considering UE will or will not support 32 HARQ processes for all supported SCS in FR2-2, it is not necessary to differentiate the FG from numerologies. Therefore, we propose to at least remove the text “for 480/960 kHz” in the component description in FG24-8 and FG24-9. **Agreement*** In NR FR2-2, a UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL (or for UL) shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL (or UL), subject to UE capability.

The support of 32 HARQ processes was also introduced in NTN WI (FG26-5) for NTN cell in FR1 and FR2-1. It is under discussion under NTN UE feature whether such capability can be extended to other non-NTN cell. The answer should obviously be yes since it was also agreed to support 32 HARQ processes for FR2-2 as part of this WI. Moreover, if the support of multiple PDSCH/PUSCH scheduling by single DCI is extended to bands outside of FR2-2, as in NRU Rel-16, the support of 32 HARQ processes should be extended together to avoid HARQ processing starvation. So we think the FG26-5 discussed in NTN WI can be applied to all numerologies in both FR1 and FR2. The FG24-8 and FG24-9 are overlapping with FG26-5. ***Proposal 10: Remove “for 480/960kHz” in the component of FG24-8 and FG24-9.******Observation 1: FG24-8 and FG24-9 are overlapping with FG26-5 (Increasing the number of HARQ processes) discussed in NTN WI. If FG26-5 were reported “per band” and defined independently of the numerologies and the feature (i.e. not limited to NTN or 60 GHz, etc.), FG24-8 and FG24-9 could be removed.***

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|  | 24-8 | 32 DL HARQ processes [for FR 2-2] | Support 32 HARQ processes in DL  |  |  |  |  | per band | N/A | N/A | N/A | FFS: extend to other FRs | Optional with capability signalling |

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| Vivo [4] |  |
| OPPO [5] | ew FG for 32 HARQ processesIn RAN1 #107b-emeeting, the following agreement was achieved:***Agreement**** *In NR FR2-2, a UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL (or for UL) shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL (or UL), subject to UE capability.*

Therefore, a new FG should be introduced to define the capability of supporting 32 HARQ processes. If introduced, this FG should be supported per FSPC. **Proposal 11: introducing a new FG to define the capability of supporting 32 HARQ processes.**  |
| ZTE/Sanechips [6] | In RAN1 #107bis e-meeting, the following agreement was made in agenda item 8.2.5, which means 32 HARQ processes in DL/UL for 120kHz is supported depends on whether a UE has capability to support 32 DL/UL HARQ processes in DL/UL for 480/960 kHz. For this, we propose to add a new feature on 32 HARQ processes in DL/UL for 120 kHz and it is a prerequisite of FG 24-8/9.

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| **Agreement*** In NR FR2-2, a UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL (or for UL) shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL (or UL), subject to UE capability.
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Besides, according to the following agreement, it had supported 32 as the maximum number of HARQ process for Rel-17 NTN and NR FR2-2 at least for 480/960 kHz SCS. However, NTN only introduces the UE feature for FR1. Therefore, it is necessary to support a separate FG 24-8 and 24-9 in FR2-2. If this feature is extended to FR1 and/or FR2-1, then it can be defined as per UE.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.**Proposal 8:** **Propose adding new Feature to support 32 HARQ processes in DL/UL for 120kHz and as prerequisite of FG 24-8/9.****Proposal 9:** **If this feature can be extended to FR1 and FR2-1, it can be defined as per UE.** |
| Nokia/Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [8] | FG24-8 and 24-9 define the capabilities for the support of 32 HARQ processes. RAN1 reached the following agreement at the last RAN1 e-meeting.

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| **Agreement*** In NR FR2-2, a UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL (or for UL) shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL (or UL), subject to UE capability.
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The agreement above can be interpreted by itself such that 1) we have to define another FG on the support of 32 HARQ processes for 120 kHz SCS, and 2) the new capability is defined as a prerequisite of FG24-8 and 24-9. However, considering the discussion so far, we are not sure if we should define such separate FG for 120 kHz SCS. 32 HARQ processes in FR2-2 is motivated based on the fact that larger number of symbols are defined for some processing related timeline parameters for larger SCSs, which potentially leads to HARQ process number starvation. In other words, we do not see it technically necessary to support 32 HARQ processes for 120 kHz SCS. Rather, we understand the intention of the agreement above to aim for an unified PHY design across the supported SCSs. Given above, we are not sure if 32 HARQ processes support deserves a separate FG. Instead, we propose to delete all the SCS-related texts in FG24-8 and 24-9. There is another important discussion on this issue – whether this FG is merged with other FG from other WI. In NR NTN WI, the same mechanism was agreed and there are corresponding FGs as FG26-5. In addition, it seems that the discussion includes another big issue behind, which is whether maximum of 32 HARQ processes can be applied to cell other than NTN/FR2-2. In short, our view is that the feature should not be applicable for other cases and correspondingly there is no need to merge the FGs. From the applicability perspective, there are two rationales:* No agreements in any WIs. The 32 HARQ processes feature was agreed in NTN WI and FR2-2 WI for these purposes, but not for other purposes. Without certain agreements at appropriate WG or TEI, such an expansion should not be allowed.
* UE burden or signaling overhead. If this feature is applicable for any cell/band and corresponding FG is per UE, then UE that would like to indicate “support” shall support this feature for any cell/band. In our view, there is motivation of this FG only for NTN/FR2-2, so the excessive support is not preferable. Alternatively if this feature is applicable for any cell/band and corresponding FG is per band, then UE needs to report support/not support for all the bands that UE supports including bands without any motivation of this feature, which is meaningless overhead.

Also, as FG24-8 and FG24-9, there is still an issue specific to FR2-2. If we are to merge it with the one in NR NTN WI, such WI-specific issues may need to be considered even in other WIs. We assume such direction just makes the discussion much more complex, and no clear need to do so is observed at this stage. Given above, we suggest the following update for NR 52.6 – 71 GHz feature list:**Proposal 2:** FG24-8 and 24-9 are not merged with FG26-5 defined in NR NTN

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| 24. NR\_ext\_to\_71GHz | 24-8 | 32 DL HARQ processes for FR 2-2 | Support 32 HARQ processes in DL | 24-1 |  |  |  | [Per UE/per FSPC/per band] |  |  |  |  | Optional with capability signalling |

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| Intel Corporation [9] |  |
| Ericsson [10] | For FG 24-8 and FG 24-9, there is an FFS on whether or not these features are supported for 120 kHz. We note that the following agreement was made in RAN1#107bis-e, hence the note with FFS on 120 kHz can be removed and the component description can be made agnostic to subcarrier spacing.**Agreement*** In NR FR2-2, a UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL (or for UL) shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL (or UL), subject to UE capability.

While it is apparent that a UE that supports 32 HARQ processes should have that capability regardless of the band number, we are fine with capability signalling per-band instead of per-UE. We understand that some UE vendors prefer to re-rest features as new bands are added, hence it can be beneficial to have per-band capability signalling to facilitate such IODT testing on a phased basis.1. Modify FG 24-8 and FG 24-9 as follows to clarify that (1) these FGs are agnostic to SCS, and (2) the capability signalling is per band.

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| 24-8 | 32 DL HARQ processes for FR 2-2 | Support 32 HARQ processes in DL ~~for 480/960 kHz~~ | 32 HARQ processes in the DL is not supported | ~~[Per UE/per FSPC/~~per band~~]~~ | ~~FFS: 120 kHz~~ | Optional with capability signalling |

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| Apple [11] | 1. FG 24-8: the signaling is per band but is only expected for a band where shared spectrum channel access must be used (similar to FG 10-1 for NR-U in 38.822).
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| Samsung [12] | It was agreed to support 32 DL and UL HARQ processes, using same solution as in NTN, but for UE features, the FGs of supporting 32 DL and UL HARQ processes should be separate from the corresponding FGs for NTN, since the type of UE to support those FGs can be different. Also, the supporting of FG 24-8 and 24-9 should be per FSPC, such that UE has a better control when implementation this feature. **Proposal 4: For FG 24-8 and FG 24-9:*** **Keep the FGs separately from supporting 32 HARQ processes in NTN;**
* **“Type” of the FGs are per FSPC.**
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| MediaTek Inc. [13] |  |
| Qualcomm Incorporated [14] |  |
| LG Electronics [15] | For FGs 24-8 and 24-9, there is one FFS point regarding whether to support 32 DL/UL HARQ processes for 120 kHz SCS based on the following agreement.

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| Agreement: (RAN1#106bis-e)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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Additionally, the following agreement was made in RAN1#107bis-e.

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| **Agreement** (RAN1#107bis-e)* In NR FR2-2, a UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL (or for UL) shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL (or UL), subject to UE capability.
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Therefore, FGs 24-8 and 24-9 should be updated according to the above agreement such that a UE capable of 32 HARQ processes in FR2-2 supports this feature for all SCSs in FR2-2.**Proposal #3: According to the agreement made in RAN1#107bis-e, update FGs 24-8 and 24-9 as follows.**

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| 24. NR\_ext\_to\_71GHz | 24-8 | 32 DL HARQ processes for FR 2-2 | Support 32 HARQ processes in DL for 120/480/960 kHz |  |

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| 24. NR\_ext\_to\_71GHz | 24-9 | 32 UL HARQ processes for FR 2-2 | Support 32 HARQ processes in UL for 480/960 kHz |  |  |  |  | [Per UE/per FSPC/per band] |  |  |  | FFS: 120 kHz | Optional with capability signalling |

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| Company | Summary |
| Huawei/HiSilicon [3] | In RAN1#107bis-e, the following agreement is achieved on the support of 32 HARQ processes for 120kHz SCS. Considering UE will or will not support 32 HARQ processes for all supported SCS in FR2-2, it is not necessary to differentiate the FG from numerologies. Therefore, we propose to at least remove the text “for 480/960 kHz” in the component description in FG24-8 and FG24-9. **Agreement*** In NR FR2-2, a UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL (or for UL) shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL (or UL), subject to UE capability.

The support of 32 HARQ processes was also introduced in NTN WI (FG26-5) for NTN cell in FR1 and FR2-1. It is under discussion under NTN UE feature whether such capability can be extended to other non-NTN cell. The answer should obviously be yes since it was also agreed to support 32 HARQ processes for FR2-2 as part of this WI. Moreover, if the support of multiple PDSCH/PUSCH scheduling by single DCI is extended to bands outside of FR2-2, as in NRU Rel-16, the support of 32 HARQ processes should be extended together to avoid HARQ processing starvation. So we think the FG26-5 discussed in NTN WI can be applied to all numerologies in both FR1 and FR2. The FG24-8 and FG24-9 are overlapping with FG26-5. ***Proposal 10: Remove “for 480/960kHz” in the component of FG24-8 and FG24-9.******Observation 1: FG24-8 and FG24-9 are overlapping with FG26-5 (Increasing the number of HARQ processes) discussed in NTN WI. If FG26-5 were reported “per band” and defined independently of the numerologies and the feature (i.e. not limited to NTN or 60 GHz, etc.), FG24-8 and FG24-9 could be removed.***

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|  | 24-9 | 32 UL HARQ processes [for FR 2-2] | Support 32 HARQ processes in UL  |  |  |  |  | per band | N/A | N/A | N/A | FFS: extend to other FRs | Optional with capability signalling |

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| Vivo [4] |  |
| OPPO [5] | ew FG for 32 HARQ processesIn RAN1 #107b-emeeting, the following agreement was achieved:***Agreement**** *In NR FR2-2, a UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL (or for UL) shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL (or UL), subject to UE capability.*

Therefore, a new FG should be introduced to define the capability of supporting 32 HARQ processes. If introduced, this FG should be supported per FSPC. **Proposal 11: introducing a new FG to define the capability of supporting 32 HARQ processes.**  |
| ZTE/Sanechips [6] | In RAN1 #107bis e-meeting, the following agreement was made in agenda item 8.2.5, which means 32 HARQ processes in DL/UL for 120kHz is supported depends on whether a UE has capability to support 32 DL/UL HARQ processes in DL/UL for 480/960 kHz. For this, we propose to add a new feature on 32 HARQ processes in DL/UL for 120 kHz and it is a prerequisite of FG 24-8/9.

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| **Agreement*** In NR FR2-2, a UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL (or for UL) shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL (or UL), subject to UE capability.
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Besides, according to the following agreement, it had supported 32 as the maximum number of HARQ process for Rel-17 NTN and NR FR2-2 at least for 480/960 kHz SCS. However, NTN only introduces the UE feature for FR1. Therefore, it is necessary to support a separate FG 24-8 and 24-9 in FR2-2. If this feature is extended to FR1 and/or FR2-1, then it can be defined as per UE.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.**Proposal 8:** **Propose adding new Feature to support 32 HARQ processes in DL/UL for 120kHz and as prerequisite of FG 24-8/9.****Proposal 9:** **If this feature can be extended to FR1 and FR2-1, it can be defined as per UE.** |
| Nokia/Nokia Shanghai Bell [7] |  |
| NTT DOCOMO, INC. [8] | FG24-8 and 24-9 define the capabilities for the support of 32 HARQ processes. RAN1 reached the following agreement at the last RAN1 e-meeting.

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| **Agreement*** In NR FR2-2, a UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL (or for UL) shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL (or UL), subject to UE capability.
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The agreement above can be interpreted by itself such that 1) we have to define another FG on the support of 32 HARQ processes for 120 kHz SCS, and 2) the new capability is defined as a prerequisite of FG24-8 and 24-9. However, considering the discussion so far, we are not sure if we should define such separate FG for 120 kHz SCS. 32 HARQ processes in FR2-2 is motivated based on the fact that larger number of symbols are defined for some processing related timeline parameters for larger SCSs, which potentially leads to HARQ process number starvation. In other words, we do not see it technically necessary to support 32 HARQ processes for 120 kHz SCS. Rather, we understand the intention of the agreement above to aim for an unified PHY design across the supported SCSs. Given above, we are not sure if 32 HARQ processes support deserves a separate FG. Instead, we propose to delete all the SCS-related texts in FG24-8 and 24-9. There is another important discussion on this issue – whether this FG is merged with other FG from other WI. In NR NTN WI, the same mechanism was agreed and there are corresponding FGs as FG26-5. In addition, it seems that the discussion includes another big issue behind, which is whether maximum of 32 HARQ processes can be applied to cell other than NTN/FR2-2. In short, our view is that the feature should not be applicable for other cases and correspondingly there is no need to merge the FGs. From the applicability perspective, there are two rationales:* No agreements in any WIs. The 32 HARQ processes feature was agreed in NTN WI and FR2-2 WI for these purposes, but not for other purposes. Without certain agreements at appropriate WG or TEI, such an expansion should not be allowed.
* UE burden or signaling overhead. If this feature is applicable for any cell/band and corresponding FG is per UE, then UE that would like to indicate “support” shall support this feature for any cell/band. In our view, there is motivation of this FG only for NTN/FR2-2, so the excessive support is not preferable. Alternatively if this feature is applicable for any cell/band and corresponding FG is per band, then UE needs to report support/not support for all the bands that UE supports including bands without any motivation of this feature, which is meaningless overhead.

Also, as FG24-8 and FG24-9, there is still an issue specific to FR2-2. If we are to merge it with the one in NR NTN WI, such WI-specific issues may need to be considered even in other WIs. We assume such direction just makes the discussion much more complex, and no clear need to do so is observed at this stage. Given above, we suggest the following update for NR 52.6 – 71 GHz feature list:**Proposal 2:** FG24-8 and 24-9 are not merged with FG26-5 defined in NR NTN

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| 24. NR\_ext\_to\_71GHz | 24-9 | 32 UL HARQ processes for FR 2-2 | Support 32 HARQ processes in UL | 24-1 |  |  |  | [Per UE/per FSPC/per band] |  |  |  |  | Optional with capability signalling |

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| Intel Corporation [9] |  |
| Ericsson [10] | For FG 24-8 and FG 24-9, there is an FFS on whether or not these features are supported for 120 kHz. We note that the following agreement was made in RAN1#107bis-e, hence the note with FFS on 120 kHz can be removed and the component description can be made agnostic to subcarrier spacing.**Agreement*** In NR FR2-2, a UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL (or for UL) shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL (or UL), subject to UE capability.

While it is apparent that a UE that supports 32 HARQ processes should have that capability regardless of the band number, we are fine with capability signalling per-band instead of per-UE. We understand that some UE vendors prefer to re-rest features as new bands are added, hence it can be beneficial to have per-band capability signalling to facilitate such IODT testing on a phased basis.1. Modify FG 24-8 and FG 24-9 as follows to clarify that (1) these FGs are agnostic to SCS, and (2) the capability signalling is per band.

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| 24-9 | 32 UL HARQ processes for FR 2-2 | Support 32 HARQ processes in UL ~~for 480/960 kHz~~ | 32 HARQ processes in the UL is not supported | ~~[Per UE/per FSPC/~~per band~~]~~ | ~~FFS: 120 kHz~~ | Optional with capability signalling |

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| Apple [11] | 1. FG 24-9: the signaling is per band but is only expected for a band where shared spectrum channel access must be used (similar to FG 10-1 for NR-U in 38.822)
 |
| Samsung [12] | It was agreed to support 32 DL and UL HARQ processes, using same solution as in NTN, but for UE features, the FGs of supporting 32 DL and UL HARQ processes should be separate from the corresponding FGs for NTN, since the type of UE to support those FGs can be different. Also, the supporting of FG 24-8 and 24-9 should be per FSPC, such that UE has a better control when implementation this feature. **Proposal 4: For FG 24-8 and FG 24-9:*** **Keep the FGs separately from supporting 32 HARQ processes in NTN;**
* **“Type” of the FGs are per FSPC.**
 |
| MediaTek Inc. [13] |  |
| Qualcomm Incorporated [14] |  |
| LG Electronics [15] | For FGs 24-8 and 24-9, there is one FFS point regarding whether to support 32 DL/UL HARQ processes for 120 kHz SCS based on the following agreement.

|  |
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| Agreement: (RAN1#106bis-e)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.
 |

Additionally, the following agreement was made in RAN1#107bis-e.

|  |
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| **Agreement** (RAN1#107bis-e)* In NR FR2-2, a UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL (or for UL) shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL (or UL), subject to UE capability.
 |

Therefore, FGs 24-8 and 24-9 should be updated according to the above agreement such that a UE capable of 32 HARQ processes in FR2-2 supports this feature for all SCSs in FR2-2.**Proposal #3: According to the agreement made in RAN1#107bis-e, update FGs 24-8 and 24-9 as follows.**

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| 24. NR\_ext\_to\_71GHz | 24-9 | 32 UL HARQ processes for FR 2-2 | Support 32 HARQ processes in UL for 120/480/960 kHz |  |

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The following is the moderator’s summary of contributions submitted to RAN1 #108-e in agenda item 8.16.4 on the same topic.

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|  26. NR\_NTN\_solutions | 26-5 | Increasing the number of HARQ processes | The maximal supported HARQ process number is X for UL and Y for DL |  | Yes | No | Increased number of HARQ processes is not supported | ~~[~~Per band or per FSPC or per UE] | No | No |  | Candidate component values for (X,Y): {(16,32),(32,16),(32,32)} | Optional with capability signalling[Note: This UE feature group is applicable only for NR NTN cell and ATG cell, for terrestrial cell except for ATG cell this feature is not supported] |

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| Company | Summary |
| Huawei, HiSilicon [16] |  |
| MediaTek Inc. [17] |  |
| OPPO [18] |  |
| Nokia, Nokia Shanghai Bell [19] | * + Consequence if not supported needs to be more specific to NR NTN, as there are similar extensions done for other WIDs as well.
 |
| NTT DOCOMO, INC. [20] | There is one important discussion on this issue – whether this FG is merged with other FG from other WI. In FR2-2 WI, the same mechanism was agreed and there are corresponding FGs as FGs 24-8/24-9. In addition, it seems that the discussion includes another big issue behind, which is whether maximum of 32 HARQ processes can be applied to cell other than NTN/FR2-2. In short, our view is that the feature should not be applicable for other cases and correspondingly there is no need to merge the FGs.For the applicability perspective, there are two rationales:* No agreements in any WIs. The 32 HARQ processes feature was agreed in NTN WI and FR2-2 WI for these purposes, but not for other purposes. Without certain agreements at appropriate WG or TEI, such an expansion should not be allowed.
* UE burden or signaling overhead. If this feature is applicable for any cell/band and corresponding FG is per UE, then UE that would like to indicate “support” shall support this feature for any cell/band. In our view, there is motivation of this FG only for NTN/FR2-2, so the excessive support is not preferable. Alternatively if this feature is applicable for any cell/band and corresponding FG is per band, then UE needs to report support/not support for all the bands that the UE supports including bands without any motivation of this feature, which is meaningless overhead.

Then with this direction, for merging perspective, each WI should make corresponding FG separately since the detailed part is different. Pre-requisites will be different, and especially for FR2-2, there would be some other issues specific to the WI. For example, how to define this capability for 120 kHz SCS seems likely to be controversial. Separate definition of this feature can avoid mixing up such WI-specific issues. Moreover, separate FG does not lead to any issue, e.g. no overhead increase.**Proposal 2:*** *Maximum of 32 HARQ processes is applicable only for NTN and FR2-2.*
* *FG 26-5 is not merged with FGs 24-8/24-9.*
 |
| Intel Corporation [21] | * Words Satellite and HAPS can be removed since it is already clear that operation with satellite or HAPS is assumed for NTN.
* UE capability for NTN can be indicated per band to allow more flexibility for UE implementation.

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|  26. NR\_NTN\_solutions | 26-5 | Increasing the number of HARQ processes | The maximal supported HARQ process number is X for UL and Y for DL |  | Yes | No | Increased number of HARQ processes is not supported | ~~[~~Per band or per FSPC or per UE] | No | No |  | Candidate component values for (X,Y): {(16,32),(32,16),(32,32)} | Optional with capability signalling[Note: This UE feature group is applicable only for NR NTN cell and ATG cell, for terrestrial cell except for ATG cell this feature is not supported] |

 |
| Apple [22] | Feature 26-5 mentions that the maximal supported HARQ process number is X for UL and Y for DL. The granularity of this feature is open. In our view, this maximum HARQ process number could be defined per FSPC. UE could have different maximal HARQ process numbers on different carriers, depending on whether NR NTN is supported or not.***Proposal 5:*** *Features 26-5 is defined per FSPC.* |
| Ericsson Hungary Ltd [23] |

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|  26. NR\_NTN\_solutions | 26-5 | Increasing the number of HARQ processes | The maximal supported HARQ process number is X for UL and Y for DL |  | Yes | No | Increased number of HARQ processes is not supported | ~~[~~Per band or or per UE] | No | No |  | Candidate component values for (X,Y): {(16,32),(32,16),(32,32)} | Optional with capability signalling[Note: This UE feature group is applicable only for NR NTN cell and ATG cell, for terrestrial cell except for ATG cell this feature is not supported] |

 |
| Samsung [24] | It is proposed that the type of FG 26-5 should be per FSPC.

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|  26. NR\_NTN\_solutions | 26-5 | Increasing the number of HARQ processes | 1. The maximal supported HARQ process number is 32 for both UL and DL
 | Per FSPC |

 |
| Qualcomm Incorporated [25] | Since NTN is designed with the assumption that legacy NR features are supported in NTN whenever needed, NR container should be used for NTN features. As such, NTN features should by default be per band or per band combination. * **NTN UE features should be at least per band differentiated so that NTN and non-NTN capabilities can be independently set.**
 |
| ZTE [26] | W.r.t FG 26-5, the type column can be updated to [~~Per band or per FSPC or~~ per UE], since supporting up to 16 HARQ process is a type of basic feature based on the granularity of per UE in the legacy Rel-15.

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|  26. NR\_NTN\_solutions | 26-5 | Increasing the number of HARQ processes | The maximal supported HARQ process number is X for UL and Y for DL |  | Yes | Increased number of HARQ processes is not supported | ~~[Per band or per FSPC or~~ per UE] | No | No |  | Candidate component values for (X,Y): {(16,32),(32,16),(32,32)} | Optional with capability signalling[Note: This UE feature group is applicable only for NR NTN cell and ATG cell, for terrestrial cell except for ATG cell this feature is not supported] |  26. NR\_NTN\_solutions |

 |
| LG Electronics [27] |  |

# Discussion/Approval Items during RAN1 #108-e — First Checkpoint

After review of contributions submitted to RAN1 #108-e on this issue, the following topics were identified by the moderator for discussion/approval during RAN1 #108-e.

**General comments**

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| Company | Comments/Questions/Suggestions |
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# Issue 1: UE features for 32 HARQ processes

After review of contributions submitted to RAN1 #108-e on this issue, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal:**

* **The Rel. 17 features that increase the number of HARQ processes are separate FGs for FR2-2 and NR NTN**
* **Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 24. NR\_ext\_to\_71GHz | 24-8 | 32 DL HARQ processes for FR 2-2 | Support 32 HARQ processes in DL for 120/480/960 kHz | 24-1 | Yes | No | 32 DL HARQ processes for FR 2-2 is not supported | ~~[Per UE/~~per FSPC~~/per band]~~ | No | No |  | ~~FFS: 120 kHz~~ | Optional with capability signalling |
| 24. NR\_ext\_to\_71GHz | 24-9 | 32 UL HARQ processes for FR 2-2 | Support 32 HARQ processes in UL for 120/480/960 kHz | 24-1 | Yes | No | 32 UL HARQ processes for FR 2-2 is not supported | ~~[Per UE/~~per FSPC~~/per band]~~ | No | No |  | ~~FFS: 120 kHz~~ | Optional with capability signalling |
|  26. NR\_NTN\_solutions | 26-5 | Increasing the number of HARQ processes | The maximal supported HARQ process number is X for UL and Y for DL |  | Yes | No | Increased number of HARQ processes is not supported for NR communication via satellite | ~~[Per band or~~ per FSPC ~~or per UE]~~ | No | No |  | Candidate component values for (X,Y): {(16,32),(32,16),(32,32)} | Optional with capability signalling~~[~~Note: This UE feature group is applicable only for NR cell for communication via satellite or with ATG gNB as specified in TS 38.101-X; ~~NR NTN cell and ATG cell,~~ for ~~terrestrial~~ any other cell ~~except for ARG cell~~ this feature is not supported~~]~~ |

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| Company | Comments/Questions/Suggestions |
| Intel | The two features for NTN and 60GHz are actually after the same thing.Furthermore, as LGE pointed out there was an working assumption for 60 GHz where it was suppose to use NTN feature as is (unless there were problems to do so).“Working assumption: The same solution to support up to 32 HARQ process number in Rel-17 NTN WI is reused for NR FR2-2.”There for we think the two features should be merged. The fact that moderator is suggesting the feature be per FSPC makes it more compelling to have the feature be defined in a generic manner. |
| Nokia, NSB | In principle we are fine with merging of the features as long as the signaling itself doesn’t become unnecessarily complex. However, we don’t see a compelling motivation to have the FGs as FSPC, as there is nothing in it that would require different behaviors for specific carriers within a frequency band or for specific carriers within a band combination. For the purposes of differentiating the support for FR2-2 and NTN it is more than enough to have the signaling defined as per band.  |
| Huawei, HiSilicon | We don’t support the proposal. We still think it is beneficial to define the FG(s) for the support of 32 HARQ processes **without** tying it to 52.6 GHz and/or NTN. The reasons are given as below:1. Since anyway the reporting granularity of the FG(s) for 32 HARQ processes would be a finer granularity, e.g. per band or even per FSPC if companies insist, then no need to define duplicated FGs in different WIs. 2. One additional benefit by doing so is that the support of 32 HARQ processes can be used for other scenarios for a UE supporting this feature, e.g. used for FR1 licensed terrestrial bands and FR2-1. For example, for the support of FR1 + FR2 CA, if the PUCCH is transmitted on FR1 with small SCS, then it can be expected that a small number of slots on FR1 would correspond to large number of slots on FR2, which will result in the need of larger number of HARQ processes on FR2, otherwise it will degrade the system performance for FR2. Another example scenario that would be beneficial from the support of 32 HARQ processes is multi-TRP case, in which case the need of number of HARQ processes would be increased. 3. Even if we don’t restrict the support of 32 HARQ processes to NTN and/or 52.6 GHz, UE still has fully flexibility to report its capability. Support of 32 HARQ processes for other WIs is not mandatory. .4. We don’t agree with the comment that extending it to other WIs would increase the signaling overhead thus should not be supported. Since UE will report the capability for a certain band only if it will support the feature. If UE can support the feature and report it for a certain band, then the signaling is necessary. On the other hand, defining 3 FGs as shown in the proposal may increase the capability signaling, e.g. if there is NTN bands in FR2-2 in the future, then with the proposal here UE needs to report the same functionality twice, which increase the signaling overhead. In general, FGs should be defined from functionality perspective, not from scenario perspective. 5. We don’t agree with the argument that that there is no agreement for other WIs thus it should not be supported. Whether to apply it to other scenarios also is what we are discussing, i.e. we are trying to see if we can make any agreement. In addition, we don’t see additional optimization or spec impact needed due to extending 32 HARQ processes to other WIs.Therefore, we still propose to define the following FGs for the support of 32 HARQ processes instead.

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| 39 | 39-1 | 32 DL HARQ processes | HARQ process operation with configurable number of DL HARQ processes of up to 32 |  |  |  |  | [per FSPC/per band] |  |  |  |  | Optional with capability signalling |
| 39 | 39-2 | 32 UL HARQ processes | HARQ process operation with configurable number of UL HARQ processes of up to 32 |  |  |  |  | [per FSPC/per band] |  |  |  |  | Optional with capability signalling |

 |
| New H3C | We are fine with supporting the FG(s) for 32 HARQ processes for NTN and FR2-2 based on previous agreement. We are open for discussion about extending this feature to other scenarios. |
| Qualcomm | We support the proposal. These two features, though similar, were introduced for different reasons. There is no need for artificially merge them, even though there are similarities. By separating the feature, we can have better flexibility in the future when evolving the designs. |
| Ericsson | For operation in FR2-2, we support that whatever UE capability is defined, it should not depend on the SCS (120, 480, 960 kHz). Hence, if the UE supports 32 HARQ processes for a band in FR2-2, it should be supported for all SCS values for that band.Given this, we don't really understand why separate FGs for FR2-2 and NTN would be necessary since the only difference between the FGs listed in the proposal is the frequency band.Hence, we think a better approach would be to define a merged FG that is agnostic to SCS with "per band" signaling granularity. Either a single FG with candidate values {32,16}, {16,32}, and {32,32} can be one way. Another would be to have separate FGs for UL/DL. Both seem equivalent.Regardless, we prefer to avoid "per FSPC," and use "per band" instead to simplify UE capability processing amongst different UEs. |
| LG Electronics | We are OK with having separate FGs for FR2-2 and NTN, to support 32 HARQ processes.One editorial comment for FG 24-9: The pre-requisite needs to be changed from 24-1 to 24-1a (corresponding to Basic FR2-2 UL support). |
| vivo | RAN1 only agreed to support 32HARQ processes in FR2-2 and NTN use cases, although RAN1 has also explicitly discussed the same thing in MBS and MIMO but eventually not agreed. Having a generic UE feature for 32HARQ process with per band will extend the use case of 32HARQ process to MBS and MIMO which somehow contradicts with previous RAN1 agreement, and many other use cases which RAN1 did not discussed at all, e.g. URLLC. |
| ZTE | We are supportive of defining the unified FGs. And prefer to take it as per UE as the first priority. The motivation behind is that from scheduling’s perspective, same implementation of gNB is considered regardless of SCS. Meanwhile, Taking the “Per UE” is beneficial to unify the UE’s behavior among all relevant scenario (with similar implementation). |

# Discussion/Approval Items during RAN1 #108-e — Second Checkpoint

Based on the comments/questions/suggestions received by the first checkpoint, the following are the revised proposals and/or proposed agreements by the moderator. Companies submitted the following views on the moderator’s proposals.

***[Please submit all comments/questions/suggestions here, late comments/questions/suggestions submitted in Section 3 will not be considered]***

**General comments**

|  |  |
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| Company | Comments/Questions/Suggestions |
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# Issue 1: FG

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Discussion/Approval Items during RAN1 #108-e — Third Checkpoint

Based on the comments/questions/suggestions received by the second checkpoint, the following are the revised proposals and/or proposed agreements by the moderator. Companies submitted the following views on the moderator’s proposals.

***[Please submit all comments/questions/suggestions here, late comments/questions/suggestions submitted in Section 4 will not be considered]***

**General comments**

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| Company | Comments/Questions/Suggestions |
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# Issue 1: FG

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Summary of Final Proposals for Agreements

This Section summarizes the final proposals for agreement in RAN1 #108-e by email. There are no tables for comments.

***[All comments must be directly made on the RAN1 email reflector]***

Companies can continue to update their comments in the previous Sections, however, these are no longer monitored by the moderator. Any such comments will be for archival purposes only and will not influence the outcome of this email discussion. Any objection to any of the proposals in this Section must be voiced directly on the RAN1 email reflector.

**Possible Agreement: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Conclusion

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

# References

1. R1-2200780, Updated RAN1 UE features list for Rel-17 NR after RAN1 #108-e, Moderators (AT&T, NTT DOCOMO, INC.)
2. R1-2202447, On support of UE feature(s) for 32 HARQ processes in Rel-17 work items, Huawei/HiSilicon
3. R1-2200958, Rel-17 UE features for extension to 71 GHz, Huawei/HiSilicon
4. R1-2201121, Discussions on UE features for NR operation from 52.6GHz to 71GHz, vivo
5. R1-2201302, Discussion on UE features for FR2-2, OPPO
6. R1-2201395, Discussion on UE features for 52.6 to 71GHz, ZTE/Sanechips
7. R1-2201409, On UE features for supporting NR from 52.6 GHz to 71 GHz, Nokia/Nokia Shanghai Bell
8. R1-2201502, Views on Rel-17 UE features for supporting NR in FR2-2, NTT DOCOMO, INC.
9. R1-2201727, Discussion on UE capability for extending NR up to 71 GHz, Intel Corporation
10. R1-2201741, UE features for extending current NR operation to 71 GHz, Ericsson
11. R1-2201792, Views on Rel-17 Beyond 52.6 GHz UE features, Apple
12. R1-2202039, On UE features for supporting NR from 52.6 GHz to 71 GHz, Samsung
13. R1-2202075, Views on UE features for supporting NR from 52.6 GHz to 71 GHz, MediaTek Inc.
14. R1-2202166, UE features for NR from 52.6 Ghz to 71 Ghzm Qualcomm Incorporated
15. R1-2202355, Discussion on UE features for NR above 52.6 GHz, LG Electronics
16. R1-2200940, Rel-17 UE features for NR NTN, Huawei/HiSilicon
17. R1-2201222, UE features for NR NTN, MediaTek Inc.
18. R1-2201303, Discussion on UE features for NTN-NR, OPPO
19. R1-2201411, On UE features for NR NTN, Nokia/Nokia Shanghai Bell
20. R1-2201504, Discussion on Rel.17 UE features for NR NTN, NTT DOCOMO, INC.
21. R1-2201729, On UE features for NR NTN, Intel Corporation
22. R1-2201794, Views on Rel-17 NR NTN UE Features, Apple
23. R1-2201807, On UE features for NR NTN, Ericsson Hungary Ltd
24. R1-2202041, UE features for NR NTN, Samsung
25. R1-2202168, UE features for NR NTN, Qualcomm Incorporated
26. R1-2202212, Discussion on UE feature for NR-NTN, ZTE
27. R1-2202290, Discussion on Rel-17 UE feature for NR NTN, LG Electronics