**3GPP TSG RAN WG1 #109-e R1-2204851**

**e-Meeting, May 9th – 20th, 2022**

**Agenda Item: 8.16.4**

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

**Title: Summary of UE features for NR NTN**

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

# Introduction

This document presents the summary of email discussion/approval [] during RAN1 #109-e. According to the Chairman’s Notes:

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| [109-e-R17-UE-features-NR-NTN-01] Email discussion on UE features for NR-NTN – Ralf (AT&T)* 1st check point for LS to RAN2: May 13
* Final check point for any remaining issues: May 20
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The following was discussed and/or agreed during RAN1 #109-e within the scope of []. All proposals are based on the latest RAN1 UE features list for Rel-17 NR in [1].

# Summary of Contributions Submitted to RAN1 #109-e

The following is the moderator’s summary of contributions submitted to RAN1 #109-e in this agenda item.

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|  26. NR\_NTN\_solutions | 26-1 | Uplink Time and Frequency pre-compensation and timing relationship enhancements | 1. UE specific TA calculation based on its GNSS-acquired position and the serving satellite ephemeris.
2. UE calculates common TA according to the parameters provided by the network (UE considers common TA as 0 if the parameter is not provided)
3. For TA update in RRC\_CONNECTED state, combination of both open (i.e. UE autonomous TA estimation, and common TA estimation) and closed (i.e., received TA commands) control loops
4. UE pre-compensates the calculated TA in its uplink transmissions
5. Support of estimating UE-gNB RTT and delaying the start of RAR window by UE-gNB RTT
6. Support of frequency pre-compensation to counter shift the Doppler experienced on the service link
7. Determining timing of the scheduling of PUSCH, PUCCH and PDCCH ordered PRACH, CSI reference resource, transmission of aperiodic SRS activation of TA command, first PUSCH transmission in CG Type 2 with cell-specific K\_offset if indicated
8. Determining timing of the UE action and assumption on a downlink configuration carried by MAC CE command by K\_mac if it is indicated and determining the timing of PDCCH monitoring in recovery search space using K-mac during beam failure recovery procedure
9. UE receives cell-specific K\_offset/K\_mac in system information
 |  | No | No | Release 17 NR UE cannot communicate via satellite | per band | No | No | No | An NTN UE is required to at least support UE specific TA and frequency calculation based at least on its GNSS-acquired position and the serving satellite ephemeris[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] | Optional with capability signalling For UE supports NR communication via satellite, UE must indicate this FG is supported. |

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| Company | Summary |
| Huawei/HiSilicon [2] | On the note in the last column, our view is that it is not strictly needed. The reason is that this FG is defined per band and it is an optional UE capability. A UE only needs to report what it supports on the particular band. The note would be needed for a per UE capability but not for per band UE capability. However, there is a similar situation in Rel-16 NR-U specific per-band FGs. For NR-U, a note “the signaling is per band but is only expected for a band where shared spectrum channel access must be used” is added even though it is NOT explicitly captured in 38.306. Overall, either way may be fine for this particular FG since it is a NTN-specific feature. To simplify the description, we suggest to **remove note in last column.** |
| ZTE [3] | Moreover, for the note column of FG26-1, 26-4, 26-5, 26-6, 26-6a, 26-6b, 26-8, 26-9, the note ~~[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]~~ should be removed since the listed FGs are defined per band, thus the note of each FG is implicitly associated with the band in which the corresponding FG is supported. |
| Vivo [4] | RAN2 raised concerns on both of FGs 26-1 and FGs 26-8 which have “N/A” in the column of “Need for the gNB to know if the feature is supported” while indicate in the column of “Mandatory/Optional” as “optional with capability signalling”. From RAN2 perspective, if there is no need for gNB to know whether a feature is supported or not, no capability signalling should be defined. RAN2 would like to know whether such capabilities are really “optional with capability signalling”. FGs 26-1 must be supported for UEs supporting NR communication via satellite, as described in the column of “Mandatory/Optional”. However, it is not mandated for UEs not supporting satellite communication but supporting other NTN scenarios, e.g. HAPS, ATG. In one word, UE can be optional with capability signalling and gNB needs to know if the feature is supported. As for FGs 26-8, gNB would indicate the polarization for UE with circular polarization to take the advantage of polarization information to save power. For UE with linear polarization, reading the polarization signalling may be unnecessary and UE can also work well in NTN even without the polarization signalling. However, in NTN, various UE types could coexist, e.g. UE with linear polarization, UE with LHCP, UE with RHCP, or with a combination of different polarization types. Thus, gNB could always indicate the polarization and UE can optionally support the feature without capability signalling. This should be captured into UE feature list, e.g. according to the text proposal we added in red in following list.

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9. UE receives cell-specific K\_offset/K\_mac in system information
 |  | ~~No~~Yes | No | Release 17 NR UE cannot communicate via satellite | per band | No | No | No | An NTN UE is required to at least support UE specific TA and frequency calculation based at least on its GNSS-acquired position and the serving satellite ephemeris[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] | Optional with capability signalling For UE supports NR communication via satellite, UE must indicate this FG is supported. |

According to above, we have following proposal which is also captured in our draft reply LS [3].***Proposal 2: RAN1 should send a reply LS to RAN2, indicating:**** ***FGs 26-1 should be optional with capability signalling and gNB needs to know if the feature is supported.***
* ***FGs 26-8 should be optional without capability signalling.***
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| Xiaomi [5] |  |
| Samsung [6] |  |
| OPPO [7] |  |
| Apple [8] | The feature 26-1 was updated or expanded to uplink time and frequency pre-compensation and timing relationship enhancements. This feature is mandatory in supporting NR communication via satellite. In the latest version of this feature, the field of “Need for the gNB to know if the feature is supported” is No. However, we think gNB needs to know if a UE supports this feature to serve it via satellite. Hence, we have the following proposal. ***Proposal 1:*** *It is necessary for the gNB to know if the feature 26-1 is supported.*  |
| NTT DOCOMO, INC. [9] | One important discussion is on notes with yellow-highlight on applicability of each FG for TN. In our view, at least report of NTN-specific features that is not used in TN is unnecessary. For example, FG 26-1 has components to connect to NTN cell and do communication appropriately. Meanwhile, such a mechanism is unnecessary for any TN. For those FGs, such a note should be captured. The FGs would be FGs 26-1/26-4/26-8/26-9.Then, there were discussions on whether such a note is captured for FGs that can potentially be used in TN as well as NTN. Basically, we believe that whether a mechanism is supported or not should be discussed in WI agenda having motivation to introduce the mechanism. Under this view, also FGs 26-5/26-6/26-6a/26-6b should have the same note as in FGs 26-1/26-4/26-8/26-9. However, it was decided in Rel-16 NR-U UE feature session that (normal) Type-3 HARQ-ACK CB is applicable for any cell including cells in licensed band. If majority companies really want the FGs for cell other than NTN cell, we do not object the direction to follow the precedent.Regarding wording of the note, we think that the note should be separate into two sentences in order to avoid misunderstanding. In addition, we are not sure ‘ATG cell’ needs to be mentioned. RAN4 decided that Rel-17 does not support ATG cell and it is discussed in Rel-18.Based on the above, the following is proposed.**Proposal 1:*** *The following note is added to at least FGs 26-1/26-4/26-8/26-9, and also to FGs 26-5/26-6/26-6a/26-6b unless majority companies prefer to use the FG also for TN cell.*
	+ *Note: This UE feature group is applicable only for NR NTN cell. This UE feature group is not supported for terrestrial cell.*
 |
| LG Electronics [10] | In the note column, there may be copy-and-paste error. It should be replaced by [Note: This UE feature group is applicable only for NR cell for communication via satellite/HAPS as specified in TS 38.101-5 or TS 38.104; for any other cell this feature is not supported]. However, the note can be removed as it can be left for UE to indicate this FG per band. |
| Nokia/Nokia Shanghai Bell [11] | * + The following highlighted note can be found on these FGs:
	+ [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]
	+ However, it is not clear how such a limitation would be applicable in practice.
		- Are the UEs expected to report support for the feature conditionally on the type of cell? This would not follow the UE capability framework for NR.
		- Another interpretation is that this would be intended at limiting the gNB implementation to prevent usage of some features that UEs have already reported to support. It is questionable what would be benefits of such approach, especially considering the said FGs are reported per band already.
	+ **Remove the note above in all these FGs.**

These are basic features for UEs supporting NR over NTN.” Hence, they should be combined into a single FG, or at the very least carry a note that they must be indicated as supported by UEs supporting NR communication via satellite. |
| Ericsson [12] | Align wording by consistent use of (e.g.) "support of".Editorial change (one comma added)

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|  26. NR\_NTN\_solutions | 26-4 | UE reporting of information related to TA pre-compensation | 1. Support UE reporting of information related to TA pre-compensation  | 26-1 | Yes | No | UE does not support reporting of information related to TA pre-compensation for NR communication via satellite | Per band | No | No | No | Note: The exact content of UE reporting of information about the TA pre-compensation is up to RAN2[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] | Optionalwith capability signalling  |

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| Company | Summary |
| Huawei/HiSilicon [2] | On the note in the last column, our view is that it is not strictly needed. The reason is that this FG is defined per band and it is an optional UE capability. A UE only needs to report what it supports on the particular band. The note would be needed for a per UE capability but not for per band UE capability. However, there is a similar situation in Rel-16 NR-U specific per-band FGs. For NR-U, a note “the signaling is per band but is only expected for a band where shared spectrum channel access must be used” is added even though it is NOT explicitly captured in 38.306. Overall, either way may be fine for this particular FG since it is a NTN-specific feature. To simplify the description, we suggest to **remove note in last column.** |
| ZTE [3] | Moreover, for the note column of FG26-1, 26-4, 26-5, 26-6, 26-6a, 26-6b, 26-8, 26-9, the note ~~[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]~~ should be removed since the listed FGs are defined per band, thus the note of each FG is implicitly associated with the band in which the corresponding FG is supported. |
| Vivo [4] |  |
| Xiaomi [5] |  |
| Samsung [6] |  |
| OPPO [7] |  |
| Apple [8] |  |
| NTT DOCOMO, INC. [9] | One important discussion is on notes with yellow-highlight on applicability of each FG for TN. In our view, at least report of NTN-specific features that is not used in TN is unnecessary. For example, FG 26-1 has components to connect to NTN cell and do communication appropriately. Meanwhile, such a mechanism is unnecessary for any TN. For those FGs, such a note should be captured. The FGs would be FGs 26-1/26-4/26-8/26-9.Then, there were discussions on whether such a note is captured for FGs that can potentially be used in TN as well as NTN. Basically, we believe that whether a mechanism is supported or not should be discussed in WI agenda having motivation to introduce the mechanism. Under this view, also FGs 26-5/26-6/26-6a/26-6b should have the same note as in FGs 26-1/26-4/26-8/26-9. However, it was decided in Rel-16 NR-U UE feature session that (normal) Type-3 HARQ-ACK CB is applicable for any cell including cells in licensed band. If majority companies really want the FGs for cell other than NTN cell, we do not object the direction to follow the precedent.Regarding wording of the note, we think that the note should be separate into two sentences in order to avoid misunderstanding. In addition, we are not sure ‘ATG cell’ needs to be mentioned. RAN4 decided that Rel-17 does not support ATG cell and it is discussed in Rel-18.Based on the above, the following is proposed.**Proposal 1:*** *The following note is added to at least FGs 26-1/26-4/26-8/26-9, and also to FGs 26-5/26-6/26-6a/26-6b unless majority companies prefer to use the FG also for TN cell.*
	+ *Note: This UE feature group is applicable only for NR NTN cell. This UE feature group is not supported for terrestrial cell.*
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| LG Electronics [10] | In the note column, there may be copy-and-paste error. It should be replaced by [Note: This UE feature group is applicable only for NR cell for communication via satellite/HAPS as specified in TS 38.101-5 or TS 38.104; for any other cell this feature is not supported]. However, the note can be removed as it can be left for UE to indicate this FG per band. |
| Nokia/Nokia Shanghai Bell [11] | * + The following highlighted note can be found on these FGs:
	+ [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]
	+ However, it is not clear how such a limitation would be applicable in practice.
		- Are the UEs expected to report support for the feature conditionally on the type of cell? This would not follow the UE capability framework for NR.
		- Another interpretation is that this would be intended at limiting the gNB implementation to prevent usage of some features that UEs have already reported to support. It is questionable what would be benefits of such approach, especially considering the said FGs are reported per band already.
	+ **Remove the note above in all these FGs.**
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| Ericsson [12] | Editorial change (one space added)

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|  26. NR\_NTN\_solutions | 26-4 | UE reporting of information related to TA pre-compensation | 1. Support UE reporting of information related to TA pre-compensation  | 26-1 | Yes | No | UE does not support reporting of information related to TA pre-compensation for NR communication via satellite | Per band | No | No | No | Note: The exact content of UE reporting of information about the TA pre-compensation is up to RAN2[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] | Optional with capability signalling  |

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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 for UL and Y for DL |  | Yes | No | Increased number of HARQ processes is not supported for NR communication via satellite | Per band | No | No | No | Candidate component values for (X,Y): {(16,32),(32,16),(32,32)}[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] | Optional with capability signalling supported] |

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| Company | Summary |
| Huawei/HiSilicon [2] | On the note in the last column, the situation is a bit different compared to other “NTN-specific” FGs. As discussed in [1], the support of 32 HARQ processes can be beneficial 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. As a matter of fact, the possibility to extend the 32 HARQ processes has been discussed before as summarized in [2]. Consensus cannot be reached due to different flavors of HARQ process ID indication. However, in NTN, the explicit HARQ process indication has already been agreed. Therefore, there seems no obstacles to extend this FG in other scenarios. Overall, we see a clear benefit of extending this FG to other scenarios and suggest to **remove the note in the last column.** |
| ZTE [3] | Moreover, for the note column of FG26-1, 26-4, 26-5, 26-6, 26-6a, 26-6b, 26-8, 26-9, the note ~~[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]~~ should be removed since the listed FGs are defined per band, thus the note of each FG is implicitly associated with the band in which the corresponding FG is supported. |
| Vivo [4] |  |
| Xiaomi [5] |  |
| Samsung [6] | NTN-TN mobility is one of the objectives of Rel-18 NR NTN enhancements. Therefore, 3GPP will start investigating systems with both NTN and TN components in Rel-18. In order to avoid any issues when discussing features from Rel-18 onward, we suggest we clarify that FG 26-5 covers operation with NTN carriers only. While this clarification has no impact for Rel-17, it will be useful in the future if there are scenarios where one carrier is for NTN and one for TN.* For component description add “when a UE is configured with NTN carriers only” as follows.

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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, when a UE is configured with NTN carriers only. |  | Yes | No | Increased number of HARQ processes is not supported for NR communication via satellite | Per band | No | 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/HAPS as specified in TS 38.101-5 or TS 38.104; for any other cell this feature is not supported] |

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| OPPO [7] |  |
| Apple [8] |  |
| NTT DOCOMO, INC. [9] | One important discussion is on notes with yellow-highlight on applicability of each FG for TN. In our view, at least report of NTN-specific features that is not used in TN is unnecessary. For example, FG 26-1 has components to connect to NTN cell and do communication appropriately. Meanwhile, such a mechanism is unnecessary for any TN. For those FGs, such a note should be captured. The FGs would be FGs 26-1/26-4/26-8/26-9.Then, there were discussions on whether such a note is captured for FGs that can potentially be used in TN as well as NTN. Basically, we believe that whether a mechanism is supported or not should be discussed in WI agenda having motivation to introduce the mechanism. Under this view, also FGs 26-5/26-6/26-6a/26-6b should have the same note as in FGs 26-1/26-4/26-8/26-9. However, it was decided in Rel-16 NR-U UE feature session that (normal) Type-3 HARQ-ACK CB is applicable for any cell including cells in licensed band. If majority companies really want the FGs for cell other than NTN cell, we do not object the direction to follow the precedent.Regarding wording of the note, we think that the note should be separate into two sentences in order to avoid misunderstanding. In addition, we are not sure ‘ATG cell’ needs to be mentioned. RAN4 decided that Rel-17 does not support ATG cell and it is discussed in Rel-18.Based on the above, the following is proposed.**Proposal 1:*** *The following note is added to at least FGs 26-1/26-4/26-8/26-9, and also to FGs 26-5/26-6/26-6a/26-6b unless majority companies prefer to use the FG also for TN cell.*
	+ *Note: This UE feature group is applicable only for NR NTN cell. This UE feature group is not supported for terrestrial cell.*
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| LG Electronics [10] | In the note column, there may be copy-and-paste error. It should be replaced by [Note: This UE feature group is applicable only for NR cell for communication via satellite/HAPS as specified in TS 38.101-5 or TS 38.104; for any other cell this feature is not supported]. However, the note can be removed as it can be left for UE to indicate this FG per band. |
| Nokia/Nokia Shanghai Bell [11] | * + The following highlighted note can be found on these FGs:
	+ [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]
	+ However, it is not clear how such a limitation would be applicable in practice.
		- Are the UEs expected to report support for the feature conditionally on the type of cell? This would not follow the UE capability framework for NR.
		- Another interpretation is that this would be intended at limiting the gNB implementation to prevent usage of some features that UEs have already reported to support. It is questionable what would be benefits of such approach, especially considering the said FGs are reported per band already.
	+ **Remove the note above in all these FGs.**
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| Ericsson [12] | Editorial change (deleted "supported]"

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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 for UL and Y for DL |  | Yes | No | Increased number of HARQ processes is not supported for NR communication via satellite | Per band | No | No | No | Candidate component values for (X,Y): {(16,32),(32,16),(32,32)}[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] | Optional with capability signalling  |

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|  26. NR\_NTN\_solutions | 26-6 | Type-2 HARQ codebook enhancement | Support of type-2 HARQ codebook enhancements when there are feedback-disabled HARQ processes | FFS | Yes | No | Type-2 HARQ codebook enhancement is not supported for NR communication via satellite | per band | No | No | No | [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] | Optional with capability signalling  |

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| Company | Summary |
| Huawei/HiSilicon [2] | On the note in the last column, our view is that it is not strictly needed. The reason is that this FG is defined per band and it is an optional UE capability. A UE only needs to report what it supports on the particular band. The note would be needed for a per UE capability but not for per band UE capability. However, there is a similar situation in Rel-16 NR-U specific per-band FGs. For NR-U, a note “the signaling is per band but is only expected for a band where shared spectrum channel access must be used” is added even though it is NOT explicitly captured in 38.306. Overall, either way may be fine for this particular FG since it is a NTN-specific feature. To simplify the description, we suggest to **remove note in last column.****Remove FFS in 5-th column.** |
| ZTE [3] | W.r.t FG 26-6, the **prerequisite column can be updated from “FFS” to “4-10”**, i.e., “Dynamic HARQ-ACK codebook”, since type-2 HARQ codebook should be first supported and then the enhancement on type-2 HARQ codebook can be performed.Moreover, for the note column of FG26-1, 26-4, 26-5, 26-6, 26-6a, 26-6b, 26-8, 26-9, the note ~~[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]~~ should be removed since the listed FGs are defined per band, thus the note of each FG is implicitly associated with the band in which the corresponding FG is supported. |
| Vivo [4] |  |
| Xiaomi [5] |  |
| Samsung [6] |  |
| OPPO [7] | The features 26-6, 26-6a, 26-6b are respectively defined for Type-1, Type-2, Type-3 HARQ codebook enhancement when there are feedback disabled HARQ processes. The pre-requisite features are open for these three features. In our view, UE needs to support the PDSCH reception associated with HARQ processes with feedback disabling, before it can construct the enhanced HARQ-ACK codebook construction. The feature of downlink HARQ disabling is defined in RAN2, which could serve as pre-requisite of features 26-6, 26-6a and 26-6b. ***Proposal 2:*** *The pre-requisite of features 26-6, 26-6a and 26-6b are the RAN2 feature of downlink HARQ disabling.*  |
| Apple [8] |  |
| NTT DOCOMO, INC. [9] | At the last meeting, ‘UE supports HARQ disabling’ was removed from these FGs since RAN2 has the corresponding FG. Then pre-requisite of these FGs is FFS to discuss whether the RAN2 FG should be added in these FGs as pre-requisite. In our understanding, HARQ-ACK CB enhancements introduced in Rel-17 NTN WI are only related to feedback-disabling mechanism. To add the RAN2 FG as pre-requisite would be straightforward without any problem. The following is proposed based on this discussion.**Proposal 2:*** *harq-FeedbackDisabled is added as pre-requisite of FGs 26-6/26-6a/26-6b.*

One important discussion is on notes with yellow-highlight on applicability of each FG for TN. In our view, at least report of NTN-specific features that is not used in TN is unnecessary. For example, FG 26-1 has components to connect to NTN cell and do communication appropriately. Meanwhile, such a mechanism is unnecessary for any TN. For those FGs, such a note should be captured. The FGs would be FGs 26-1/26-4/26-8/26-9.Then, there were discussions on whether such a note is captured for FGs that can potentially be used in TN as well as NTN. Basically, we believe that whether a mechanism is supported or not should be discussed in WI agenda having motivation to introduce the mechanism. Under this view, also FGs 26-5/26-6/26-6a/26-6b should have the same note as in FGs 26-1/26-4/26-8/26-9. However, it was decided in Rel-16 NR-U UE feature session that (normal) Type-3 HARQ-ACK CB is applicable for any cell including cells in licensed band. If majority companies really want the FGs for cell other than NTN cell, we do not object the direction to follow the precedent.Regarding wording of the note, we think that the note should be separate into two sentences in order to avoid misunderstanding. In addition, we are not sure ‘ATG cell’ needs to be mentioned. RAN4 decided that Rel-17 does not support ATG cell and it is discussed in Rel-18.Based on the above, the following is proposed.**Proposal 1:*** *The following note is added to at least FGs 26-1/26-4/26-8/26-9, and also to FGs 26-5/26-6/26-6a/26-6b unless majority companies prefer to use the FG also for TN cell.*
	+ *Note: This UE feature group is applicable only for NR NTN cell. This UE feature group is not supported for terrestrial cell.*
 |
| LG Electronics [10] | In the note column, there may be copy-and-paste error. It should be replaced by [Note: This UE feature group is applicable only for NR cell for communication via satellite/HAPS as specified in TS 38.101-5 or TS 38.104; for any other cell this feature is not supported]. However, the note can be removed as it can be left for UE to indicate this FG per band.In R2-2230551, FG for disabling HARQ feedback for downlink transmission is captured as below. Hence, prerequisite feature groups for 26-6, 26-6a and 26-6b should be x-2 where x is TBD. |
| Nokia/Nokia Shanghai Bell [11] | * + The following highlighted note can be found on these FGs:
	+ [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]
	+ However, it is not clear how such a limitation would be applicable in practice.
		- Are the UEs expected to report support for the feature conditionally on the type of cell? This would not follow the UE capability framework for NR.
		- Another interpretation is that this would be intended at limiting the gNB implementation to prevent usage of some features that UEs have already reported to support. It is questionable what would be benefits of such approach, especially considering the said FGs are reported per band already.
	+ **Remove the note above in all these FGs.**

These are basic features for UEs supporting NR over NTN.” Hence, they should be combined into a single FG, or at the very least carry a note that they must be indicated as supported by UEs supporting NR communication via satellite. |
| Ericsson [12] |  |

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|  26. NR\_NTN\_solutions | 26-6a | Type-1 HARQ codebook enhancement | 1. Support of Type-1 HARQ codebook enhancements when there are feedback-disabled HARQ processes
 |  FFS | Yes | No | Type-1 HARQ codebook enhancement is not supported for NR communication via satellite | per band | No | No | No | [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] | Optional with capability signalling  |

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| Company | Summary |
| Huawei/HiSilicon [2] | On the note in the last column, our view is that it is not strictly needed. The reason is that this FG is defined per band and it is an optional UE capability. A UE only needs to report what it supports on the particular band. The note would be needed for a per UE capability but not for per band UE capability. However, there is a similar situation in Rel-16 NR-U specific per-band FGs. For NR-U, a note “the signaling is per band but is only expected for a band where shared spectrum channel access must be used” is added even though it is NOT explicitly captured in 38.306. Overall, either way may be fine for this particular FG since it is a NTN-specific feature. To simplify the description, we suggest to **remove note in last column.****Remove FFS in 5-th column.** |
| ZTE [3] | W.r.t FG 26-6a and 26-6b, the **prerequisite column can be updated from “FFS” to “4-11”**, i.e., “Semi-static HARQ-ACK codebook”, since type-1 and type-3 HARQ codebook should be first supported and then the enhancement on them can be performed.Moreover, for the note column of FG26-1, 26-4, 26-5, 26-6, 26-6a, 26-6b, 26-8, 26-9, the note ~~[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]~~ should be removed since the listed FGs are defined per band, thus the note of each FG is implicitly associated with the band in which the corresponding FG is supported. |
| Vivo [4] |  |
| Xiaomi [5] |  |
| Samsung [6] |  |
| OPPO [7] |  |
| Apple [8] | The features 26-6, 26-6a, 26-6b are respectively defined for Type-1, Type-2, Type-3 HARQ codebook enhancement when there are feedback disabled HARQ processes. The pre-requisite features are open for these three features. In our view, UE needs to support the PDSCH reception associated with HARQ processes with feedback disabling, before it can construct the enhanced HARQ-ACK codebook construction. The feature of downlink HARQ disabling is defined in RAN2, which could serve as pre-requisite of features 26-6, 26-6a and 26-6b. ***Proposal 2:*** *The pre-requisite of features 26-6, 26-6a and 26-6b are the RAN2 feature of downlink HARQ disabling.*  |
| NTT DOCOMO, INC. [9] | At the last meeting, ‘UE supports HARQ disabling’ was removed from these FGs since RAN2 has the corresponding FG. Then pre-requisite of these FGs is FFS to discuss whether the RAN2 FG should be added in these FGs as pre-requisite. In our understanding, HARQ-ACK CB enhancements introduced in Rel-17 NTN WI are only related to feedback-disabling mechanism. To add the RAN2 FG as pre-requisite would be straightforward without any problem. The following is proposed based on this discussion.**Proposal 2:*** *harq-FeedbackDisabled is added as pre-requisite of FGs 26-6/26-6a/26-6b.*

One important discussion is on notes with yellow-highlight on applicability of each FG for TN. In our view, at least report of NTN-specific features that is not used in TN is unnecessary. For example, FG 26-1 has components to connect to NTN cell and do communication appropriately. Meanwhile, such a mechanism is unnecessary for any TN. For those FGs, such a note should be captured. The FGs would be FGs 26-1/26-4/26-8/26-9.Then, there were discussions on whether such a note is captured for FGs that can potentially be used in TN as well as NTN. Basically, we believe that whether a mechanism is supported or not should be discussed in WI agenda having motivation to introduce the mechanism. Under this view, also FGs 26-5/26-6/26-6a/26-6b should have the same note as in FGs 26-1/26-4/26-8/26-9. However, it was decided in Rel-16 NR-U UE feature session that (normal) Type-3 HARQ-ACK CB is applicable for any cell including cells in licensed band. If majority companies really want the FGs for cell other than NTN cell, we do not object the direction to follow the precedent.Regarding wording of the note, we think that the note should be separate into two sentences in order to avoid misunderstanding. In addition, we are not sure ‘ATG cell’ needs to be mentioned. RAN4 decided that Rel-17 does not support ATG cell and it is discussed in Rel-18.Based on the above, the following is proposed.**Proposal 1:*** *The following note is added to at least FGs 26-1/26-4/26-8/26-9, and also to FGs 26-5/26-6/26-6a/26-6b unless majority companies prefer to use the FG also for TN cell.*
	+ *Note: This UE feature group is applicable only for NR NTN cell. This UE feature group is not supported for terrestrial cell.*
 |
| LG Electronics [10] | In the note column, there may be copy-and-paste error. It should be replaced by [Note: This UE feature group is applicable only for NR cell for communication via satellite/HAPS as specified in TS 38.101-5 or TS 38.104; for any other cell this feature is not supported]. However, the note can be removed as it can be left for UE to indicate this FG per band.In R2-2230551, FG for disabling HARQ feedback for downlink transmission is captured as below. Hence, prerequisite feature groups for 26-6, 26-6a and 26-6b should be x-2 where x is TBD. |
| Nokia/Nokia Shanghai Bell [11] | * + The following highlighted note can be found on these FGs:
	+ [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]
	+ However, it is not clear how such a limitation would be applicable in practice.
		- Are the UEs expected to report support for the feature conditionally on the type of cell? This would not follow the UE capability framework for NR.
		- Another interpretation is that this would be intended at limiting the gNB implementation to prevent usage of some features that UEs have already reported to support. It is questionable what would be benefits of such approach, especially considering the said FGs are reported per band already.
	+ **Remove the note above in all these FGs.**

These are basic features for UEs supporting NR over NTN.” Hence, they should be combined into a single FG, or at the very least carry a note that they must be indicated as supported by UEs supporting NR communication via satellite. |
| Ericsson [12] |  |

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|  26. NR\_NTN\_solutions | 26-6b | Type-3 HARQ codebook enhancement  | Support of Type-3 HARQ codebook enhancements when there are feedback-disabled HARQ processes | FFS | Yes | No | Type-3 HARQ codebook enhancement is not supported for NR communication via satellite | per band | No | No | No | [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] | Optional with capability signalling  |

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| Company | Summary |
| Huawei/HiSilicon [2] | On the note in the last column, our view is that it is not strictly needed. The reason is that this FG is defined per band and it is an optional UE capability. A UE only needs to report what it supports on the particular band. The note would be needed for a per UE capability but not for per band UE capability. However, there is a similar situation in Rel-16 NR-U specific per-band FGs. For NR-U, a note “the signaling is per band but is only expected for a band where shared spectrum channel access must be used” is added even though it is NOT explicitly captured in 38.306. Overall, either way may be fine for this particular FG since it is a NTN-specific feature. To simplify the description, we suggest to **remove note in last column.****Remove FFS in 5-th column.** |
| ZTE [3] | W.r.t FG 26-6a and 26-6b, the **prerequisite column can be updated from “FFS” to “4-11”**, i.e., “Semi-static HARQ-ACK codebook”, since type-1 and type-3 HARQ codebook should be first supported and then the enhancement on them can be performed.Moreover, for the note column of FG26-1, 26-4, 26-5, 26-6, 26-6a, 26-6b, 26-8, 26-9, the note ~~[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]~~ should be removed since the listed FGs are defined per band, thus the note of each FG is implicitly associated with the band in which the corresponding FG is supported. |
| Vivo [4] |  |
| Xiaomi [5] |  |
| Samsung [6] |  |
| OPPO [7] |  |
| Apple [8] | The features 26-6, 26-6a, 26-6b are respectively defined for Type-1, Type-2, Type-3 HARQ codebook enhancement when there are feedback disabled HARQ processes. The pre-requisite features are open for these three features. In our view, UE needs to support the PDSCH reception associated with HARQ processes with feedback disabling, before it can construct the enhanced HARQ-ACK codebook construction. The feature of downlink HARQ disabling is defined in RAN2, which could serve as pre-requisite of features 26-6, 26-6a and 26-6b. ***Proposal 2:*** *The pre-requisite of features 26-6, 26-6a and 26-6b are the RAN2 feature of downlink HARQ disabling.*  |
| NTT DOCOMO, INC. [9] | At the last meeting, ‘UE supports HARQ disabling’ was removed from these FGs since RAN2 has the corresponding FG. Then pre-requisite of these FGs is FFS to discuss whether the RAN2 FG should be added in these FGs as pre-requisite. In our understanding, HARQ-ACK CB enhancements introduced in Rel-17 NTN WI are only related to feedback-disabling mechanism. To add the RAN2 FG as pre-requisite would be straightforward without any problem. The following is proposed based on this discussion.**Proposal 2:*** *harq-FeedbackDisabled is added as pre-requisite of FGs 26-6/26-6a/26-6b.*

One important discussion is on notes with yellow-highlight on applicability of each FG for TN. In our view, at least report of NTN-specific features that is not used in TN is unnecessary. For example, FG 26-1 has components to connect to NTN cell and do communication appropriately. Meanwhile, such a mechanism is unnecessary for any TN. For those FGs, such a note should be captured. The FGs would be FGs 26-1/26-4/26-8/26-9.Then, there were discussions on whether such a note is captured for FGs that can potentially be used in TN as well as NTN. Basically, we believe that whether a mechanism is supported or not should be discussed in WI agenda having motivation to introduce the mechanism. Under this view, also FGs 26-5/26-6/26-6a/26-6b should have the same note as in FGs 26-1/26-4/26-8/26-9. However, it was decided in Rel-16 NR-U UE feature session that (normal) Type-3 HARQ-ACK CB is applicable for any cell including cells in licensed band. If majority companies really want the FGs for cell other than NTN cell, we do not object the direction to follow the precedent.Regarding wording of the note, we think that the note should be separate into two sentences in order to avoid misunderstanding. In addition, we are not sure ‘ATG cell’ needs to be mentioned. RAN4 decided that Rel-17 does not support ATG cell and it is discussed in Rel-18.Based on the above, the following is proposed.**Proposal 1:*** *The following note is added to at least FGs 26-1/26-4/26-8/26-9, and also to FGs 26-5/26-6/26-6a/26-6b unless majority companies prefer to use the FG also for TN cell.*
	+ *Note: This UE feature group is applicable only for NR NTN cell. This UE feature group is not supported for terrestrial cell.*
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| Nokia/Nokia Shanghai Bell [11] | * + The following highlighted note can be found on these FGs:
	+ [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]
	+ However, it is not clear how such a limitation would be applicable in practice.
		- Are the UEs expected to report support for the feature conditionally on the type of cell? This would not follow the UE capability framework for NR.
		- Another interpretation is that this would be intended at limiting the gNB implementation to prevent usage of some features that UEs have already reported to support. It is questionable what would be benefits of such approach, especially considering the said FGs are reported per band already.
	+ **Remove the note above in all these FGs.**
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| Ericsson [12] |  |

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|  26. NR\_NTN\_solutions | 26-8 | Support of polarization signalling in NR NTN | 1. Support polarization indication reception in SIB indicating DL and/or UL polarization information using respective polarization type parameters to indicate: RHCP or LHCP or linear
2. Support polarization signalling for target serving cell in handover command message
3. Support polarization signalling for non-serving cell in RRM measurement configuration
 |  | No | No | UE is not able to take the advantage of polarization information to save power | Per band | No | No | No | [For UE supports NR communication via satellite, 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] | Optional with capability signalling  |

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| Company | Summary |
| Huawei/HiSilicon [2] | On the note in the last column, our view is that it is not strictly needed. The reason is that this FG is defined per band and it is an optional UE capability. A UE only needs to report what it supports on the particular band. The note would be needed for a per UE capability but not for per band UE capability. However, there is a similar situation in Rel-16 NR-U specific per-band FGs. For NR-U, a note “the signaling is per band but is only expected for a band where shared spectrum channel access must be used” is added even though it is NOT explicitly captured in 38.306. Overall, either way may be fine for this particular FG since it is a NTN-specific feature. To simplify the description, we suggest to **remove note in last column.**Remove “[For UE supports  NR communication via ~~[NTN/~~ satellite~~/HAPS/ATG]~~, UE must indicate this FG is supported]”. |
| ZTE [3] | Moreover, for the note column of FG26-1, 26-4, 26-5, 26-6, 26-6a, 26-6b, 26-8, 26-9, the note ~~[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]~~ should be removed since the listed FGs are defined per band, thus the note of each FG is implicitly associated with the band in which the corresponding FG is supported. |
| Vivo [4] | RAN2 raised concerns on both of FGs 26-1 and FGs 26-8 which have “N/A” in the column of “Need for the gNB to know if the feature is supported” while indicate in the column of “Mandatory/Optional” as “optional with capability signalling”. From RAN2 perspective, if there is no need for gNB to know whether a feature is supported or not, no capability signalling should be defined. RAN2 would like to know whether such capabilities are really “optional with capability signalling”. FGs 26-1 must be supported for UEs supporting NR communication via satellite, as described in the column of “Mandatory/Optional”. However, it is not mandated for UEs not supporting satellite communication but supporting other NTN scenarios, e.g. HAPS, ATG. In one word, UE can be optional with capability signalling and gNB needs to know if the feature is supported. As for FGs 26-8, gNB would indicate the polarization for UE with circular polarization to take the advantage of polarization information to save power. For UE with linear polarization, reading the polarization signalling may be unnecessary and UE can also work well in NTN even without the polarization signalling. However, in NTN, various UE types could coexist, e.g. UE with linear polarization, UE with LHCP, UE with RHCP, or with a combination of different polarization types. Thus, gNB could always indicate the polarization and UE can optionally support the feature without capability signalling. This should be captured into UE feature list, e.g. according to the text proposal we added in red in following list.

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|  26. NR\_NTN\_solutions | 26-8 | Support of polarization signalling in NR NTN | 1. Support polarization indication reception in SIB indicating DL and/or UL polarization information using respective polarization type parameters to indicate: RHCP or LHCP or linear
2. Support polarization signalling for target serving cell in handover command message
3. Support polarization signalling for non-serving cell in RRM measurement configuration
 |  | No | No | UE is not able to take the advantage of polarization information to save power | Per band | No | No | No | [For UE supports NR communication via satellite, 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] | Optional ~~with~~ without capability signalling  |

According to above, we have following proposal which is also captured in our draft reply LS [3].***Proposal 2: RAN1 should send a reply LS to RAN2, indicating:**** ***FGs 26-1 should be optional with capability signalling and gNB needs to know if the feature is supported.***
* ***FGs 26-8 should be optional without capability signalling.***

In RAN1 #108-e meeting, UE feature on support of polarization signalling in NR NTN is listed. If UE is equipped with linear polarization, reading such polarization signalling seems unnecessary as UE cannot be able to take the advantage of polarization information to save power. On the other hand, for UE supporting this feature, i.e. UE is capable of reading such polarization signalling, it’s not clear whether UE is required to support circular polarization or not and there could be different understandings:1. UE is required to support circular polarization if UE is capable of reading the polarization signalling;
2. UE is not required to support circular polarization if UE is capable of reading the polarization signalling.

In our understanding, UE should not be required to support circular polarization even if UE is capable of reading the polarization signalling, which should be clarified and captured in the feature description, e.g. according to the text proposal we added in red in below table.

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| 26. NR\_NTN\_solutions | 26-8 | Support of polarization signalling in NR NTN | 1. Support polarization indication reception in SIB indicating DL and/or UL polarization information using respective polarization type parameters to indicate: RHCP or LHCP or linear
2. Support polarization signalling for target serving cell in handover command message
3. Support polarization signalling for non-serving cell in RRM measurement configuration
 |  | No | No | UE is not able to take the advantage of polarization information to save power.  | Per band | No | No | No | [For UE supports NR communication via satellite, 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]Note: UE supporting this feature is not required to support circular polarization. | Optional with capability signalling  |

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| Xiaomi [5] |  |
| Samsung [6] |  |
| OPPO [7] |  |
| Apple [8] |  |
| NTT DOCOMO, INC. [9] | One important discussion is on notes with yellow-highlight on applicability of each FG for TN. In our view, at least report of NTN-specific features that is not used in TN is unnecessary. For example, FG 26-1 has components to connect to NTN cell and do communication appropriately. Meanwhile, such a mechanism is unnecessary for any TN. For those FGs, such a note should be captured. The FGs would be FGs 26-1/26-4/26-8/26-9.Then, there were discussions on whether such a note is captured for FGs that can potentially be used in TN as well as NTN. Basically, we believe that whether a mechanism is supported or not should be discussed in WI agenda having motivation to introduce the mechanism. Under this view, also FGs 26-5/26-6/26-6a/26-6b should have the same note as in FGs 26-1/26-4/26-8/26-9. However, it was decided in Rel-16 NR-U UE feature session that (normal) Type-3 HARQ-ACK CB is applicable for any cell including cells in licensed band. If majority companies really want the FGs for cell other than NTN cell, we do not object the direction to follow the precedent.Regarding wording of the note, we think that the note should be separate into two sentences in order to avoid misunderstanding. In addition, we are not sure ‘ATG cell’ needs to be mentioned. RAN4 decided that Rel-17 does not support ATG cell and it is discussed in Rel-18.Based on the above, the following is proposed.**Proposal 1:*** *The following note is added to at least FGs 26-1/26-4/26-8/26-9, and also to FGs 26-5/26-6/26-6a/26-6b unless majority companies prefer to use the FG also for TN cell.*
	+ *Note: This UE feature group is applicable only for NR NTN cell. This UE feature group is not supported for terrestrial cell.*
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| LG Electronics [10] | In the note column, there may be copy-and-paste error. It should be replaced by [Note: This UE feature group is applicable only for NR cell for communication via satellite/HAPS as specified in TS 38.101-5 or TS 38.104; for any other cell this feature is not supported]. However, the note can be removed as it can be left for UE to indicate this FG per band. |
| Nokia/Nokia Shanghai Bell [11] | * + The following highlighted note can be found on these FGs:
	+ [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]
	+ However, it is not clear how such a limitation would be applicable in practice.
		- Are the UEs expected to report support for the feature conditionally on the type of cell? This would not follow the UE capability framework for NR.
		- Another interpretation is that this would be intended at limiting the gNB implementation to prevent usage of some features that UEs have already reported to support. It is questionable what would be benefits of such approach, especially considering the said FGs are reported per band already.
	+ **Remove the note above in all these FGs.**
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| Ericsson [12] |  |

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|  26. NR\_NTN\_solutions | 26-9 | UE-specific K\_offset  | 1. Reception of UE-specific K\_offset via MAC-CE

Determining the timing of PUSCH, PUCCH, CSI reference resource, transmission of aperiodic SRS, activation of TA command, first PUSCH transmission in CG Type 2 with UE-specific Koffset | 26-1, 26-4 | Yes | No | UE-specific K\_offset reception is not supported for NR communication via satellite | Per band | No | No | No | [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] | Optional with capability signalling |

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| Company | Summary |
| Huawei/HiSilicon [2] | On the note in the last column, our view is that it is not strictly needed. The reason is that this FG is defined per band and it is an optional UE capability. A UE only needs to report what it supports on the particular band. The note would be needed for a per UE capability but not for per band UE capability. However, there is a similar situation in Rel-16 NR-U specific per-band FGs. For NR-U, a note “the signaling is per band but is only expected for a band where shared spectrum channel access must be used” is added even though it is NOT explicitly captured in 38.306. Overall, either way may be fine for this particular FG since it is a NTN-specific feature. To simplify the description, we suggest to **remove note in last column.** |
| ZTE [3] | Moreover, for the note column of FG26-1, 26-4, 26-5, 26-6, 26-6a, 26-6b, 26-8, 26-9, the note ~~[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]~~ should be removed since the listed FGs are defined per band, thus the note of each FG is implicitly associated with the band in which the corresponding FG is supported. |
| Vivo [4] |  |
| Xiaomi [5] |  |
| Samsung [6] |  |
| OPPO [7] |  |
| Apple [8] |  |
| NTT DOCOMO, INC. [9] | One important discussion is on notes with yellow-highlight on applicability of each FG for TN. In our view, at least report of NTN-specific features that is not used in TN is unnecessary. For example, FG 26-1 has components to connect to NTN cell and do communication appropriately. Meanwhile, such a mechanism is unnecessary for any TN. For those FGs, such a note should be captured. The FGs would be FGs 26-1/26-4/26-8/26-9.Then, there were discussions on whether such a note is captured for FGs that can potentially be used in TN as well as NTN. Basically, we believe that whether a mechanism is supported or not should be discussed in WI agenda having motivation to introduce the mechanism. Under this view, also FGs 26-5/26-6/26-6a/26-6b should have the same note as in FGs 26-1/26-4/26-8/26-9. However, it was decided in Rel-16 NR-U UE feature session that (normal) Type-3 HARQ-ACK CB is applicable for any cell including cells in licensed band. If majority companies really want the FGs for cell other than NTN cell, we do not object the direction to follow the precedent.Regarding wording of the note, we think that the note should be separate into two sentences in order to avoid misunderstanding. In addition, we are not sure ‘ATG cell’ needs to be mentioned. RAN4 decided that Rel-17 does not support ATG cell and it is discussed in Rel-18.Based on the above, the following is proposed.**Proposal 1:*** *The following note is added to at least FGs 26-1/26-4/26-8/26-9, and also to FGs 26-5/26-6/26-6a/26-6b unless majority companies prefer to use the FG also for TN cell.*
	+ *Note: This UE feature group is applicable only for NR NTN cell. This UE feature group is not supported for terrestrial cell.*
 |
| LG Electronics [10] | In the note column, there may be copy-and-paste error. It should be replaced by [Note: This UE feature group is applicable only for NR cell for communication via satellite/HAPS as specified in TS 38.101-5 or TS 38.104; for any other cell this feature is not supported]. However, the note can be removed as it can be left for UE to indicate this FG per band. |
| Nokia/Nokia Shanghai Bell [11] | * + The following highlighted note can be found on these FGs:
	+ [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]
	+ However, it is not clear how such a limitation would be applicable in practice.
		- Are the UEs expected to report support for the feature conditionally on the type of cell? This would not follow the UE capability framework for NR.
		- Another interpretation is that this would be intended at limiting the gNB implementation to prevent usage of some features that UEs have already reported to support. It is questionable what would be benefits of such approach, especially considering the said FGs are reported per band already.
	+ **Remove the note above in all these FGs.**

These are basic features for UEs supporting NR over NTN.” Hence, they should be combined into a single FG, or at the very least carry a note that they must be indicated as supported by UEs supporting NR communication via satellite. |
| Ericsson [12] | Align wording by consistent use of (e.g.) "support of".

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|  26. NR\_NTN\_solutions | 26-9 | UE-specific K\_offset  | 1. Support reception of UE-specific K\_offset via MAC-CE

Support determining the timing of PUSCH, PUCCH, CSI reference resource, transmission of aperiodic SRS, activation of TA command, first PUSCH transmission in CG Type 2 with UE-specific K\_offset | 26-1, 26-4 | Yes | No | UE-specific K\_offset reception is not supported for NR communication via satellite | Per band | No | No | No | [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] | Optional with capability signalling |

 |

**Others**

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| Company | Summary |
| Huawei/HiSilicon [2] | In addition, the following agreement on the K1 extension was made in RAN1 #104-e:Agreement:For unpaired spectrum, extend the value range of K1 from (0..15) to (0..31) FFS: Whether there is an impact on the size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI.The above feature has not been captured in the NTN UE capability. A Rel-17 UE should be able to support this feature as an optional UE capability.

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| 26. NR\_NTN\_solutions | 26-X | K1 range extension | 1. Support of extended K1 value range of (0..31) for unpaired spectrum. |  | Yes | No |  | Per band | No | No | No |  | Optional with capability signalling  |

 |
| ZTE [3] |  |
| Vivo [4] |  |
| Xiaomi [5] | In RAN1 104e meeting, an agreement on the K1 extension was made as follows:The motivation to have extension of K1 is to support the contiguous DL slots in specific TDD deployment scenario. UE should be able to support this feature when operating with some specific TDD configuration. Thus this should be added as an optional UE feature.Agreement:For unpaired spectrum, extend the value range of K1 from (0..15) to (0..31) FFS: Whether there is an impact on the size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI.***Proposal 1: Add the extension of K1 value as the UE feature specifically to TDD cases.***

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 26. NR\_NTN\_solutions | 26-x | K1 extension | extend the value range of K1 from (0..15) to (0..31) for unpaired spectrum |  | No | No | HARQ function cannot be supported on specific band | Per band | Yes | No |  |  | optional |

 |
| Samsung [6] |  |
| OPPO [7] | In RAN1 #104e meeting, the following agreement was achieved:

|  |
| --- |
| ***Agreement****For unpaired spectrum, extend the value range of K1 from (0..15) to (0..31)* *FFS: Whether there is an impact on the size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI.* |

The support of extending K1 range from (0..15) to (0..31) should be a UE capability. Therefore, a new FG should be introduced to define this feature. The following table gives an example.

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| --- | --- | --- | --- | --- |
| 26. NR\_NTN\_solutions | 26-10 | K1 extension  | 1. Extending K1 range from (0..15) to (0..31) | 26-1 |

**Proposal: introducing a new FG to define the capability of support extending K1 range from (0..15) to (0..31).**  |
| Apple [8] |  |
| NTT DOCOMO, INC. [9] |  |
| LG Electronics [10] |  |
| Nokia/Nokia Shanghai Bell [11] |  |
| Ericsson [12] |  |

# Discussion/Approval Items during RAN1 #109-e — First Checkpoint

After review of contributions submitted to RAN1 #109-e in this agenda item, the following topics were identified by the moderator for discussion/approval during RAN1 #109-e.

**General comments**

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| Company | Comments/Questions/Suggestions |
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# Issue 1: FG 26-1

After review of contributions submitted to RAN1 #109-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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

* **Note: Proposals to change the sixth column are discussed in in [109-e-R17-UE-features] “Email discussion on incoming LS (R1-2205090) on updated Rel-17 RAN1 UE features list for NR by May 13 – Ralf (AT&T)”**

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|  26. NR\_NTN\_solutions | 26-1 | Uplink Time and Frequency pre-compensation and timing relationship enhancements | 1. Support of UE specific TA calculation based on its GNSS-acquired position and the serving satellite ephemeris.
2. Support of U~~E calculates~~ common TA calculation according to the parameters provided by the network (UE considers common TA as 0 if the parameters are ~~is~~ not provided)
3. For TA update in RRC\_CONNECTED state, support of combination of both open (i.e. UE autonomous TA estimation, and common TA estimation) and closed (i.e., received TA commands) control loops
4. Support of ~~UE~~ pre-compensation~~es~~ of the calculated TA in its uplink transmissions
5. Support of estimating UE-gNB RTT and delaying the start of RAR window by UE-gNB RTT
6. Support of frequency pre-compensation to counter shift the Doppler experienced on the service link
7. Support of determining timing of the scheduling of PUSCH, PUCCH and PDCCH ordered PRACH, CSI reference resource, transmission of aperiodic SRS activation of TA command, first PUSCH transmission in CG Type 2 with cell-specific K\_offset if indicated
8. Support of determining timing of the UE action and assumption on a downlink configuration carried by MAC CE command by K\_mac if it is indicated and determining the timing of PDCCH monitoring in recovery search space using K-mac during beam failure recovery procedure
9. Support of UE receiving~~es~~ cell-specific K\_offset/K\_mac in system information
 |  | No | No | Release 17 NR UE cannot communicate via satellite | per band | No | No | No | An NTN UE is required to at least support UE specific TA and frequency calculation based at least on its GNSS-acquired position and the serving satellite ephemeris~~[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]~~ | Optional with capability signalling For UE supports NR communication via satellite, UE must indicate this FG is supported. |

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| Company | Comments/Questions/Suggestions |
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# Issue 2: FG 26-4

After review of contributions submitted to RAN1 #109-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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

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|  26. NR\_NTN\_solutions | 26-4 | UE reporting of information related to TA pre-compensation | 1. Support UE reporting of information related to TA pre-compensation  | 26-1 | Yes | No | UE does not support reporting of information related to TA pre-compensation for NR communication via satellite | Per band | No | No | No | Note: The exact content of UE reporting of information about the TA pre-compensation is up to RAN2~~[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]~~ | Optionalwith capability signalling  |

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| Company | Comments/Questions/Suggestions |
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# Issue 3: FG 26-5

After review of contributions submitted to RAN1 #109-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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

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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 for UL and Y for DL, when a UE is configured with NTN carriers only. |  | Yes | No | Increased number of HARQ processes is not supported for NR communication via satellite | Per band | No | No | No | Candidate component values for (X,Y): {(16,32),(32,16),(32,32)}~~[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]~~ | Optional with capability signalling ~~supported]~~ |

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| Company | Comments/Questions/Suggestions |
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# Issue 4: FG 26-6

After review of contributions submitted to RAN1 #109-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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

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|  26. NR\_NTN\_solutions | 26-6 | Type-2 HARQ codebook enhancement | Support of type-2 HARQ codebook enhancements when there are feedback-disabled HARQ processes | ~~FFS~~ *harq-FeedbackDisabled* | Yes | No | Type-2 HARQ codebook enhancement is not supported for NR communication via satellite | per band | No | No | No | ~~[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]~~ | Optional with capability signalling  |

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| Company | Comments/Questions/Suggestions |
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# Issue 5: FG 26-6a

After review of contributions submitted to RAN1 #109-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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

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|  26. NR\_NTN\_solutions | 26-6a | Type-1 HARQ codebook enhancement | 1. Support of Type-1 HARQ codebook enhancements when there are feedback-disabled HARQ processes
 | ~~FFS~~ *harq-FeedbackDisabled* | Yes | No | Type-1 HARQ codebook enhancement is not supported for NR communication via satellite | per band | No | No | No | ~~[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]~~ | Optional with capability signalling  |

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| Company | Comments/Questions/Suggestions |
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# Issue 6: FG 26-6b

After review of contributions submitted to RAN1 #109-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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

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|  26. NR\_NTN\_solutions | 26-6b | Type-3 HARQ codebook enhancement  | Support of Type-3 HARQ codebook enhancements when there are feedback-disabled HARQ processes | ~~FFS~~ *harq-FeedbackDisabled* | Yes | No | Type-3 HARQ codebook enhancement is not supported for NR communication via satellite | per band | No | No | No | ~~[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]~~ | Optional with capability signalling  |

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| Company | Comments/Questions/Suggestions |
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# Issue 7: FG 26-8

After review of contributions submitted to RAN1 #109-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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

* **Note: Proposals to change the sixth and 14th column are discussed in in [109-e-R17-UE-features] “Email discussion on incoming LS (R1-2205090) on updated Rel-17 RAN1 UE features list for NR by May 13 – Ralf (AT&T)”**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  26. NR\_NTN\_solutions | 26-8 | Support of polarization signalling in NR NTN | 1. Support polarization indication reception in SIB indicating DL and/or UL polarization information using respective polarization type parameters to indicate: RHCP or LHCP or linear
2. Support polarization signalling for target serving cell in handover command message
3. Support polarization signalling for non-serving cell in RRM measurement configuration
 |  | No | No | UE is not able to take the advantage of polarization information to save power | Per band | No | No | No | ~~[For UE supports NR communication via satellite, UE must indicate this FG is supported]~~Note: UE supporting this feature is not required to support circular polarization.~~[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]~~ | Optional with capability signalling  |

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| Company | Comments/Questions/Suggestions |
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# Issue 8: FG 26-9

After review of contributions submitted to RAN1 #109-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

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

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|  26. NR\_NTN\_solutions | 26-9 | UE-specific K\_offset  | 1. Support of reception of UE-specific K\_offset via MAC-CE
2. Support of determining the timing of PUSCH, PUCCH, CSI reference resource, transmission of aperiodic SRS, activation of TA command, first PUSCH transmission in CG Type 2 with UE-specific Koffset
 | 26-1, 26-4 | Yes | No | UE-specific K\_offset reception is not supported for NR communication via satellite | Per band | No | No | No | ~~[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]~~ | Optional with capability signalling |

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| Company | Comments/Questions/Suggestions |
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# Issue 9: New FGs

After review of contributions submitted to RAN1 #109-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FG**

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| 26. NR\_NTN\_solutions | 26-10 | K1 range extension | 1. Support of extended K1 value range of (0..31) for unpaired spectrum |  | Yes | No | K1 range extension is not supported  | Per band | No | No | No |  | Optional with capability signalling  |

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| Company | Comments/Questions/Suggestions |
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# Discussion/Approval Items during RAN1 #109-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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| Company | Comments/Questions/Suggestions |
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# Discussion/Approval Items during RAN1 #109-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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| Company | Comments/Questions/Suggestions |
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# Summary of Final Proposals for Agreements

This Section summarizes the final proposals for agreement in RAN1 #109-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.

## Final Proposals for Agreement by the First Check Point

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

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## Final Proposals for Agreement by the Second Check Point

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

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# Conclusion

In addition to the agreements in Section 6, that were reached by email during RAN1 #109-e, the following was agreed by GTW during RAN1 #109-e:

# References

1. R1-2202929, Updated RAN1 UE features list for Rel-17 NR after RAN1 #108-e including remaining RAN1 issues, Moderators (AT&T, NTT DOCOMO, INC.)
2. R1-2203090, Rel-17 UE features for NR NTN, Huawei/HiSilicon
3. R1-2203233, Discussion on UE feature for NR-NTN, ZTE
4. R1-2203532, Remaining issues on UE features for NR NTN, vivo
5. R1-2203782, Discussion on UE features for NR-NTN, xiaomi
6. R1-2203879, UE features for NR NTN, Samsung
7. R1-2204008, Discussion on UE features for NTN-NR, OPPO
8. R1-2204221, Views on Rel-17 NR NTN UE features, Apple
9. R1-2204359, Discussion on Rel.17 UE features for NR NTN, NTT DOCOMO, INC.
10. R1-2204520, Discussion on Rel-17 UE feature for NR NTN, LG Electronics
11. R1-2204589, On UE features for NR NTN, Nokia/Nokia Shanghai Bell
12. R1-2204661, On UE features for NR NTN, Ericsson