3GPP TSG RAN WG2 Meeting #121bis-e R2-2304253

**Electronic meeting, 17th-26th April 2023**

**Agenda item:** 6.6.3

**Source:** Intel Corporation

**Title:** Report of email discussion [AT121bis-e][113][NR NTN] UE capabilities (Intel)

**Document for:**  Discussion and decision

# Introduction

This email discussion #113 provides topics for discussion on UE capabilities for Rel-17 NR NTN considering the related proposals submitted in TDocs [1]-[4]. The detailed information for this email discussion is as below:

* [AT121bis-e][113][NR NTN] CP corrections 2 (Intel)

Initial scope: Discuss corrections in 6.6.3 on “capability”

Initial intended outcome: Summary of the offline discussion with list of agreeable corrections/CRs

Deadline for companies' feedback: Friday 2023-04-21 08:00 UTC

Deadline for rapporteur's summary (in R2-2304253): Friday 2023-04-21 10:00 UTC

Proposals marked "for agreement" in R2-2304253 not challenged until Monday 2023-04-24 10:00 UTC will be declared as agreed via email by the session chair (for the rest the discussion might continue online).

# Discussion

## Correction on NR NTN UE capabilities [1]

In [1], the following two changes are proposed for TS 38.306 as below:

***First change:***

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| ***Reason for change*** | 1. *condEventA4* for CHOis introduced by R17 NR NTN WI, and *condEventA4* for CPAC is introduced by R17 DCCA WI. In RAN2#120, the R17 DCCA correction CR R2-2213372 was agreed, i.e., to clarify in the field description of *condExecutionCond* that “For CHO in terrestrial networks, the network does not indicate a MeasId associated with condEventA4. For CPA and for MN-initiated inter-SN CPC, the network only indicates MeasId(s) associated with condEventA4”. The reason of change is “Conditional event A4 was added in Rel-17 and seems applicable to Rel-16 features like CHO and intra-SN CPC, or for Rel-17 inter-SN CPC, while RAN2 agreed to only use conditional event A4 for CPA and MN-initated CPC” in DCCA WI.  In current field description of UE capability *eventA4BasedCondHandover-r17*, it seems that supporting *condEventA4* in a TN band is not prohibited for an NTN-capable UE, so *condEventA4* for CHO may still be configured in TN cell for an NTN-capable UE supporting *condEventA4* in a TN band. But this is not the intention. To align with the latest restriction made in RRC spec, some clarification in field description of *eventA4BasedCondHandover-r17* is needed, i.e., this field is only for NR NTN, in this way supporting *condEventA4* in a TN band will be prohibited. |
| ***Summary of change*** | 1. Clarify that *eventA4BasedCondHandover-r17* indicates whether the UE supports Event A4 based conditional handover in NTN bands. |
| ***Proposed change*** |  |

1. Whether the first proposed change in [1] can be agreed?

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| **Company’s name** | **Y or N** | **Comments, if any** |
| MediaTek | Y |  |
| vivo | N | A TN cell anyway will not configure event A4 conditional handover trigger condition based on the limitation in RRC spec, so this change is not necessary. |
| Intel | Y | Proponent. This is a clarification from UE capability pov, the clarification of NW configuration has been clarified in previous RRC CR. |
| OPPO | Y |  |
| Xiaomi | No | Share the same view with vivo that the TN cell can’t configure the condEventA4 CHO for UE according to the RRC spec, the change is not essential. |
| ZTE | Can go with majority | The correction is not wrong but also not so essential. |
| Thales | No strong view | Share ZTE’s view, not so essential. |
| Apple | - | Agree with vivo, but we can go with majority. |
| Nokia | N | Same understanding with vivo. What do we gain if this CR is pursued? Isn’t it clear now already? |
| Qualcomm | N | It seems already clear from the last sentence. |
| Samsung | No strong view | follow majority |
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***Second change:***

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| ***Reason for change*** | 2. Location-based and time-based measurement initiation in R17 are only applicable to NTN quasi-Earth fixed system. This behaviour is aligned to where its key parameters (i.e., referenceLocation and t-Service) are currently defined, i.e., they are only broadcast in NTN quasi-Earth fixed system information. The corresponding restrictions should also be added in UE capability descriptions. |
| ***Summary of change*** | 1. Add “in NTN quasi-Earth fixed system” in the description of Location-based measurement initiation feature and Time-based measurement initiation feature, and make one editorial change accordingly. |
| ***Proposed change*** |  |

1. Whether the second proposed change in [1] can be agreed?

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| **Company’s name** | **Y or N** | **Comments, if any** |
| MediaTek | Y |  |
| vivo | N | Based on the limitation in RRC spec, only a quasi-fixed cell can configure the location-based/time-based measurement related parameters, the above change is not needed. |
| Intel | Y | Proponent. Considering in R18, location/time based measurement initiation are agreed for earth moving cell, it’s necessary to make differentiation between R17 and R18, i.e., between quasi earth moving cell and earth moving cell. |
| OPPO | Y |  |
| Xiaomi | Y | R18 will introduce time and location based neighbhour cell measurement for earth moving cell, we are fine with the change. |
| ZTE | Can go with majority | With the reference to 38304 it seems sufficient that this feature only applies to idle/inactive, and it is clear in RRC it is for earth fixed. We are not sure if the same capability will be used for earth-moving or not, if so we may need to revise the description back. But we are fine if majority prefers to make it more clear. |
| Thales | Y | Clarification for Rel17 before EMC in Rel18. |
| Apple | Y |  |
| Nokia | N | Agree with vivo. |
| Samsung | Y |  |
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## Clarification on TN EUTRA capability reporting [3]

In [3], the following change is proposed for TS 38.331 as below:

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| ***Reason for change*** | For EUTRA, following is specified in TS 36.331.  *If the UE is NTN capable, the UE reports its E-UTRAN radio access capabilities for the network type (TN or NTN) to which it is connected.*  If UE is connected to NR 5GS NTN and network requests UE to send EUTRA capability, the reported UE capability for EUTRA should belong to NTN (i.e. NTN CE mode capabilities) if NTN specific parameters are included (i.e. the UE actually supports NTN operation in CE mode)  If the UE is connected to NR 5GS TN, the reported UE capability for EUTRA belongs to TN.  This is not clear in the TS 38.331 specification as UE may also support NR NTN and IoT NTN in CE mode. |
| ***Summary of change*** | Correction is added such that when UE is connected to NR NTN and gNB requests EUTRA capability, then the UE supporting EUTRA NTN will report EUTRA radio access capabilities for NTN to which it is connected. |
| ***Proposed change*** |  |

1. Whether the proposed change in [3] can be agreed?

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| **Company’s name** | **Y or N** | **Comments, if any** |
| MediaTek | Y, but | Agree with the intention, but the specification changes (CR) needs to be properly written, as now both “if else” in “2>” includes “if UE supports E-UTRA”. |
| Vodafone | N | **The UE capabilities are stored in the AMF and are NOT pulled from the UE at every RRC connection**.  The proposal does not work (it destroys basic release 15 operation and is NOT BACKWARDS COMPATIBLE with R15-17 gNB).  The proposed change means that EVERY NR cell has no idea as to whether or not the E-UTRA capability relates to its TN or NTN capability. It is important that the operation of terrestrial networks is not disrupted by the occasional use of an NTN.  In my estimation, the most likely inter-RAT mobility scenarios are:  TN-NR to/from TN-LTE; (vast majority)  TN-NR to NTN-LTE ;  NTN-LTE to TN-NR  And it is VERY unlikely to have  NTN cat M to or from NR NTN mobility  Hence we should optimize the system around the likely scenarios (rather than breaking R15), and use the existing approach for TN-LTE <-> NTN LTE mobility to solve the case of NTN-LTE <-> NR NTN mobility.  I agree that a correction CR is needed in 38.331 but suggest the following:  1> if the *ue-CapabilityRAT-RequestList* contains a *UE-CapabilityRAT-Request* with *rat-Type* set to *eutra*:  2> if the UE supports E-UTRA:  3> include in the *ue-CapabilityRAT-ContainerList* a *ue-CapabilityRAT-Container* of the type *UE-EUTRA-Capability* associated with terrestrial network and with the *rat-Type* set to *eutra* as specified in TS 36.331 [10], clause 5.6.3.3, according to the *capabilityRequestFilter*, if received;  \*\*\*\*\*\*\* end of change \*\*\* |
| vivo | See comments | We agree the intention of this contribution, but we think it should be discussed in IoT\_NTN\_enh-Core. |
| Intel | N | We are not sure whether there is a UE that supports both NR NTN and IoT NTN functions. In our view, they should be separate UEs. |
| OPPO | Y | Agree with the intention. |
| ZTE | N | Not sure about the use case here, under which circumstance will an IoT NTN UE will report its capability to NR NTN? |
| Apple | See comments | We agree with the intention, but we may need to discuss the use case together with IOT-NTN people.  In detail, in this case, we can consider the following two possibilities:   * Option 1: which capability to be reported is up to UE implementation if UE have two capability set. * Option 2: UE always report the legacy E-UTRA capability (not associated to IOT NTN). |
| Nokia |  | Not sure why this is discussed in NR NTN? |
| Qualcomm | Y | We are proponent.  We disagree with Vodafone that it destroys the Rel-15-17 operation. They always report TN UE-EUTRA capability and continue to do so because the clause “if UE supports E-UTRA” remains same for them as it is not changed for TN.  If we are to limit the handover scenario, then as proposed by Vodafine, the UE can always report TN UE-EUTRA capability in NR whether be it is TN NR or NTN NR. This solution also works but is not future proof. |
| Vodafone (2) | N | Disagree with Qualcomm.  If the UE supports TN-EUTRA and NTN-EUTRA then when attaching to NR-NTN, the Qualcomm proposal loads the NTN-EUTRA capability into the AMF. At subsequent idle or connected mode mobility to a TN-NR cell, that TN-NR cell has no idea which EUTRA capability it has…. And at handover from that TN-NR cell to an LTE-TN cell, the target LTE-TN cell is given the wrong UE-LTE capability (and the target cannot use the source cell ID to deduce that the UE-LTE capability was sent during an Attach with an NR-NTN cell).  Hence the CR in 3034 does not work.  I believe that my suggested proposal should work with the TS 23.401 R17 behaviour of:   1. The UE doing a “TAU with UE capability change” at entry/exit of LTE cell broadcast satellite SIB; 2. Configuring TN [or NTN] target cells to know that the source cell ID is NTN [or respectively TN] and retrieving the LTE capability from the UE… with the slight extension that an LTE-NTN target cell also needs to pull the UE capability at handover from an NR-NTN cell.   And if NR-NTN <-> LTE NTN handover is deemed to be really important, then an r18 optimisation could be done to add one bit inside the LTE UE capability to say whether the capability os for TN or NTN. |
| Samsung | N, but | We are not sure about the use case either. We are not sure about handovers from NR to eMTC or NB-IoT.  If this is to be supported, there needs to be a lot more basic discussions over what is supported or not and it will likely involve SA2. |
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## Handling of features with different UE capability support in TN and NTN

This section provides few discussion points considering documents [2][4]. The following was agreed during RAN2#121 on expected UE behaviour when a configured feature has different UE support between NTN and TN:

* *RAN2 confirms that* ***UE should only use/apply configurations of a given feature when UE supports the feature*** *in the corresponding cell in which UE is camping, connecting, or resuming to*

From previous discussion, there was slightly majority preference to only clarify operation of eDRX and not SDT. However this meeting, both documents [2][4] further explains why SDT is also a concern scenario to be updated in current specification when handling UE capability support of SDT is different between in TN and NTN.

When UE receives a configuration to be used in RRC\_INACTIVE and that UE complies with it in current cell, current specification captures that this UE in RRC\_INACTIVE continue to use it in other cells. Focusing on eDRX and SDT configurations:

* For SDT, when a UE is configured with SDT and all other conditions are met (i.e., cell supports SDT, upper layers trigger resume, UL data is available in a RB configured for SDT and lower layer conditions are fulfilled), TS 38.331 defines that the UE shall initiate resume proc. For SDT (as shown below). There is no mention of UE support for SDT:

**5.3.13.1b Conditions for initiating SDT**

A UE in RRC\_INACTIVE initiates the resume procedure for SDT when all of the following conditions are fulfilled:

1. the upper layers request resumption of RRC connection; and
2. *SIB1* includes *sdt-ConfigCommon*; and
3. *sdt-Config* is configured; and
4. all the pending data in UL is mapped to the radio bearers configured for SDT; and
5. lower layers indicate that conditions for initiating SDT as specified in TS 38.321 [3] are fulfilled.

NOTE: How the UE determines that all pending data in UL is mapped to radio bearers configured for SDT is left to UE implementation.

* For INACTIVE eDRX, when UE is configured with INACTIVE eDRX and moves to a cell in which the UE does not support this eDRX, according to the spec, the UE currently continues operating with this eDRX (i.e. UE continues monitoring paging based on INACTIVE eDRX, assuming that the cell allows the usage of it).

In summary, when UE is configured with SDT/eDRX and the conditions for SDT/eDRX are met, UE is expected to initiate SDT or operate in eDRX. There is no check in the current specification on whether UE supports SDT/eDRX in current cell. When the UE that does not support a feature in both TN and NTN moves between TN and NTN cells it cannot comply with the current configuration. The following sections discuss the key points to agree considering the proposed solutions in [2][4].

### UE behaviour

1. When a UE in RRC\_INACTIVE reselect to a cell in which cannot comply with one of its configured features (i.e. eDRX or SDT), what is the preferred UE behaviour?
   1. UE autonomously release the configuration that does not comply with its supported capability in the new reselected cell [4].
   2. UE ignores the corresponding configuration (i.e., is considered as not configured) in current cell [2] but does not release the configuration. The configuration is released by the network when the UE initiates an SDT/Connection with the network.

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| **Company’s name** | **Option** | **Comments, if any** |
| MediaTek | Option 2 |  |
| vivo | See comments | Similar to the behavior of inability to comply with *RRCReconfiguration* in the current specification, UE ignores the corresponding configuration. Regarding how/when to release the configuration, we think it is up to implementation, no spec impact is needed. |
| Intel | Option 2 | Option 1) is not preferable as it allows the UE to autonomously release a configuration provided by the network without network knowledge. This kind of behaviour is usually not preferable and can cause out-of-sync scenarios between UE and network (e.g. when UE performs ping pong btwn TN and NTN). On summary, option 2 is preferable for us to keep intended configured UE behaviour when UE performs ping-pong happen between TN and NTN.  Another possible is to align with legacy handling when UE receives a configuration that cannot comply, however our understanding is that this is not preferable as it would require unnecessary signaling and significant specification changes in order to enable e.g., upon cell reselecting from NTN to TN (or viceverse), the UE to resume due to a configuration that becomes invalid (similar to legacy operation defined in section “*5.3.5.8.2 Inability to comply with RRCReconfiguration*“) or even establish a new RRC connection if UE were moved autonomously to RRC\_IDLE (similar to legacy operation defined in section “*5.3.13.11 Inability to comply with RRCResume*”). |
| OPPO | Option 2 |  |
| Xiaomi | Option 2 |  |
| ZTE | See comments | This issue is not an NTN specific issue and has been discussed for several meetings. It has been point out that the common understanding is that UE will not initiate a feature that it is not supported in current cell, and no specs impact is needed, otherwise we will end up doing this for every feature. |
| Thales | Option 2 |  |
| Apple | Option 2 | Actually we don’t expect network provides the RNA configuration to cover both TN and NTN cell. |
| Nokia | Option 2 | Although we share the ZTE view here as well. |
| Qualcomm | Option 2 with comments | We think wording “comply” and “is considered not configured” are not clear as when UE moves back (ping pong) it has to be complied and it has to be considered configured.  We think correction something like Option 2 is needed, but we suggest following:  5.2.2.4.2              Actions upon reception of the *SIB1*  Upon receiving the *SIB1* the UE shall:   1. store the acquired *SIB1*;   <<skipped>>   1. if in RRC\_INACTIVE and this cell type (TN or NTN) is different from the cell type (TN or NTN) where the *SuspendConfig* was configured:   2>ignore those RRC configurations in *suspendConfig* which are related to the feature that the UE cannot support in this cell.   1. if in RRC\_CONNECTED while T311 is not running:   2>  disregard the *frequencyBandList*, if received, while in RRC\_CONNECTED;  2>  forward the *cellIdentity* to upper layers;  2>  forward the *trackingAreaCode* to upper layers, if included;  2>  forward the *trackingAreaList* to upper layers, if included;  2>  forward the received *posSIB-MappingInfo* to upper layers, if included;  2>  apply the configuration included in the *servingCellConfigCommon*;  2>  if the UE has a stored valid version of a SIB or posSIB, in accordance with clause 5.2.2.2.1, that the UE requires to operate within the cell in accordance with clause 5.2.2.1:  3>  use the stored version of the required SIB or posSIB;  2>  else:  3>  acquire the required SIB or posSIB requested by upper layer as defined in clause 5.2.2.3.5;  NOTE:      Void.   1. else: |
| Samsung | Option 2 |  |
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### Cell reselection scenario

A UE could have different capability support of eDRX and RRC\_INACTIVE in TN and NTN. For example, UE can support SDT in NTN but not in TN or vice versa. Rapporteur’s understanding is that the concern scenario is equally applicable regardless of whether cell reselection is performed from NTN to TN or vice versa. This seems to be a point to confirm/check considering the proposed solutions [2][4].

1. Which cell reselection scenario should be addressed when clarifying the expected UE in RRC\_INACTIVE reselect to a cell in which cannot comply with one of its configured features (i.e. eDRX or SDT)??
   1. Re-selection from NTN to TN only [4].
   2. Any cell reselection between NTN and TN [2].

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| **Company’s name** | **Option** | **Comments, if any** |
| MediaTek | Option 2) |  |
| vivo | Option 2) | Both situations of UE supporting a given feature in TN but not in NTN and UE supporting a given feature in TN but not in NTN should be addressed. |
| Intel | Option 2) |  |
| OPPO | Option 2) |  |
| Xiaomi | Option 2 |  |
| Apple | Option 2 |  |
| Nokia | Option 2 | Assuming those scenarios will happen at all (RNA over TN and NTN). |
| Qualcomm | Option 2 |  |
| Samsung | Option 2 |  |
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### Preferred approach of TP

1. Which approach of TP is preferable to address current issue (note the actual TP itself will be based on the agreements to the previous questions)?
2. Actions upon reception of SIB19 are updated [4].

**5.2.2.4.21 Actions upon reception of *SIB19***

Upon receiving *SIB19*, the UE ~~in RRC\_CONNECTED~~ shall:

1. if in RRC\_CONNECTED

2> start or restart T430 for serving cell with the timer value set to *ntn-UlSyncValidityDuration* for the serving cell from the subframe indicated by *epochTime* for the serving cell;

1. if in RRC\_INACTIVE

2> if *ra-SDT-NTN* or *srb-SDT-NTN* is not supported

3> release the SDT configuration, if configured

1. Adding a new section that explains UE behaviour when UE cannot comply with a configuration available in RRC\_INACTIVE [2]. The following new section is proposed to be defined as part of §5.3.8 RRC release in TS 38.331.

**x.y.z Inability to comply with a configuration available in RRC\_INACTIVE**

The UE shall:

1. if the UE in RRC\_INACTIVE is unable to comply with a configuration available or stored due to any un-supported feature in current cell upon cell reselection between TN and NTN;

2> the corresponding configuration is ignored (i.e., is considered as not configured) in current cell.

1. Other approaches.

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| **Company’s name** | **Approach** | **Comments, if any** |
| MediaTek | Approach 1 |  |
| Vodafone | Approach 1 | With some NTN systems, cell reselection between NTN and TN is not detectable at the UE. The wording in approach 1 linking to the SIB is the logical approach. |
| Vivo | Approach 2) | The solution should not be limited to a feature, a general text is preferred. |
| Intel | Approach 2 | We understand that approach 1 have few drawbacks which make it not preferable:   * a) it only covers the scenario when UE reselect from TN to NTN (i.e., similar section would also need to be created to cover reselection from NTN to TN in other section) to a SIB that is only received in NTN. * b) we will need to add each of the features that is impacted. For Rel-17, this involves RA-SDT, SRB-SDT and eDRX, and in future other features might also need to be added. * c) it hides the fact that we are allowing the network to provide a configuration for RRC\_INACTIVE that is valid in current cell but becomes invalid when reselecting to other kind of network. * d) there are already discussions to reuse SIB19 for non-NTN cases (ATG), R2-2302438, and hence it may not be a reliable indication of reselection between TN and NTN.   Our preference is to capture an approach similar to 2) that is more generic and clearly explains the target scenario and the expected UE behaviour when that happens. We understand that the section that explains “Inability to comply with a configuration available in RRC\_INACTIVE” could also be included in any of the following sections: §5.2.2 System information acquisition, §5.3.8 RRC release, §5.3.13 RRC connection resume, or §5.6 UE capabilities. We have slightly preference to include this new section as part §5.3.8 RRC release as the *RRCRelease* message is the one that conveys the actual configurations used in RRC\_INACTIVE that later became invalid in the new cell. |
| OPPO | Option 2） |  |
| Xiaomi | Approach 2 | Approach 2 is forward compatibility.  For approach 1, we understand the UE should not release the SDT configuration when the CG-SDT and srb-SDT-NTN are supported. |
| ZTE | None | Please refer to our replies in discussion point 4. We don’t think it is an NTN specific issue and not sure why we only capture it for SDT. |
| Thales | Approach 2 |  |
| Apple | Approach 2 | Approach 2 provides a general way to cover all the features which may be different between TN and NTN in INACTIVE state. |
| Nokia | Approach 2 or None |  |
| Qualcomm | Approach 3 | We think wording “comply” and “is considered not configured” are not clear as when UE moves back (ping pong) it has to be complied and it has to be considered configured.  We think Approach 2 needs wording work. But we suggest following:  5.2.2.4.2              Actions upon reception of the *SIB1*  Upon receiving the *SIB1* the UE shall:   1. store the acquired *SIB1*;   <<skipped>>   1. if in RRC\_INACTIVE and this cell type (TN or NTN) is different from the cell type (TN or NTN) where the *SuspendConfig* was configured:   2>ignore those RRC configurations in *suspendConfig* which are related to the feature that the UE cannot support in this cell.   1. if in RRC\_CONNECTED while T311 is not running:   2>  disregard the *frequencyBandList*, if received, while in RRC\_CONNECTED;  2>  forward the *cellIdentity* to upper layers;  2>  forward the *trackingAreaCode* to upper layers, if included;  2>  forward the *trackingAreaList* to upper layers, if included;  2>  forward the received *posSIB-MappingInfo* to upper layers, if included;  2>  apply the configuration included in the *servingCellConfigCommon*;  2>  if the UE has a stored valid version of a SIB or posSIB, in accordance with clause 5.2.2.2.1, that the UE requires to operate within the cell in accordance with clause 5.2.2.1:  3>  use the stored version of the required SIB or posSIB;  2>  else:  3>  acquire the required SIB or posSIB requested by upper layer as defined in clause 5.2.2.3.5;  NOTE:      Void.   1. else: |
| Vodafone 2 |  | Where are cell types TN and NTN defined, please? Please refer to a cell broadcasting SIB xx (xx being the new SIBs from R17) |
| Samsung | Approach 2 |  |

# Report: summary and proposals

<Section to be updated by Rapporteur>

This report summarizes the views of xx companies ().

1. xxx
2. xxx
3. xxxx.

# Conclusion

The observations captured are the following:

**Observation 1.** xxxx.

The proposals captured are the following:

**Proposal 1.** xxx

The following list shows the proposals above organized based on the suggested priority aiming to help during its meeting discussion:

**Proposals for easy agreement**

xxx

**Proposals for discussion**

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# Annex: companies’ point of contact

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| **Company** | **Point of contact** | **Email address** |
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# Reference

1. R2-2302693 Correction on NR NTN UE capabilities Intel Corporation CR Rel-17 38.306 17.4.0 0888 - F NR\_NTN\_solutions-Core
2. R2-2302868 Features with different UE capability support in TN and NTN Intel Corporation discussion Rel-17 NR\_NTN\_solutions-Core
3. R2-2303034 Clarification on TN EUTRA capability reporting Qualcomm Incorporated CR Rel-17 38.331 17.4.0 3979 - F NR\_NTN\_solutions-Core
4. R2-2303785 Clarification on feature configurations upon TN NTN mobility in RRC\_INACTIVE Ericsson CR Rel-17 38.331 17.4.0 4027 - F NR\_NTN\_solutions-Core