**3GPP T****SG-RAN WG2 Meeting #118-e R2-220xxxx**

**E-Meeting, May 09th – May 20th, 2022**

**Agenda item:**  **6.10.4.1**

**Source: Intel Corporation**

**Title: Report of email discussion [AT118-e][108][NTN] UE capabilities (Intel)**

**Document for: Discussion**

# Introduction

This is the report of the following email discussion:

**[AT118-e][108][NTN] UE capabilities (Intel)**

Initial scope: discuss UE capabilities based on contributions in 6.10.4

Initial intended outcome: Summary of the offline discussion with e.g.:

         List of proposals for agreement (if any)

         List of proposals that require online discussions

         List of proposals that should not be pursued (if any)

Deadline (for companies' feedback): Tuesday 2022-05-10 0800 UTC

Deadline (for rapporteur's summary in R2-22XXXXX): Tuesday 2022-05-10 1000 UTC

# Discussion

## Known remaining issue 1: IoT bits for TN UE capabilities

In 6.10.4, the following papers have proposals for this issue:

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| tdoc number | Proposals |
| R2-2205572 Ericsson | Proposal 2 Separate Interoperability Test bits for IoT NTN might be added if cases were TN features would not apply to NTN are found.  Proposal 3 RAN2 to discuss adding IoT bits to the TN identified capabilities that would not work in NTN. |
| R2-2204662  Qualcomm Inc. | Add new Rel-17 non-critical extension to convey a subset of UE Radio Access Capability Parameters differently for NR NTN.  – *NTN-Parameters*  The IE *NTN-Parameters* is used to convey the subset of UE Radio Access Capability Parameters differently for NR NTN, see TS 38.306 [26]. This IE is not used if the subset of UE Radio Access Capability Parameters is same for both NR TN and NR NTN.  ***NTN-Parameters* information element**  -- ASN1START  -- TAG-NTNPARAMETERS-START  NTN-Parameters-r17 ::= SEQUENCE {  inactiveState-r17 ENUMERATED {supported} OPTIONAL,  delayBudgetReporting-r17 ENUMERATED {supported} OPTIONAL,  overheatingInd-r17 ENUMERATED {supported} OPTIONAL,  bh-RLF-Indication-r17 ENUMERATED {supported} OPTIONAL,  referenceTimeProvision-r17 ENUMERATED {supported} OPTIONAL,  onDemandSIB-Connected-r17 ENUMERATED {supported} OPTIONAL,  redirectAtResumeByNAS-r17 ENUMERATED {supported} OPTIONAL,  mpsPriorityIndication-r17 ENUMERATED {supported} OPTIONAL,  ra-SDT-r17 ENUMERATED {supported} OPTIONAL,  srb-SDT-r17 ENUMERATED {supported} OPTIONAL,  gNB-SideRTT-BasedPDC-r17 ENUMERATED {supported} OPTIONAL,  bh-RLF-RecoveryDetection-Indication-r17 ENUMERATED {supported} OPTIONAL,  mbs-ParametersNTN-r17 MBS-Parameters-r17 OPTIONAL  sliceInfoforCellReselection-r17 ENUMERATED {supported} OPTIONAL,  measAndMobParametersNTN-r17 MeasAndMobParametersNTN-r17 OPTIONAL,  mac-ParametersNTN-r17 MAC-ParametersNTN-r17 OPTIONAL,  phy-ParametersNTN-r17 Phy-ParametersNTN-r17 OPTIONAL,  nonCriticalExtension SEQUENCE {} OPTIONAL  }  -- TAG-NTNPARAMETERS-STOP  -- ASN1STOP |
| R2-2204843  Intel, THALES | Proposal 1: when UE reports nonTerrestrialNetwork-r17, all the per-UE capabilities UE indicates apply to both TN and NTN operations. |
| R2-2205306  Huawei, HiSilicon | Proposal 1: The discussion on whether existing TN capabilities need separate NTN capabilities or IoT bits is focused on per-UE capabilities.  Proposal 2: UE capabilities in the following parameters can be duplicated to indicate the support in NTN:  1) mac-Parameters; 2) phy-Parameters; 3) measAndMobParameters; 4) fdd-Add-UE-NR-Capabilities; 5) fr1-Add-UE-NR-Capabilities.  UE capabilities in the following parameters do not need to differentiate between TN and NTN:  1) sdap-Parameters; 2) pdcp-Parameters; 3) rlc-Parameters; 4) interRAT-Parameters; 5) rf-Parameters; 6) featureSets; 7) featureSetCombinations; 8) tdd-Add-UE-NR-Capabilities; fr2-Add-UE-NR-Capabilities.  Proposal 3: Introduce separated capabilities regarding SON/MDT for NTN. The capabilities related to NR-DC, overheating, power saving and IMS do not need to differentiate between TN and NTN. |

Based on companies’ proposals, this remaining issue can be discussed in three steps:

**Step 1**: RAN2 to confirm that “The discussion on whether existing TN capabilities need separate NTN capabilities or IoT bits is focused on per-UE capabilities”.

**Step 2**: two options for consideration:

Option 1: Add separate IoT bits to convey a subset of UE Radio Access Capability Parameters differently for NR NTN. It also implies that other per-UE UE capabilities not within this list are applicable to both TN and NTN.

Option 2: when UE reports *nonTerrestrialNetwork-r17*, all the per-UE capabilities UE indicates apply to both TN and NTN operations

**Step 3**: if we go with option 1, which existing TN UE capabilities need separate IoT bits for NTN.

The following questions are for these 3 steps respectively to collect companies’ views.

**Question 1: whether it’s agreeable to confirm “The discussion on whether existing TN capabilities need separate NTN capabilities or IoT bits is focused on per-UE capabilities”?**

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| **Company** | **Y or N** | **Additional comments** |
| Qualcomm | Yes | As RAN4 agreed the NTN band identifier is separate from the TN. |
| Huawei, HiSilicon | Y | Proponent. NTN satellite bands have their unique band numbers, per band and per BC capabilities can be differentiated by the band numbers. |
| Samsung | Y |  |
| Lenovo | Yes |  |
| vivo | Yes with comment | Whereas we share the view that per-UE capabilities should be the ones mainly focused on, it is not clear to us how to treat the TN capabilities with other granularity, e.g. per band, per BC, per FS, etc., by this proposal. We assume that the TN capabilities with other granularities should not apply to both TN and NTN, due to NTN specific operating bands introduced, i.e. separate NTN capabilities inevitably needed for them. Maybe this should be clarified along with this proposal, if confirmed. |
| OPPO | Yes |  |
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| Thales | Yes |  |
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**Question 2: to address this IoT bits issue, which option is preferred?**

**Option 1:** Add separate IoT bits to convey a subset of UE Radio Access Capability Parameters differently for NR NTN. It also implies that other per-UE UE capabilities not within this list are applicable to both TN and NTN.

**Option 2:** when UE reports *nonTerrestrialNetwork-r17*, all the per-UE capabilities UE indicates apply to both TN and NTN operations.

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| **Company** | **Option 1 or 2** | **Additional comments** |
| Qualcomm | Option 1 | Option 2 does not work for UE supporting both TN and NTN. For example, the UE may support 2 step RACH, RRC inactive state in TN but not in NTN. |
| Huawei, HiSilicon | Option 1 |  |
| Samsung | Option 1 | Option 2 requires UE to have the same UE capabilities for TN and NTN, but some TN features may not be supported in NTN. |
| Lenovo | Option 1 |  |
| vivo | Option 1 with comments | Basically, we think all TN essential/mandatory UE features (i.e. those with “Yes” in column “M” in 38.306) should be applied to NTN as well. Therefore, the subset of the Radio access capability parameters specific to NTN, as in Option 1, should exclude any TN mandatory UE features. |
| OPPO | Option 1 | Similar view as Qualcomm. |
| Thales | Option 1 |  |
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**Question 3: if we go with option 1, which existing TN UE capabilities need separate IoT bits for NTN?**

**Candidate list 1:**

***NTN-Parameters* information element**

-- ASN1START

-- TAG-NTNPARAMETERS-START

NTN-Parameters-r17 ::= SEQUENCE {

inactiveState-r17 ENUMERATED {supported} OPTIONAL,

delayBudgetReporting-r17 ENUMERATED {supported} OPTIONAL,

overheatingInd-r17 ENUMERATED {supported} OPTIONAL,

bh-RLF-Indication-r17 ENUMERATED {supported} OPTIONAL,

referenceTimeProvision-r17 ENUMERATED {supported} OPTIONAL,

onDemandSIB-Connected-r17 ENUMERATED {supported} OPTIONAL,

redirectAtResumeByNAS-r17 ENUMERATED {supported} OPTIONAL,

mpsPriorityIndication-r17 ENUMERATED {supported} OPTIONAL,

ra-SDT-r17 ENUMERATED {supported} OPTIONAL,

srb-SDT-r17 ENUMERATED {supported} OPTIONAL,

gNB-SideRTT-BasedPDC-r17 ENUMERATED {supported} OPTIONAL,

bh-RLF-RecoveryDetection-Indication-r17 ENUMERATED {supported} OPTIONAL,

mbs-ParametersNTN-r17 MBS-Parameters-r17 OPTIONAL

sliceInfoforCellReselection-r17 ENUMERATED {supported} OPTIONAL,

measAndMobParametersNTN-r17 MeasAndMobParametersNTN-r17 OPTIONAL,

mac-ParametersNTN-r17 MAC-ParametersNTN-r17 OPTIONAL,

phy-ParametersNTN-r17 Phy-ParametersNTN-r17 OPTIONAL,

nonCriticalExtension SEQUENCE {} OPTIONAL

}

-- TAG-NTNPARAMETERS-STOP

-- ASN1STOP

**Candidate list 2:**

1) mac-Parameters;

2) phy-Parameters;

3) measAndMobParameters;

4) fdd-Add-UE-NR-Capabilities;

5) fr1-Add-UE-NR-Capabilities

6) SON/MDT related capabilities.

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| **Company** | **Candidate list 1 or 2** | **Additional comments** |
| Qualcomm | Candidate list 1  Or candidate list 2 + additional capabilities | There are many other UE capabilities which are not part of any of the candidate 2 list. So adding those (like inactiveState) + candidate list 2 is also fine.  Also, not clear if fdd-Add-UE-NR-Capabilities is necessary. |
| Huawei, HiSilicon | 2 | Proponent. List 2 can be taken as a baseline. Agree that *inactiveState* can also be added. |
| Samsung | At lease list 2 | For list 1, several capabilities seems no need of separate IoT bits, e.g. inactiveState, delayBudgetReporting, overheatingInd, etc. |
| Lenovo | Candidate list 1 or candidate list 2 + inactive |  |
| vivo |  | No strong view. But as commented above, we think those TN mandatory features should be excluded from this list, even if option 1 is agreed. |
| OPPO | Candidate list 1 | Candidate list 1 is the simple way. |
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**Summary:**

## Known remaining issue 2: interpretation of *ntn-ScenarioSupport-r17*

In 6.10.4, the following papers have proposals for this issue:

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| tdoc number | Proposals |
| R2-2205572 Ericsson | Proposal 1 ntn-ScenarioSupport-r17 should be used for both essential and optional NTN capabilities. |
| R2-2204843  Intel, THALES | Proposal 2: ntn-ScenarioSupport-r17 also applies to optional NTN UE capabilities. |
| R2-2205701  Samsung | Proposal 2: Define IoT bit for the support of {GSO, NGSO, both}, and this indication means all Rel-17 NTN essential features and optional features UE indicates have been tested in the corresponding scenario(s). |

Companies’ views are aligned according to the proposals above, and other companies are invited to provide views on the proposals.

**Question 4: whether it’s agreeable that “*ntn-ScenarioSupport-r17* is used for both essential and optional NTN capabilities”?**

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| **Company** | **Y or N** | **Additional comments** |
| Qualcomm | Yes |  |
| Huawei, HiSilicon | Y |  |
| Samsung | Y |  |
| Lenovo | Yes |  |
| vivo | Yes |  |
| OPPO | Yes |  |
| Thales | Yes |  |
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**Summary:**

## Known remaining issue 3: Fixed Dish type UE

In 6.10.4, the following papers have proposals for this issue:

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| tdoc number | Proposals |
| R2-2205572 Ericsson | Proposal 4 Postpone the discussion on UEs without GNSS receiver to Release 18. |
| R2-2204843  Intel, THALES | Proposal 3: RAN2 to confirm that static “VSAT” type NTN capable UE without GNSS module but with GNSS coordinates can report gnss-Location-r16 UE capability. |

Since the views are different, companies are invited to choose which one is preferred.

**Question 5: regarding how to handle “Fixed Dish type UE without GNSS module but with GNSS coordinates”, which option is preferred?**

**Option 1:** postpone the discussion on UEs without GNSS receiver to Release 18

**Option 2:** static “VSAT” type NTN capable UE without GNSS module but with GNSS coordinates can report gnss-Location-r16 UE capability

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| **Company** | **option 1 or 2** | **Additional comments** |
| Qualcomm | option 2. | But also ok to defer the discussion to Rel-18. |
| Huawei, HiSilicon | Option 1 | The R17 WI assumes UE has GNSS capability. |
| Samsung | Option 2 | We wonder whether it makes a difference between with GNSS coordinates and GNSS module to support NR NTN. |
| Lenovo | Option 1 | Prefer to discuss in Rel-18 as Rel-17 assumes GNSS capability. |
| vivo | Option 1 |  |
| OPPO | Option 1 | UE without GNSS receiver is not in the scope of Rel-17. |
| Thales | Option 2 | As long as the UE knows its GNSS position, all NTN procedures will be supported |
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**Summary:**

## Other issue 1: NTN only UE

In 6.10.4, the following paper has proposals for this issue:

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| tdoc number | Proposals |
| R2-2205593  Interdigital, Inc. | Proposal 1: RAN2 to discuss and decide whether NTN-only UE needs to be supported.  Proposal 2: If NTN-only UE is not supported then no special handling is needed. This is already implied by existing NTN capabilities.  Proposal 3: If NTN-only UE is supported then, for this type of device, SIB19 is considered as essential system information and the cell is treated as barred if missing.  Proposal 4: If NTN-only UE is supported then introduce a new capability “ntn-Only”. |

As part of the discussion on handling of cell barring, the concept of NTN-only UE is raised. And the corresponding impact on UE capabilities needs to be addressed.

**Question 6: whether NTN-only UE needs to be supported?**

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| **Company** | **Y or N** | **Additional comments** |
| Qualcomm | N | We see there is no need to specify this but any UE is allowed to report which bands it supports. The bands UE includes in the UE capability container could be just two n255 and 256, i.e., only NTN bands. |
| Huawei, HiSilicon |  | We agree with QC. |
| Samsung | N | The support of NTN is an extension of NR TN. UE capable to access NTN must be able to access TN according to NTN essential features. We wonder if NTN-only UE really exists. |
| Lenovo | N | Agree with Qualcomm. |
| vivo | N | As commented above, we think that the UE shall at least be equipped with all those TN mandatory capabilities defined in TS 38.306, in order to be an NR UE, and this makes the UE able to get access to the TN. Also considering that there haven’t been different UE types ever introduced in NR, we are not sure what such an “NTN-only” UE actually means. |
| OPPO | N | Agree with QC. |
| Thales | N | No Handset devices are expected to be NTN only UE.  However some of the VSAT terminals may be NTN-only UE. |
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**Question 7: if the answer to Q6 is no, do you further agree to the following proposals?**

**Proposal 2**: If NTN-only UE is not supported then no special handling is needed. This is already implied by existing NTN capabilities.

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| **Company** | **Y or N** | **Additional comments** |
| Qualcomm | Y | See our response in Q6. |
| Samsung | Y |  |
| Lenovo | Y |  |
| vivo | Y |  |
| OPPO | Y | If there is no NTN-only UE, no further work on this is needed. |
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**Question 8: if the answer to Q6 is yes, do you further agree to the following proposals?**

**Proposal 3**: If NTN-only UE is supported then, for this type of device, SIB19 is considered as essential system information and the cell is treated as barred if missing.

**Proposal 4**: If NTN-only UE is supported then introduce a new capability “ntn-Only”.

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| **Company** | **Y or N** | **Additional comments** |
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**Summary:**

## Other issue 2: SMTC enhancements for GSO

In 6.10.4, the following paper has proposals for this issue:

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| tdoc number | Proposals |
| R2-2205701  Samsung | Proposal 1: The SMTC enhancements (event-triggered assistance information reporting, 2 SMTC in parallel) are optional for GSO capable UE. |

In RAN2#117-e meeting, RAN2 made the following agreement regarding SMTC enhancements:

1. The SMTC enhancements (event-triggered assistance information reporting, 2 SMTC in parallel) are essential for NGSO capable UEs.

And for GSO capable UEs, it is still an FFS.

**Question 9: whether the following proposal is agreeable?**

**Proposal 1:** The SMTC enhancements (event-triggered assistance information reporting, 2 SMTC in parallel) are optional for GSO capable UE.

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| **Company** | **Y or N** | **Additional comments** |
| Qualcomm | N | See Q4, isn’t it easy to follow ***ntn-ScenarioSupport-r17***. |
| Huawei, HiSilicon | Y | We think the proponent intends to clarify that SMTC enhancements are not essential for GSO UEs. How to capture it can be further discussed, e.g. capture it in *ntn-ScenarioSupport-r17* but clarify it is optional, or add a separate capability. |
| Samsung | Y | The propagation delay difference between cells in GSO scenario can be static or change very slow, and the impact on SMTC seems not critical. If SMTC enhancement is agreed to be optional for GSO, a separate IoT bit for GSO and NGSO may be need for this feature. |
| Lenovo | Y | Optional for GSO UE is OK. |
| vivo | Y | Since the attributes of this capability is different for GSO and NGSO cases, maybe a clarification is needed in TS 38.306 for this. |
| OPPO | Y | For GSO, UE does not have to support the SMTC enhancements, e.g. 2 SMTC in parallel, since the SMTC window is relatively stable. |
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**Summary:**

## Other issue 3: Clarification on TA reporting UE capability

In 6.10.4, the following paper has proposals for this issue:

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| tdoc number | Proposals |
| R2-2204842  Intel | Incorporate event-triggered TA reporting feature into TA reporting UE capability.  ***uplink-TA-Reporting-r17***  Indicates whether the UE supports UE reporting of information related to TA pre-compensation, i.e., event-triggered TA reporting in RRC connected mode and system information triggered TA reporting during initial access*.* UE indicating support of this feature shall also indicate support of *uplinkPreCompensation-r17* for this band. |

TA reporting UE capability based on the RAN1 UE feature list (R1-2202928) was captured in R2-2204304 (Draft mega CR), and one RAN2 agreement “Incorporate event-triggered TA reporting feature into TA reporting UE capability defined in RAN1 feature list” needs to be captured based on it.

**Question 10: whether the following implementation to capture “Incorporate event-triggered TA reporting feature into TA reporting UE capability defined in RAN1 feature list” is agreeable?**

***uplink-TA-Reporting-r17***

Indicates whether the UE supports UE reporting of information related to TA pre-compensation, i.e., event-triggered TA reporting in RRC connected mode and system information triggered TA reporting during initial access*.* UE indicating support of this feature shall also indicate support of *uplinkPreCompensation-r17* for this band.

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| **Company** | **Y or N** | **Additional comments** |
| Qualcomm | N | Why it is applicable for TA reporting during initial access. |
| Huawei, HiSilicon | N | We think “system information triggered TA reporting during initial access” is a bit unclear, maybe it can be revised to “TA reporting during initial access in RRC\_IDLE/RRC\_INACTIVE”. |
| Samsung | Y with comment | As RAN2 agreed, TA reporting during random access is optional to help scheduling and configuring timing relationship. TA report in RA can also be triggered in RRC re-establishment, and in HO command, it would be better to be more precise, e.g. “event-triggered TA reporting in RRC connected mode and TA reporting during random access”. |
| Lenovo | N | We prefer Huawei’s description. |
| vivo | Comments | Intention is agreeable. However, the wording “system information triggered” sounds a bit strange, and the TA reporting triggered by the ta-Report indicator in the SI is not limited to only initial access. May be reworded as “i.e. event-triggered TA reporting in RRC connected mode, and TA reporting triggered based on *ta-Report* in SI/dedicated signalling during RA procedure”. |
| OPPO | N | Similar view as Huawei. |
| Thales | Y | We support the capability of TA reporting in RRC connected mode (upon event trigger)  We also believe it is beneficial to trigger TA report during random access procedure |
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**Summary:**

# Conclusion

Based on this offline discussion on UE capabilities, the following proposals are made:

** List of proposals for agreement:**

** List of proposals that require online discussions:**

# References

1. R2-2205572 On NTN capabilities Ericsson
2. R2-2204662 NTN UE capability signalling Qualcomm Incorporated
3. R2-2204843 Discussion on remaining issues on NTN UE capabilities Intel Corporation,

THALES

1. R2-2205306 Discussion on UE capabilities for NTN Huawei, HiSilicon
2. R2-2205593 NTN-only UE Interdigital, Inc.
3. R2-2205701 Open issues on UE capabilities Samsung Research America
4. R2-2204842 Clarification on TA reporting UE capability Intel Corporation