**3GPP T****SG-RAN WG2 Meeting #119-e R2-220xxxx**

**E-Meeting, Aug 17 – 29, 2022**

**Agenda item:**  **6.10.3.2.1**

**Source: Intel Corporation**

**Title: Report of [AT119-e][102][NR-NTN] SMTC and gaps (Intel)**

**Document for: Discussion and Decision**

# Introduction

This is the report of the following offline discussion on remaining SMTC and gap issues:

**[AT119-e][102][NR-NTN] SMTC and gaps (Intel)**

Initial scope: Discuss corrections related to remaining SMTC and gaps issues (from proposals in R2-2207068, R2-2207149, R2-2207243, R2-2207268, R2-2207269, R2-2207270, R2-2207271, R2-2208214, R2-2208466)

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)

Initial deadline (for companies' feedback): Thursday 2022-08-18 0600 UTC

Initial deadline (for rapporteur's summary in R2-2208752): Thursday 2022-08-18 1000 UTC

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| **tdoc list:**R2-2207271 Discussion on RAN4 reply LS on measurement gaps Intel Corporation discussion Rel-17 NR\_NTN \_solutions-Core**=> move from 6.10.1.1**R2-2207268 Draft 331 CR for NR NTN measurement related UE capabilities Intel Corporation draftCR Rel-17 38.331 17.1.0 F NR\_NTN \_solutions-CoreR2-2207269 Draft 306 CR for NR NTN measurement related UE capabilities Intel Corporation draftCR Rel-17 38.306 17.1.0 F NR\_NTN \_solutions-CoreR2-2207270 Discussion on UE capability for 2 SMTC in parallel Intel Corporation discussion Rel-17 NR\_NTN \_solutions-Core**=> move from 6.10.3.2.3**R2-2207149 Remaining issues on SMTCs and gaps Huawei , HiSilicon discussion Rel-17 NR\_NTN \_solutions-CoreR2-2208214 Correction to associate two concurrent measurement gaps to one frequency layer for NR NTN Nokia, Nokia Shanghai Bell CR Rel-18 38.331 17.1.03382 - F NR\_NTN \_solutions-CoreR2-2208466 Correction for measurement gap Xiaomi draftCR Rel-17 38.331 17.1.0 NR\_NTN \_solutions-CoreR2-2207243   Draft 331 CR for NR NTN SMTC   Samsung Research America     draftCR Rel-17           38.331  17.1.0   F          NR\_NTN\_solutions-CoreR2-2207068   Correction on NTN UE capabiltiy   OPPO  CR       Rel-17  38.306  17.1.0   0758     -           F          NR\_NTN\_solutions-Core |

# Discussion

## 2.1 Spec impact of RAN4 reply LS on measurement gaps

For Rel-17 NR NTN, RAN2 received the reply LS [1] from RAN4 on measurement gap enhancements for NTN. The content of this LS is as below:

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| **1. Overall Description:**RAN4 thanks RAN2 for the LS sent in R2-2204114 asking about the feasibility for NR NTN when one frequency layer is associated to both concurrent measurement gaps with the same gap type.RAN4 reached consensus in this matter that one frequency layer can be associated to both concurrent measurement gaps with the same gap type. There is no need to define additional NTN UE capability for this association.**2. Actions:****To RAN2****ACTION:** RAN4 kindly asks RAN2 to take the above answers into account. |

There are two pieces of key information for RAN2 to consider:

1. One frequency layer can be associated to both concurrent measurement gaps with the same gap type

2. There is no need to define additional NTN UE capability for this association

Regarding how to capture “One frequency layer can be associated to both concurrent measurement gaps with the same gap type”, the following papers provides the corresponding CR or TP.

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| R2-2207271  | MeasObjectNR ::= SEQUENCE {…… [[ associatedMeasGapSSB-r17 MeasGapId-r17 OPTIONAL, -- Need R associatedMeasGapCSIRS-r17 MeasGapId-r17 OPTIONAL, -- Need R smtc4list-r17 SSB-MTC4List-r17 OPTIONAL, -- Need R measCyclePSCell-r17 ENUMERATED {ms160, ms256, ms320, ms512, ms640, ms1024, ms1280, spare1} OPTIONAL, -- Need R cellsToAddModListExt-v1710 CellsToAddModListExt-v1710 OPTIONAL -- Need N ]], [[ associatedMeasGapSSB2-NTN-r17 MeasGapId-r17 OPTIONAL, -- Need R associatedMeasGapCSIRS2-NTN-r17 MeasGapId-r17 OPTIONAL -- Need R ]]} |
| R2-2207149  | MeasObjectNR ::= SEQUENCE { …… [[ associatedMeasGapSSB-r17 MeasGapId-r17 OPTIONAL, -- Need R associatedMeasGapCSIRS-r17 MeasGapId-r17 OPTIONAL, -- Need R smtc4list-r17 SSB-MTC4List-r17 OPTIONAL, -- Need R measCyclePSCell-r17 ENUMERATED {ms160, ms256, ms320, ms512, ms640, ms1024, ms1280, spare1} OPTIONAL, -- Need R cellsToAddModListExt-v1710 CellsToAddModListExt-v1710 OPTIONAL -- Need N ]] [[ associatedMeasGapSSB2-v17xy MeasGapId-r17 OPTIONAL, -- Need R associatedMeasGapCSIRS2-v17xy MeasGapId-r17 OPTIONAL, -- Need R ]]} |
| R2-2208214  | MeasObjectNR ::= SEQUENCE { ……  [[ associatedMeasGapSSB-r17 MeasGapId-r17 OPTIONAL, -- Need R associatedMeasGapCSIRS-r17 MeasGapId-r17 OPTIONAL, -- Need R smtc4list-r17 SSB-MTC4List-r17 OPTIONAL, -- Need R measCyclePSCell-r17 ENUMERATED {ms160, ms256, ms320, ms512, ms640, ms1024, ms1280, spare1} OPTIONAL, -- Need R cellsToAddModListExt-v1710 CellsToAddModListExt-v1710 OPTIONAL -- Need N ]],[[ associatedMeasGapSSB2-r17 MeasGapId-r17 OPTIONAL, -- Cond NTN]]} |
| R2-2208466  | MeasObjectNR ::= SEQUENCE { …… [[ associatedMeasGapSSB-r17 MeasGapId-r17 OPTIONAL, -- Need R associatedMeasGap2SSB-r17 MeasGapId-r17 OPTIONAL, -- Need R associatedMeasGapCSIRS-r17 MeasGapId-r17 OPTIONAL, -- Need R associatedMeasGap2CSIRS-r17 MeasGapId-r17 OPTIONAL, -- Need R smtc4list-r17 SSB-MTC4List-r17 OPTIONAL, -- Need R measCyclePSCell-r17 ENUMERATED {ms160, ms256, ms320, ms512, ms640, ms1024, ms1280, spare1} OPTIONAL, -- Need R cellsToAddModListExt-v1710 CellsToAddModListExt-v1710 OPTIONAL -- Need N ]]} |

Based on companies’ papers, companies are aligned to capture the second measurement gap ID within IE *Measobject* NR in RRC spec. The difference is in CR detail. Since different reference signals within the same *MeasObjectNR* mean different measurement frequency layers, we need separate fields for SSB measurement and CSI-RS measurement.

**Question 1: whether the following proposal is agreeable:**

**Proposal: RAN2 to capture in TS 38.331 RAN4 agreement that one frequency layer and two concurrent measurement gaps with the same gap type can be associated, i.e., *associatedMeasGapSSB2* and *associatedMeasGapCSIRS2* within IE *MeasObjectNR*.**

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| **Company** | **Y or N** | **Additional comments** |
| Huawei, HiSilicon | Y |  |
| MediaTek | Y |  |
| Lenovo | Y |  |
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Regarding the UE capability, RAN4 indicates that “There is no need to define additional NTN UE capability for this association”. The following paper suggests to capture the support of this association as “if a UE supports both NTN features and concurrent gap features, it also supports the association between one frequency layer and two concurrent measurement gaps with the same gap type.” The TP is as below:

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| R2-2207271  | ***nonTerrestrialNetwork-r17***Indicates whether the UE supports NR NTN access. If the UE indicates this capability the UE shall support the following NTN essential features, i.e., timer extension in MAC/RLC/PDCP layers and RACH adaptation to handle long RTT, acquiring NTN specific SIB and more than one TAC per PLMN broadcast in one cell. A UE shall support two concurrent measurement gaps for one measurement object if the UE supports both *concurrentMeasGap-r17* and *nonTerrestrialNetwork-r17*. |
| R2-2207271  | ***concurrentMeasGap-r17***Indicates whether the UE supports the concurrent measurements gaps as specified in TS 38.133 [5]. The capability signalling comprises the following parameters:- *concurrentPerUE-OnlyMeasGap-r17* indicates whether the UE supports more than 1 per-UE measurement gap (i.e. gap combination configuration id = 2 as specified in TS38.133 [5]), or*-* *concurrentPerUE-PerFRCombMeasGap-r17* indicates whether the UE supports all concurrent gap combination configurations as specified in TS 38.133 [5] including support of more than 1 per-UE measurement gap configurations. For UE capable of Rel-15 per-FR gap (*independentGapConfig*), this field indicates whether the UE supports more than 1 per-FR gap measurement gap configurations in an FR, or simultaneous 1 per UE measurement gap plus 1 per-FR measurement gap configurations in an FR, or more than 1 per-UE measurement gap configurations.A UE shall support two concurrent measurement gaps for one measurement object if the UE supports both concurrentMeasGap-r17 and nonTerrestrialNetwork-r17. |

**Question 2: whether the following proposal is agreeable:**

**Proposal: if a UE supports both NTN features and concurrent gap features, it also supports the association between one frequency layer and two concurrent measurement gaps with the same gap type.**

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| **Company** | **Y or N** | **Additional comments** |
| Huawei, HiSilicon | N | NTN features should not be mixed with MGE features, as RAN4 will not define the requirements for joint configuration of NTN and MGE in R17.RAN4 has already introduced a feature for NTN multiple gaps (25-3 in RAN4 feature list):

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| 25.NR\_NTN\_solutions | 25-3 | Parallel measurements with multiple measurement gaps | Support of 2 measurement gaps |

In our understanding, “There is no need to define additional NTN UE capability for this association” in the RAN4 LS means that, if the UE supports 25-3, it will support 2 gaps associated with one frequency layer. No additional spec impact is needed. |
| MediaTek | N | Agree with Huawei |
| Lenovo | N | RAN4 indicates that “There is no need to define additional NTN UE capability for this association”, which means that feature for NTN multiple gaps (25-3) is sufficient. |
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## 2.2 UE capability for 2 SMTC in parallel

In RAN2 118e meeting, the following agreement was made.

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

The corresponding UE capability indication is not specified yet, and R2-2207243 proposes to define a UE capability for this feature as below.

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| R2-2207243 | ntn-SMTC-GSO ENUMERATED {supported} OPTIONAL |

But as explained in R2-2207270, there is a discrepancy for GSO capable UE. In the latest RAN4 feature list [2], NTN “UE is mandatory to support 2 and can optionally support 4 if the feature is supported” as below. In RAN4 feature list, there is no differentiation between GSO and NGSO UEs, i.e., for both of them, it is mandatory to support 2 SMTCs in parallel.

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| **Index** | **Feature group** | **Components** | **Note** |
| 25-1 | Parallel measurements on multiple SMTC-s for a single frequency carrier | Support of measurements on target cells belonging to 4 SMTC-s on a single frequency carrier | UE is mandatory to support 2 and can optionally support 4 if the feature is supported |

RAN2 needs to discuss how to handle this discrepancy, i.e., to go with RAN4 feature list or go with RAN2 agreements. For example:

**Option 1) RAN2 agreement is updated to align with RAN4 agreement**

For this option 1), the TP for 25-1 of RAN4 feature list would be as below. In this case “2 SMTC-s on a single frequency carrier” is mandatory for both GSO capable UE and NGSO capable UE.

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| ***parallelSMTC-r17***Indicates whether the UE supports NTN RRM measurements on target cells belonging to 4 SMTC-s on a single frequency carrier. If a UE does not include this field but includes *nonTerrestrialNetwork-r17*, the UE supports NTN RRM measurements on target cells belonging to 2 SMTC-s on a single frequency carrier. |

**Option 2) RAN2 agreement is kept (and RAN4 is informed to update their specification)**

For this option 2), we need to define a separate UE capability for the support of NTN RRM measurements on target cells belonging to 2 SMTC-s on a single frequency carrier and to 4 SMTC-s on a single frequency carrier. In addition, for the 2 SMTC-s on a single frequency carrier, it is defined that it is mandatory to report for NGSO capable UE (and optional for GSO capable UE). The corresponding TPs for the new UE capabilities for both 4 SMTC-s and 2 SMTC-s is as shown below as an example:

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| ***parallelFourSMTC-r17***Indicates whether the UE supports NTN RRM measurements on target cells belonging to 4 SMTC-s on a single frequency carrier.  |

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| ***parallelTwoSMTC-r17***Indicates whether the UE supports NTN RRM measurements on target cells belonging to 2 SMTC-s on a single frequency carrier. It is mandatory to report for UE which supports the NTN features in NGSO scenario. |

**Question 3: regarding the UE capability for 2 SMTC in parallel, which option can be agreeable:**

**Option 1: RAN2 agreement is updated to align with RAN4 agreement, i.e., “2 SMTC-s on a single frequency carrier” is mandatory for both GSO capable UE and NGSO capable UE.**

**Option 2: RAN2 agreement is kept and RAN4 is informed to update their specification, i.e., it’s mandatory for NGSO capable UE but optional for GSO capable UE to support “2 SMTC-s on a single frequency carrier”.**

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| **Company** | **which option is agreeable?** | **Additional comments** |
| Huawei, HiSilicon | No strong view | Both options are ok for us.The reason for not mandating the support of multiple SMTCs for GSO is that, GSO satellites are stationery, and will not cause the SMTC offset to change. But if GSO-NGSO mobility is considered, UEs will need to measure NGSO neighbours even if it is served by a GSO. In this sense, it is also reasonable for the UE to support multiple SMTCs. |
| MediaTek | No strong view |  |
| Lenovo | both acceptable | We slightly prefer Option 1 as there is no restriction of GSO-NGSO mobility for now. |
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## 2.3 UE capability for service link propagation delay difference report

To capture the UE capability for service link propagation delay difference report, the corresponding CR or TP are provided by papers as below:

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| R2-2207268 | MeasAndMobParametersCommon ::= SEQUENCE {……[[serviceLinkPropDelayDiffReporting-r17 ENUMERATED {supported} OPTIONAL]]} |
| R2-2207269 |  |
| R2-2207068 |  |

The difference between them is in the 38.306 wording aspect. Since in RAN2#117 RAN2 agreed that “The SMTC enhancements (event-triggered assistance information reporting, 2 SMTC in parallel) are essential for NGSO capable UEs”, it seems R2-2207269 can be adopted as the baseline for final CR.

**Question 4: whether the draft CR R2-2207268 and R2-2207269 can be adopted as baseline for specifying the UE capability for service link propagation delay difference report:**

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| **Company** | **Y or N** | **Additional comments** |
| Huawei, HiSilicon | Y |  |
| MediaTek | Y |  |
| Lenovo | Y |  |
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## 2.4 Corrections on NTN SMTC enhancements

As spotted by R2-2207149 and R2-2207243, “In IE *SSB-MTC4*, *pci-List* and *offset* are specified, and the periodicity and duration parameters have to be derived from *smtc1* configuration”, and current description in clause 5.5.2.10 of 38.331 is not aligned with this design. So, the following changes are proposed:

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| R2-2207149 | If *smtc4list* is present, for cells indicated in the *pci-List* parameter in each *SSB-MTC4* element of the list in the same *MeasObjectNR*, the UE shall setup an additional SS /PBCH block measurement timing configuration (SMTC) in accordance with the received received *periodicity* and *duration* parameter in the *smtc1* configuration and use the *Offset* (derived from parameter *periodicityAndOffset*) from each *SSB-MTC4* configuration. The first subframe of each SMTC occasion occurs at an SFN and subframe of the NR SpCell meeting the above condition. |
| R2-2207243 | If *smtc4list* is present, for cells indicated in the *pci-List* parameter in each *SSB-MTC4* element of the list in the same *MeasObjectNR*, the UE shall setup an additional SS/PBCH block measurement timing configuration (SMTC) in accordance with the received *offset* parameter in the *SSB-MTC4* configuration and use the *periodicity* (derived from parameter *periodicityAndOffset*) and *duration* parameter from the *smtc1* configuration. The first subframe of each SMTC occasion occurs at an SFN and subframe of the NR SpCell meeting the above condition. |

The intention of these two papers is the same, but with different CR wordings. Considering the *offset-r17* in IE *SSB-MTC4* is provided directly, i.e., NOT “derived from parameter *periodicityAndOffset”*, R2-2207243 seems more accurate. And since the change is for wording correction, the agreed change can be merged to NR NTN RRC Rapporteur correction CR.

**Question 5: whether the spec change on** ***smtc4list*** **related** **description in clause 5.5.2.10 of 38.331 in CR R2-2207243 can be agreed, and merged into NR NTN RRC Rapporteur correction CR?**

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| **Company** | **Y or N** | **Additional comments** |
| Huawei, HiSilicon | Y |  |
| MediaTek | Y |  |
| Lenovo | Y |  |
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Regarding further clarification on SMTC related NW/UE behaviour, the following proposals are made in R2-2207149. Since no other papers have the similar proposals or focus on the same issue, these proposals could be discussed one by one.

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| **Proposal 1: For UEs in RRC\_CONNECTED, the SMTC configured by the NW can be directly used by the UE, i.e., no need to add the PDD to the configured offset.****Proposal 2: For UEs in RRC\_CONNECTED, to assist the NW adjust SMTC, clarify the intended UE behavior:*** **Option 1: UE reports SFTD in an event-triggered manner, or the NW configures the UE to (re-)report SFTD once in a while. PDD reporting is not needed.**
* **Option 2: UE reports SFTD only once, and report PDD in an event-triggered manner subsequently.**

**Proposal 3: In SIB2/SIB4, the NW can broadcast at most 2 SMTCs per frequency.****Proposal 4: The SMTC in SIB2/4 is based on a common understanding, and RAN2 chooses from the following:*** **Option 1: The broadcast SMTC assumes PDD = X ms. The PDD in Idle/Inactive includes both service link and feeder link. (applicable for intra-NTN)**
* **Option 2: The broadcast SMTC assumes the UE is located at the reference location. (applicable for intra-NTN)**
* **Option 3: UE ignores the offset of SMTC, and determines the SMTC offset by blind detection. (applicable for both intra-NTN and NTN-TN)**

**Proposal 5: The UE reports the calculated SMTC offset upon entering RRC\_CONNCTED.** |

**Question 6: whether P1 in R2-2207149 is agreeable?**

**Proposal 1: For UEs in RRC\_CONNECTED, the SMTC configured by the NW can be directly used by the UE, i.e., no need to add the PDD to the configured offset.**

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| **Company** | **Y or N** | **Additional comments** |
| Huawei, HiSilicon | Y | We think it’s useful to figure out which interpretation is correct:* **Understanding 1**: The SMTC configured by the NW assumes PDD = 0. When using the SMTC, the actual offset equals to the configured offset plus the PDD.
* **Understanding 2**: The SMTC configured by the NW can be directly used by the UE. If the PDD changes later, the UE reports the new PDD, and NW adjusts accordingly.

The first understanding brings extra complexity at the UE side, as the SMTC involves multiple neighbor cells on the same frequency, and each of them has a different PDD. Understanding 2 is simpler, and can guarantee the NW and UE are aligned. |
| MediaTek | Y |  |
| Lenovo | Y with comments | A pre-condition is that NW has received a reported PDD from the UE. As long as the NW has a reported PDD before the configuration, UE can assume that NW calculation is accurate and directly use the configuration. New PDD can be reported if there is further change. |
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**Question 7: regarding P2 in R2-2207149, which option is agreeable?**

**Proposal 2: For UEs in RRC\_CONNECTED, to assist the NW adjust SMTC, clarify the intended UE behavior:**

* **Option 1: UE reports SFTD in an event-triggered manner, or the NW configures the UE to (re-)report SFTD once in a while. PDD reporting is not needed.**
* **Option 2: UE reports SFTD only once, and report PDD in an event-triggered manner subsequently.**

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| **Company** | **which option is agreeable?** | **Additional comments** |
| Huawei, HiSilicon | Both are ok | The intention is that, SFTD is essential for the NW to configured SMTC, but is has not been discussed in NTN.Besides, the PDD agreed in the previous meeting refers to the timing difference between serving cell and neighbor cell, which is exactly the role of SFTD. Therefore, RAN2 should at least figure out the relationship between PDD and SFTD.Below are some further clarifications:To configure the SMTC for neighbor cell measurements correctly, the serving cell needs to obtain the following information:1. The SSB transmission pattern of neighbor cell, which is included in the inter-node message *MeasurementTimingConfiguration*. However, the timing of the SSB configuration in *MeasurementTimingConfiguration* is based on the cell for which the message is included. So an additional information is also needed (as in ②).
2. The timing difference between serving cell and neighbor cell, i.e., SFTD.

These information are enough for terrestrial network, but in NTN, there are some other considerations. Firstly, in terrestrial network, the SFTD is per cell. However, the NTN cell has a large coverage, and the SFTD value for each UE is various, so the SFTD measured and reported by one UE cannot be applicable to all UEs in the cell. Moreover, the satellite is moving continuously, causing the timing difference between the serving cell and neighbor cell to change.Among the two options listed, Option 2 has fewer spec impact as PDD reporting is already captured in the spec, but Option 1 is actually simpler because the UE only needs to report SFTD, no need to report PDD. |
| MediaTek | No strong view |  |
| Lenovo | Option 2 | Reporting new PDD upon change is sufficient and has fewer spec impact. |
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**Question 8: whether P3 in R2-2207149 is agreeable?**

**Proposal 3: In SIB2/SIB4, the NW can broadcast at most 2 SMTCs per frequency.**

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| **Company** | **Y or N** | **Additional comments** |
| Huawei, HiSilicon | Y |  |
| MediaTek | Y |  |
| Lenovo | Y |  |
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**Question 9: regarding P4 in R2-2207149, which option is agreeable?**

**Proposal 4: The SMTC in SIB2/4 is based on a common understanding, and RAN2 chooses from the following:**

* **Option 1: The broadcast SMTC assumes PDD = X ms. The PDD in Idle/Inactive includes both service link and feeder link. (applicable for intra-NTN)**
* **Option 2: The broadcast SMTC assumes the UE is located at the reference location. (applicable for intra-NTN)**
* **Option 3: UE ignores the offset of SMTC, and determines the SMTC offset by blind detection. (applicable for both intra-NTN and NTN-TN)**

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| **Company** | **which option is agreeable?** | **Additional comments** |
| Huawei, HiSilicon | Slightly prefer Option 1 | The issue is that, UEs at different locations have different PDD, while the SMTC in SIB is a cell-specific information. So the NW and UE needs to have an aligned understanding of the SMTC.The baseline should be the TN operation.In TN, there is no PDD, so the broadcast SMTC assumes PDD = 0 ms. Similar assumption should be made in NTN.Otherwise the NW does not know how to configure the SMTC. |
| MediaTek | Option 1 |  |
| Lenovo | Option 1 | For broadcast NW can assume PDD=0 or X (e.g. PDD at ref location). |
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**Question 10: whether P5 in R2-2207149 is agreeable?**

**Proposal 5: The UE reports the calculated SMTC offset upon entering RRC\_CONNCTED.**

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| **Company** | **Y or N** | **Additional comments** |
| Huawei, HiSilicon | Y | If not reported, the NW needs to configure the UE to report SFTD and then configure the SMTC to the UE for measurements.Since the UE already has the estimated value, the SFTD reporting procedure can be omitted if the value is reported to the NW. |
| MediaTek | Y |  |
| Lenovo |  | UE can calculate and report PDD as assistance information after entering CONNECTED, and we think it would be sufficient. |
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# Conclusion

# References

[1] R4-2210611 Reply LS on measurement gap enhancements for NTN

[2] R4-2211189 Rel-17 RAN4 UE feature list for NR CMCC