3GPP TSG-RAN WG2 Meeting #116 Electronic draftR2-2111340

Elbonia, 1 – 12 of November 2021

**Agenda item: 8.10.3.3**

**Source: Nokia, Nokia Shanghai Bell**

**Title: [AT116-e][103][NTN] SMTC and gaps (Nokia)**

**WID/SID: NR\_NTN\_solutions - Rel-17**

**Document for: Discussion and Decision**

# 1 Introduction

The scope of this paper is as follows:

* [AT116-e][103][NTN] SMTC and gaps (Nokia)

Initial scope: Continue the discussion on SMTC and gaps, based on the proposals in [R2-2111333](file:///C:\Data\3GPP\RAN2\Inbox\R2-2111333.zip)

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 2021-11-04 1000 UTC

Initial deadline (for rapporteur's summary in R2-2111340): Thursday 2021-11-04 1600 UTC

Proposals marked "for agreement" in R2-2111340 not challenged until Friday 2021-11-05 0800 UTC will be declared as agreed via email by the session chair (for the rest the discussion will further continue offline until the CB session in Week2).

During the online discussion at RAN2#116, the following has been agreed:

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| Agreements:  1. We don't introduce new mechanisms (e.g. based on MAC CE) to activate/deactivate SMTCs for NTN neighbour measurements. Which SMTCs the UE will consider is only based on RRC configuration (UE based solutions are not excluded by this). |

The remainder of this paper discusses the other parts of R2-2111333, not covered during the GTW discussion.

# 2 Discussion

This section is divided topic-wise, based on what has been contributed by the companies in SMTC/measurement gap related papers to RAN2#116 and later summarized in [16].

## 2.1 Assistance information for NW-based SMTC configuration

First topic to consider is how to ensure the NW gets assistance information to properly configure the SMTCs and measurement gaps. In the papers submitted to RAN2#116 there are numerous approaches presented which are summarized below:

* Use delay report [10] [15][7] [5][1]
  + Propagation delay difference from the UE to its serving and neighboring cells in UE assistance for measurement gap and/or SMTC configuration, or the propagation delay from the UE to its neighboring cell [7]
  + Delay value modulo periodicity in milliseconds [10]
  + SFTD [11]
  + UE assistant information could be propagation delay or propagation delay difference[5]
  + UE can be configured to report service link propagation delay difference between serving satellite and neighbor satellite. [1]
* Use UE location information [3] [6] [8] [13][12]
  + Wait for SA3 response on user consent for UE location before determining the nature of UE assistance information for initial SMTC/Gap timing determination.[2]
  + UE can report its location to assist network with SMTC window/measurement gap configuration, but efficient estimation of propagation delay also requires additional knowledge about target cell ephemeris and feeder link delay. [12]

As can be seen, the views are split and companies support either to report a kind of propagation delay information or UE location information. The latter is still subject to the user consent – to be resolved by SA3. For the propagation delay-related assistance information there seems to be no consensus how this can be implemented (i.e. using SFTD, propagation delay, propagation delay difference, delay modulo periodicity in milliseconds, etc.).

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| **Question 1: How should the NTN assistance information for SMTC/MG configuration be defined? I.e. in the form of:**   1. **propagation delay** 2. **UE location reporting** | | |
| **Company** | **Answer** | **Comments** |
| Ericsson | B location |  |
| MediaTek | Either a) or b) | Depends on if SA3 agrees on location reporting. |
| Apple | a) |  |
| Lenovo, Motorola Mobility | a) delay report | Delay report is more straight-forward and can be directly used by network. The format can be further discussed. This report does not need UE’s consent and interwork with other WGs.  Location report is pending on SA3’s reply. However even if SA3 replies YES, UE location reporting still needs UE’s consent meaning possibility of UE rejection. |
| Huawei, HiSilicon | b | It depends on SA3 reply |
| Qualcomm | b) first +  a) second | Wherever possible, location report in any form finer or coarse is the first priority to use. With this, signaling overhead of broadcasting ephemeris of each neighbor satellite to calculate propagation delay difference is avoided.  If network is unable to configure UE with location report in any form (coarse or finer), propagation delay report is needed. |
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There are different proposal how the propagation delay-based assistance information reporting can be specified. Please share your view how this can be done:

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| **Question 2: If supported, how delay-based assistance information should be defined? Please choose one of the options and provide justification/description:**   1. **SFTD** 2. **propagation delay** 3. **propagation delay difference** 4. **delay modulo periodicity in milliseconds** 5. **other option** | | |
| **Company** | **Answer** | **Comments** |
| Ericsson |  | **If RAN2 agrees with delay reporting, RAN2 needs to analyse the options. E.g. what all information/signals from neighbor cells UE needs for calculating the delay e.g. SFTD** |
| MediaTek | Either b) or c) | Either propagation delay or the delay difference could be used. |
| Apple | b) | Seems the most straightforward |
| Lenovo, Motorola Mobility | b) or c) | Information of service link propagation delay or propagation delay difference needs to be provided to network by UE assistance. Information of feeder link propagation delay or propagation delay difference can be obtained by network implementation. |
| Huawei, HiSilicon | b | The SFTD measurement is mainly used in DC scenarios, to facilitate the coordination of gap and/or DRX configuration between MN and SN, and SFTD measurement is dependent on UE capabilities. |
| Qualcomm | c) | The delay difference is sufficient as anyway network does not know the UE location (that’s why UE needs to report this). |
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Moreover, as has been mentioned e.g. in [12], RAN2 shall consider if for the propagation delay estimation it is also needed to have the neighbour cell ephemeris information and know the FL delay component.

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| **Question 3: Please explain how Feeder Link related delay component should be known and taken into account. Please also comment if neighbour cell ephemeris should play a role in assessing the delay.** | |
| **Company** | **Answer** |
| MediaTek | It should be provided in the neighbor list |
| Apple | We are not sure neighbor cell ephemeris information can be relied upon for assessing delay accurately |
| Lenovo, Motorola Mobility | Neighbour cell ephemeris information has been agreed to be provided to UE. Information of feeder link propagation delay or propagation delay difference are only relevant to network deployment so that serving cell can know it by network implementation. |
| Huawei, HiSilicon | Neighbour cell ephemeris is needed. Moreover, the neighbour cell ephemeris should be associated to the PCI of the neighbour cell. When the network requests UE to provide propagation delay of a neighbour, it needs to indicate the PCI to the UE.  However, UE does not need to consider feeder link delay of neighbour cells. Feeder link delay can be exchanged between gNBs. |
| Qualcomm | How does ephemeris help in assessing feeder link delay as gateway location is not known? There are simply two methods (1) network compensates the feeder link so UE does not have to worry about feeder link delay (2) network provides the drift rate for each neighbor at which feeder link changes. |

## 2.2 Triggering the assistance information and adjusting the SMTC:

Next topic, largely associated with what has been discussed in 2.1, concerns the triggering of assistance information/SMTC adjustments. In the papers submitted to RAN2#116 the following can be found:

* UE will transmit assistance information when the difference between networks configuration and UEs own measurement is above a pre-defined threshold [9]
* Introduce event-triggered distance-based UE location reporting, e.g. triggered when the UE moves a distance exceeding a configured threshold since its last reported location.[8]
* to provide location information timely a new event should be introduced to reflect the validity of SMTC configuration e.g. the associated neighbour cells cannot be detected based on currently enabled SMTC for a period of time.[3]
* drift threshold is introduced to switch between different SMTC/Gap configurations to measure a neighbour satellite. [2]

Of course, the exact triggering details depend on whether the propagation delay or UE location is used for assisting the NW. It needs to be also decided if the UE shall always report to the network that e.g. the timing/location difference becomes larger than threshold or can the UE apply a shift of the time window of switch to another configuration by itself, as it is proposed e.g. in [2][12].

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| **Question 4: How the assistance information for NTN SMTC adjustments is triggered? Please choose from the options below:**   1. **reporting is triggered when the difference between the NW configuration and UEs own measurement is above the configured threshold** 2. **If UE-location reporting is supported, triggering occurs when UE moves a distance exceeding a configured threshold** 3. **Validity timer for SMTC configuration – triggering when the associated neighbor cells cannot be detected based on configured SMTC for a period of time** 4. **Other** | | |
| **Company** | **Answer** | **Comments** |
| Ericsson | B preferred, A as backup |  |
| MediaTek | A is preferred |  |
| Apple | A |  |
| Lenovo, Motorola Mobility | A |  |
| Huawei, HiSilicon | C is preferred | Option A is a bit unclear. According to the proponent’s paper, “NW configuration” could refer to offset, MGL. But it is uncertain how the UE determines when the difference is above the threshold. Does it mean UE cannot detect SSBs in the SMTC window? Or does it mean the UE determines a SMTC configuration by itself and verifies whether the NW configuration is reasonable?  We think Option C is better, because when the SSBs of neighbour cells cannot be detected for a period of time, it means the current SMTC configuration needs to be updated. In this case, it is natural that the UE shall report the assistance information to help the NW adjust the configuration. |
| Qualcomm | B preferred.  Other (e) backup | Option (e) If UE cannot be configured with location report, then still measurement report triggering can be used. The measurement report can be either empty or indicate “not detected” for the configured measurement object. |
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It would be also beneficial to decide if the UE in NW-based solution needs to always report the assistance information and cannot perform any shifts within what has been configured (e.g. move the time window of particular SMTC by a configurable offset).

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| **Question 5: In the NW-based SMTC solution, can the UE shift the previously configured SMTC by a configurable offset instead of (or in addition to) reporting the assistance information?** | | |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | No | **Especially for gaps, it is essential for network to know when UE considers to have a measurement gap.** |
| MediaTek | No |  |
| Apple | Maybe | Could be useful as long as UE informs network |
| Lenovo, Motorola Mobility | See comments | UE should report to network if it shifts the SMTC to ensure aligned understanding. |
| Huawei, HiSilicon | No | For the network-based solution, if UE reports the assistance info, the NW should be able to provide accurate SMTC windows, and the UE should trust the configuration.  If the UE autonomously shifts the offset, it should fall into UE-based solution, which is another discussion. |
| Qualcomm | Yes | But this should be time-based shift. network should also indicate UE with SMTC validity time and after validity expire, UE can shift by the configured offset. This will avoid signaling overhead, meaning UE does not need to send UL message.  If network knows UE location, very good.  If network does not know UE location, any configuration provided by network will have same issue. Anyway network will provide configuration based on a reference point in a cell, e.g., cell center and also considering other assistance information.  UE anyway can send measurement report with “not detected” indication so that network can update the configuration. |
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## 2.3 UE-based mechanism for SMTC adjustments

One of the FFSs captured at RAN2#115 concerned the UE-based mechanism for SMTC/measurement gap adjustments. The following views are provided in the papers submitted to RAN2#116:

* RRCIDLE/RRCINACTIVE UEs they can measure SSB of neighbouring cells by adjusting the SMTC configuration in system information based on its location and ephemeris.[6]
* Support for UE-based SMTC adjustments [5] [12]
* UE-based SMTC/GAP Selection Scheme approach the UE needs explicitly or implicitly report the selected SMTC/measurement gap configuration to the NW to guarantee an alignment between the NW and the UE.[5]
* Preclude UE based SMTC/gap adjustment in R17 [3]
* UE can track the relative movement of neighbor cell’s SSB within the SMTC window and update the window/measurement gap when the time-wise movements exceed a threshold. The UE will inform the network about such SMTC/measurement gap configuration updates. [12]

As can be seen, there are companies openly supporting such UE-based scheme and those who suggest this option shall be precluded in Rel-17 NTN. One may notice, the NW-based solution, discussed based on the TDoc excerpts in section 2.1 and section 2.2 already largely resembles the UE-based approach. The only main difference may be that in NW-based approach the NW configures multiple SMTCs/MGs (unlike in UE-based approach where one configuration + UE-triggered shifts are proposed) and UE switches between them, but in a semi-autonomous way, as proposed in e.g. [2]. Thus, the effort to support also the so-called “UE-based SMTC adjustment” may not be that big, considering what kind of issues are already resolved or are to be resolved for NW-based solution.

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| **Question 6: Do you support a UE-based solution for SMTC adjustments, where the UE is allowed to perform configuration adaptation if a configured condition is met (e.g. time window moves by more than a preconfigured threshold, etc.)?** | | |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | No |  |
| MediaTek | Yes |  |
| Apple | Yes |  |
| Lenovo, Motorola Mobility | Yes |  |
| Huawei, HiSilicon | Yes but | It should be useful for Idle/Inactive mode UEs, because there’s no dedicated signalling for these UEs.  But the detailed solution can be further discussed. For instance, the UE can choose one SMTC windows from the multiple SMTCs broadcast by the NW. |
| Qualcomm | No | We have concern with UE signaling overhead. |
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## 2.4 On the activation of SMTCs and parallel use

Next thing to consider is how multiple SMTCs/measurement gaps are used in parallel. Are they separately configured and activated or perhaps all configured are active automatically? Is the UE capable of using all in parallel? The following can be extracted from the papers submitted to RAN2#116:

* NW dynamically activates the SMTCs using MAC CE [13]
* SMTC configured by the network cannot be deactivated [10]
* Use all configured SMTCs in parallel [11][6]
* If assistance information is applied UE should assume the network has optimized the SMTC/gap configuration and use all SMTCs/gaps instead of using only a partial set. [6]
* UE can use only a partial set of configured SMTCs in parallel based on network indication.[3]

At RAN2#116 the following has been agreed:

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| Agreements:  1. We don't introduce new mechanisms (e.g. based on MAC CE) to activate/deactivate SMTCs for NTN neighbour measurements. Which SMTCs the UE will consider is only based on RRC configuration (UE based solutions are not excluded by this). |

The above means there is no separate mechanism that would be needed to activate/deactivate already configured SMTCs. During the discussion it was asked whether it means the UE can/shall use all configured SMTCs in parallel or perhaps can use one at a time. In our understanding, the aforementioned agreement somewhat implies UE uses all configured SMTCs, without any further indication which shall be in use now. RAN2 is asked to express the view on the above aspect.

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| **Question 7: Do you agree the UE uses all configured SMTCs in parallel (i.e. no need to define how the UE switches between them)?** | | |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | Yes |  |
| MediaTek | No | Switching between multiple SMTCs could be more efficient than reporting multiple offsets, while dealing with SMTC changes. |
| Apple | Yes | We prefer a simple solution |
| Lenovo, Motorola Mobility | Yes |  |
| Huawei, HiSilicon | Yes | For NW-based solution, yes. For UE-based solution, the UE can choose the appropriate SMTC from the SMTCs provided by the network. |
| Qualcomm | No | SMTC/MG periodically must be updated. Either network explicitly configures with RRC signaling each time or network provides multiple configurations with time window when each configuration to use. |
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## 2.5 Stage-3 details

In several papers Stage-3 aspects have been also outlined:

* Additional SMTC are not included, but smtc1 can include up to 4 periodicityAndOffset [10]
* Introduce a list of cells that need /- offset to the SMTC configured by smtc1. [4]
* remove existing restriction to allow configuration of more than one measurement object with the same SSB frequency [4]

Obviously, there are many open question above, which needs to be answered first, before moving to defining Stage-3 details. However, it is perhaps beneficial to list some of those Stage-3 proposals now, also considering NR RRC running CR for NTN has been already circulated.

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| **Question 8: Do you agree to keep the ‘single smtc per MO principle’, but allow up to 4 periodicityAndOffset parameters to be provided per smtc?** | | |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | yes |  |
| MediaTek | FFS | Let’s agree to a baseline first. |
| Apple | Yes |  |
| Lenovo, Motorola Mobility | Yes |  |
| Huawei, HiSilicon | Yes | The multiple SMTCs differ only in offsets. |
| Qualcomm | No | Based on current running CR, the bullet 2nd (if only different offset needed) and bullet 3rd (if offset, periodicity, duration etc. also needed to be signalled differently) are already possible from RRC signalling point of view. |
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We believe agreeing multiple MOs for the same SSB frequency may not be needed, if RAN2 agreed to allow multiple SMTCs per MO (or multiple offsets per SMTC per MO).

## 2.6 Measurement gaps

Eventually, it has to be noted that most of the discussion concerns SMTC configuration specifically, while RAN2 needs to also address how to configure multiple measurement gaps. The following has been contributed:

* RAN2 to agree up to 4 measurement gap patterns for NTN UE and coordinate the RRC configuration details with other WI. [8]
* Multiple measurement gap patterns [14]
* Move the discussion on measurement gaps to WI: NR and MR-DC Measurement Gap Enhancements [10]
* Multiple MGs configuration is supported. [4]
* Measurement gap configuration without SMTC configuration is allowed. [4]
* More than one gap can be configured for different neighbour cells measurement. [1]
* In NTN it may be challenging for a UE to utilize the longest SMTC window within a measurement gap. [12]

As can be seen, some companies suggest the topic shall be addressed in another WI (NR and MR-DC Measurement Gap Enhancements). However, in our understanding, RAN2 is not entitled to make such decisions regarding the scope.

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| **Question 9: Do you think the measurement gap related aspects for Rel-17 NTN shall be still addressed in this WI? Please share more details in the Comments box.** | | |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | yes | **We prefer gaps to match the SMTC. However, we should check other WI agreements to avoid specifying same ASN1 impact from different WI.** |
| MediaTek | Yes | Agree with Ericsson’s views. |
| Apple | Yes |  |
| Lenovo, Motorola Mobility | Yes |  |
| Huawei,HiSilicon | Yes | Agree with Ericsson. |
| Qualcomm | Yes |  |
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Regarding the other aspects covered in the papers, it needs to be decided if multiple gaps or gap patterns are supported. In addition, how many measurement gaps/patterns can be supported in order not to impact the scheduling flexibility

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| **Question 10: Assuming the topic of measurement gaps is continued in this WI, how many gaps or gap patterns are needed? Please explain how measurement gap patterns are defined if you support this option.** | | |
| **Company** | **Answer** | **Comments** |
| Ericsson |  | **To match SMTC pattern** |
| MediaTek |  | As few as possible. |
| Lenovo, Motorola Mobility |  | Match SMTC pattern |
| Huawei, HiSilicon |  | Same view as MediaTek. |
| Qualcomm | 2 | Same view as MediaTek. |
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In the papers it was also raised how to ensure the gap is aligned with, e.g. SMTC window to be measured.

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| **Question 11: Do you think RAN2 should study how to ensure the gap is aligned with SMTC window to be measured?** | | |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | ? | **What does the study mean?** |
| MediaTek | Yes | We need to find some solution. |
| Lenovo, Motorola Mobility | No | We think network implementation can do the work. |
| Huawei, HiSilicon | No | In Rel-15, there’s no study on aligning SMTC and gaps. The alignment is up to implementation. No need to over-specify. |
| Qualcomm | No | Network can provide/update the SMTC and MG configuration for alignment. |
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Finally, it shall be identified which SMTC-related decisions can be also adopted for MGs.

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| **Question 12: Which SMTC-related decisions should be also adopted for measurement gaps in NTN?** | |
| **Company** | **Answer** |
| Ericsson | **All and ensuring SMTC related agreements are such that they make sense for gaps as well. Thus no UE based suffling of the window/pattern** |
| MediaTek | At least the Assistance Information can be reused for gaps. Further details can be agreed after we make some progress on SMTC. |
| Lenovo, Motorola Mobility | Agreements on UE assistance can be adopted. |
| Huawei, HiSilicon | Can be postponed after SMTC agreements are settled down. |
| Qualcomm | All those assistance information can be for both SMTC and MG configuration. |

# 3 Conclusion

The following proposals have been made in this document:

# References

1. R2-2109502 Discussion on mobility management for connected mode UE in NTN OPPO discussion
2. R2-2109634 Efficient Configuration of SMTC and Measurement Gaps in NR-NTN MediaTek Inc.
3. R2-2109638 Discussion on remaining issues on SMTC Intel Corporation discussion Rel-17
4. R2-2109972 SMTC and MG enhancements Qualcomm Incorporated discussion Rel-17
5. R2-2110267 Further discussion on SMTC and measurement Gap configuration for NTN CMCC
6. R2-2110277 Discussion on SMTC and measurement gap configuration Huawei, HiSilicon
7. R2-2110310 UE assistance for measurement gap and SMTC configuration in NTN Lenovo, Motorola Mobility
8. R2-2110340 Connected mode aspects for NTN Ericsson
9. R2-2110357 SMTC enhancement in NTN Sony
10. R2-2110384 SMTC and measurement gap enhancements LG Electronics Inc.
11. R2-2110469 Consideration on CHO and measurements ZTE corporation, Sanechips
12. R2-2110613 Final views on SMTC and measurement gaps for Rel-17 NTN Nokia, Nokia Shanghai Bell
13. R2-2110815 Measurements and handover Samsung Research America
14. R2-2111028 Discussion on connected mode aspects for NTN Xiaomi Communications
15. R2-2111166 Remaining Issues on SMTC and measurement Gap configuration for NTN Rakuten Mobile, Inc
16. R2-2111333 [103][NTN] Summary of SMTC/gaps aspects in AI 8.10.3.3 Nokia

# Annex A: SMTC/gaps related agreements

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| **1. For Rel-17 NTN, Rel-17 NR operation is enhanced (e.g. the SMTC configuration and UE measurement gap configuration) aiming to address the issues associated with the different/larger propagation delays, and the satellites (considering e.g. their deployment, mobility, height, minimum elevation and prioritizing typical NTN scenarios).**  **2. Rel-17 NTN will not rely only on network implementation to address the issue explained in agreement 1.**  **3. Enhancements of the SMTC configuration is supported for Rel-17 NTN.**  **4. Optional new UE assistance is defined in Rel-17 NTN for network to properly (re)configure the SMTC and/or measurement gap**  **Agreements - via email (from offline [106])**  **1. For Rel-17 NTN, one or more SMTC configuration(s) associated to one frequency can be configured. FFS solution details.**  **- The SMTC configuration can be associated with a set of cells (e.g., per satellite or any other suitable set per gNB determination).**  **- The multiple SMTC configurations are enabled by introducing different new offsets in addition to the legacy SMTC configuration. FFS how the offsets will be managed/signalled.**  **FFS the following open questions:**  **(a) can the UE be configured with multiple SMTCs per carrier and use them all in parallel?**  **(b) How the NW knows which SMTC (incl. offsets/periodicity, etc.) is relevant for a particular UE?**  **(c) Is there any validity: in time or for certain location only, foreseen in such multiple SMTC configuration?**  **(d) What is the potential impact on the signalling, assuming this delay is a dynamic value?**  **(e) What about the feeder link delay? Is it considered anywhere?**  **2. The configuration of one or multiple offsets is left up to the network implementation.**  **3. It is up to network to update the SMTC configuration of the UE to accommodate the different propagation delays.**  **RAN2#115:**  Offline 112  1. The specific maximum number of SMTC configuration in one measurement object with the same ssbFrequency can be 4. And a LS will be sent to RAN4 to confirm the conclusion.  2. In NTN, NW-based solution is supported, i.e. the final SMTC/measurement gap configuration is generated and provided by NW in NTN to a given UE (based on the propagation delay difference between at least one target cell and the serving cell of a given UE). FFS whether UE-based solution is supported or not.  3. In NTN, it is necessary of the UE to report assistant information to the NW (which can be configured by NW or upon NW’s request) to assist NW calculating the offset for SMTC/GAP configurations. FFS the detailed information.  Agreements:  1. The UE can be configured with multiple SMTCs per carrier. FFS if the UE can use only a partial set or all of them in parallel, and in case FFS whether based on network configuration or UE implementation |