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%3A%5CData%5C3GPP%5CRAN2%5CInbox%5CR2-2111333.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. |
| Intel | b | With the knowledge of ephemeris, NW can also predict the trend of SMTC/Gap adjustment, and provide updated configuration accordingly. If only propagation delay is reported, a more frequent reporting may be foreseen. |
| Xiaomi | b) or a) | If SA3 agrees UE location report with user consent and gNB has user consent, UE could report UE location as assistance information. Otherwise, UE can report propagation delay difference for SMTC/Gap configuration.So, we should wait for SA3 response. |
| ZTE | 1. Delay report using SFTD
 | * We prefer to reuse the existing SFTD to assist SMTC/gap configuration in NTN and there is no need to define a similar procedure with the same purpose while we have already had one.
* If we reuse SFTD, there is no need to divide the delay different into two parts: service link and feederlink as the reported value from UE would cover both.
 |
| CATT | b firsta second | If location report can be agreed, we don’t suggest any other reporting. Otheriwise, we can consider a). |
| Sony | Either b) or a) |  |
| LGE | a) propagation delay | If the UE location is reported, than UE should report again when UE travels more than a certain distance. While UE is stationary, the UE will not report the location again, but the NTN cell keeps moving, so NW should keep calculating the propagation delay based on the NTN cell movement, and update the SMTC/gap configuration, even when the AI is not updated. However, in option a), the AI will be reported whenever the propagation delay is changed more than a certain value. NW need to update the SMTC/gap configuration only when the AI is reported. Therefore, option a) is simpler in NW implementation perspective. |
| Samsung  | b | Wait for SA3 response. |
| OPPO | a) | Propagation delay difference between serving cell and neighbor cells |
| Spreadtrum | b) or a) | If security is confirmed by SA3, UE location is preferred, otherwise, propagation delay is OK. |
| ETRI | a) | We prefer to use propagation delay. |
| CMCC | a  | Since UE location reporting requires User Consent, which may not be always available, it cannot work for all the UEs.Propagation delay difference is the most straightforward information which can be used to assist SMTC/Gap configuration directly.Moreover, the network can acquire the feeder link propagation delay difference to assist SMTC/measurement gap configuration. So, UE only need to report the service link propagation delay difference as the assistance information for SMTC/measurement gap configuration. |
| vivo | Either a) or b) | It is beneficial to UE since the UE does not need to convert location information to propagation delay. But whether the UE can report the UE location information depends on SA3’s feedback. |
| Nokia | b) | We think the UE location reporting (if agreed by SA3) is a better choice, as it can serve multiple purposes. It is true it will not change if the UE is stationary, while the satellites are still moving. However, the NW is likely to be aware of the ephemeris, so it can figure out the up-to-date propagation delay and necessary shift to apply. |
| Rakuten Mobile | Propagation Delay | Due to security and privacy concerns. |

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). |
| Xiaomi | c) | It can be used to configure SMTC/gap directly |
| ZTE | a) | * We prefer to reuse the existing SFTD to assist SMTC/gap configuration in NTN and there is no need to define a similar procedure with the same purpose while we have already had one.
* If we reuse SFTD, there is no need to divide the delay different into two parts: service link and feederlink as the reported value from UE would cover both.
 |
| CATT | c) |  |
| Sony | c) |  |
| LGE | a, b, c, d | All options are acceptable to us.In option b and d, UE needs to report the propagation delay of the serving cell also, but it is normal to report the measurement result of serving along with the measurement result of neighbour cells. |
| OPPO | c) | It can be used to configure SMTC/gap directly |
| Spreadtrum | c) | Delay difference of service link propagation is straightforward. |
| ETRI | c) |  |
| CMCC | c) | Pls. See our comments to Q1. |
| vivo | b) or c) | If really propagation delay based manner is adopted, these two options are simple for both the network and UE. |
| Nokia | c) | Delay difference would be a better choice than absolute delay value (option b), as this will show some trend.  |
| Rakuten Mobile | b),c) |  |
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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. |
| Xiaomi | We think feeder link delay component can be compensated by NW, NW know the location of NTN Gateway and satellites.If UE need to estimate the propagation delay of neighbour cell or propagation delay difference, the neighbour cell ephemeris information should be provided to UE. |
| ZTE | If we reuse SFTD, there is no need to divide the delay different into two parts: service link and feederlink as the reported value from UE would cover both. |
| CATT | Neighbour cell ephemeris is needed to calculate the propagation delay of neighbour cell. And the propagation delay in feeder link can be compensated by NW. It is tricking that NW configures the propagation delay in feeder link for UE getting the total delay, and then report the total delay. The calculation procedure can be done in NW. |
| Sony | Neighbour cell ephemeris information should be provided to UE in order to calculate the propagation delay.Feeder link delay is compensated by network. |
| Samsung | If UE location is reported to assist network, network has to know neighbour cell ephemeris and feeder link delay. And it’s up to network implementation how serving gNB can know these information, e.g. neighbour satellite ephemeris and feeder link delay can be provisioned to gNB in NTN deployment and identified based on UE location information. |
| OPPO | Agree with Xiaomi that feeder link delay component can be compensated by NW, because NW knows the location of NTN Gateway and satellite positions. |
| Spreadtrum | Based on the neighbour cell ephemeris, gNB could acquire the feeder link delay difference. |
| ETRI | The feeder link delay can be compensated by the network. The UE provide the service link delay difference with the neighbour cells.  |
| CMCC | In our mind, if we go to C , only additional neighbour cell ephemeris for service link delay is needed for UE, where the network can acquire the feeder link propagation delay difference by itself. |
| vivo | Information of Feeder Link related delay can be obtained by network implementation. No extra Spec impact is needed. |
| Nokia | Ephemeris is needed to calculate how to measure the neighbours. OK to assume the NW is responsible for compensating the FL delay, if that is what the majority wants. This could be somewhat problematic for the IDLE mode, where the UE also measures the neighbours (can everything be provided via SI?). |
| Rakuten Mobile | Agree with others, based on neighbour cell ephermeris, gNB can acquire feeder link delay difference. |

## 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. |
| Intel | a | It’s basically the same as “the associated neighbour cells cannot be detected based on currently enabled SMTC for a period of time” |
| Xiaomi | C) or d) | Option d): If UE-location reporting is supported, we can reuse the agreement of UE location report trigger which has been discussed in NTN LCS and follow its progress.If UE assistance information is defined as propagation delay related information, option c) may be better. |
| ZTE | d) | We prefer to reuse SFTD and the existing triggers can also be used. |
| CATT | B |  |
| Sony | a) | In our understanding, option A can work for both scenarios where e.g. either a UE can’t detect neighbour cell’s SSB or the difference between network’s SMTC/measurement gap configuration and UE’s own calculation (UE can calculate it based on e.g. neighbour cell ephemeris and possibly UE’s location) is above a threshold which is configured by network.  |
| LGE | a, c | a) and c) are very similar. If the difference between the NW configuration and UEs own measurement is above the configured threshold, the UE may fail to measure the associated cells. |
| Samsung |  | RAN2-115e has agreed working assumption in 8.10.3.1 that “Event triggered-based UE location reporting are configured by gNB to obtain UE location update of mobile UEs in RRC\_CONNECTED”. We should wait until that WA is agreed and event is defined, and the defined event can be adopted here for SMTC/MG, no additional mechanism is needed. |
| OPPO | d) periodical reporting | Whether and how to adjust SMTC offsets is up to NW implementation. UE location trigger is not reliable. Even though UE does not move, due to satellite’s move, SMTC offsets need to be adjusted. |
| Spreadtrum | C) | Timer based report is simple and friend to power consuming. |
| ETRI | a) |  |
| CMCC | Prefer a) |  |
| vivo | a) is preferred |  |
| Nokia | a) and b) | We support both a) and b). All depends also on which assistance information reporting will be specified. |
| Rakuten Mobile | a) | Also, mentioned in our paper [15] |

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. |
| Intel | No | This should be under network control. |
| Xiaomi | Maybe | If NW knows UE location information, NW can configure suitable initial SMTC configuration and offset based on UE location and ephemeris info due to the predictable satellite movement. Based on NW configuration, UE can update SMTC window and NW and UE have same understanding for SMTC configuration. If NW don’t know UE location, NW can’t configure suitable initial SMTC configuration and offset. So, this solution cannot work well. |
| ZTE | No | We understand NW-based solution would be sufficient. |
| CATT | Maybe |  |
| Sony | Maybe | UE can report the shift to network. |
| LGE |  | If UE is allowed to shift the configured SMTC/gap without NW command, the UE should report the assistance information so that the UE and NW can have the same understanding on the SMTC/gap. Please note that there is no use if SMTC is only sifted without shifting measurement gap. |
| Samsung | No | For NW-based solution, network configures UE to shift SMTC window. |
| OPPO | No | For NW-based solution, UE should not autonomously shift the window and only do as NW configures. |
| Spreadtrum | No | Network could guarantee the accuracy of SMTC window, so the extra UE report is not needed. |
| ETRI | No | UE can report the network that the shift is required. The shift should be configured by the network.  |
| CMCC | Yes | This could enable the UE timely refresh the SMTC or GAP configuration to compensate the delay variation from the satellite’s moving. |
| vivo | No | The network can configure/update the appropriate SMTC(s) based on the assistance information reported by the UE. |
| Nokia | No | We are OK to keep the NW-based solution as a fully NW-side controlled solution – UE just reports, NW adjusts and sends the new configuration. However, a separate question is whether we also support a UE-based solution (next question).  |

## 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. |
| Intel | No | When NW based solution can work well, no need to consider other optimizations. |
| Xiaomi | No | In R17, NW-based solution is enough. |
| ZTE | No | We understand NW-based solution would be sufficient. |
| CATT | No |  |
| Sony | Yes |  |
| LGE | No | We already have NW based solution. We cannot see any justification to have another solution. |
| Samsung | No | NW-based solution can resolve the issue in Rel-17, UE-based solution can be considered for future enhancement. |
| OPPO | No |  |
| Spreadtrum | No | Smart gNB could configure the window correctly. |
| ETRI | Yes |  |
| CMCC | Yes | Taking into account the characteristics of the NTN network ,i.e. the satellite keep in sweeping, to provide more flexibility and reduce the signalling overhead for frequent assistant information reporting, we prefer to support UE-based SMTC/Gap configuration solution. |
| Nokia | Yes | UE-based solution is well-justified, contrary to what some companies said above, as it allows to avoid the signalling overhead. It is also in fact quite similar to NW-based solution, where the UE anyway monitors the drift and reports to the NW. Here the UE would be allowed to shift the configuration by allowed step.  |
| Rakuten Mobile | No | Different UE’s may have different behaviour, not recommended for network operator. |

## 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. |
| Intel | Yes |  |
| Xiaomi | Yes |  |
| ZTE | Yes |  |
| CATT | Yes | We think that more than one SMTC is aim to apply the different propagation delay of neighbor cell. If NW doesn’t want UE to measurement the one of the neighbor cell, NW can configure less than 4. |
| Sony | Yes |  |
| LGE | Yes |  |
| Samsung | No | Different SMTCs/MG can be used by UE over time, signalling to switch between configured SMTCs is more flexible than sending SMTCs/MG configuration every time.  |
| OPPO | Yes |  |
| Spreadtrum | Yew | If UE does not use all the configured SMTCs, it shall indicate to gNB which SMTC is used and which is not used. Some extra indications shall be introduced, which is too complex for Rel-17.  |
| ETRI | Yes |  |
| CMCC | No | We prefer to use a partial set or all of the multiple SMTCs based on network configuration. In other word, it is left to UE implementation. |
| vivo | Yes | In our view, if the network provides multiple SMTC configurations, the network expects the UE to apply all the configurations. So the UE should follow the intention of the NW instead of only using a partial set of the configurations. |
| Nokia | Yes | Considering our online agreement, we think it is OK to assume the UE measures within all currently configured SMTCs. |
| Rakuten Mobile | Yes |  |

## 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. |
| Intel | FFS | It could be discussed in running CR offline after we have more detailed agreements. |
| Xiaomi | Yes |  |
| ZTE | FFS | It could be discussed in running CR offline. |
| CATT | Yes |  |
| Sony | FFS |  |
| LGE | Yes |  |
| Samsung | FFS |  |
| OPPO | FFS |  |
| Spreadtrum | Yes |  |
| ETRI | Yes |  |
| CMCC | Yes |  |
| vivo | Yes | In RAN2#113bis-e, RAN2 agreed that “The multiple SMTC configurations are enabled by introducing different new offsets in addition to the legacy SMTC configuration.” So we think it is a reasonable way of signalling. |
| Nokia | Yes | But also OK to move that to the running CR discussion, outside of this meeting. |

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 |  |
| Intel | Yes | Working assumption about gap adaptation can be made first, then we could check with the progress in gap enhancement WI to avoid conflict. |
| Xiaomi | Yes | Agree with Ericsson. |
| ZTE | / | We understand it is up to RAN4 to decide the gap and there is an ongoing RAN4 WI on concurrent gap which aims to define multiple gap/gap patterns. We can identify the NTN specific requirements for the concurrent gap with the detailed solution or RAN2 impact discussed under agenda item 8.22 for NR and MR-DC gap enhancements. |
| CATT | Yes | Agree with Ericsson. |
| Sony | Yes |  |
| LGE |  | Basically, we think the all enhancements RAN2 has agreed for SMTC should be applied to the measurement gap also, since the inter-frequency measurement can be performed only within the configured measurement gap. However, if companies have different thought and we don’t have enough time to have separate discussion on measurement gap, it would be better to move the discussion no measurement gap to WI: Measurement Gap Enhancements |
| Samsung | Yes | Agree with Ericsson |
| OPPO | Yes |  |
| Spreadtrum | Yes | Agree with Ericsson. |
| ETRI | Yes |  |
| CMCC | Yes | We could try to keep match between gaps and SMTC configuration when design the detailed gaps configuration. |
| vivo | Yes |  |
| Nokia | Yes | Let’s try to work out RAN2-related measurement gaps details for NTN in this WI. Of course, the awareness what happens in other WIs and RAN WGs is desirable. |
| Rakuten Mobile | yes |  |

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. |
| intel |  | Same view as MediaTek. |
| Xiaomi |  | Same view as MediaTek. |
| ZTE |  | We understand it is up to RAN4 to decide the gap and there is an ongoing RAN4 WI on concurrent gap which aims to define multiple gap/gap patterns. We can identify the NTN specific requirements for the concurrent gap with the detailed solution or RAN2 impact discussed under agenda item 8.22 for NR and MR-DC gap enhancements. |
| CATT | 4 | To match SMTC pattern |
| Sony |  | Same view as MediaTek. |
| LGE | At least 4 gaps | But the maximum number can be decided by RAN4. |
| Samsung | At most 4 | Support multiple measurement gap patterns, no larger than the number of SMTC patterns. |
| OPPO |  | Match SMTC pattern |
| Spreadtrum |  | Match SMTC pattern. |
| ETRI |  | It should be to match the SMTC pattern. |
| CMCC |  | Try to match SMTC configuration. |
| vivo |  | Following the existing principle, measurement gap should match SMTC pattern. |
| Nokia |  | Agree with preceding comments – measurement gaps shall match the SMTCs. Thus, at most 4 gaps are needed, but a lower number is also OK (2, as suggested by QC), as we are not sure the UE will have so many inter-frequency NTN neighbours to measure in parallel. |
| Rakuten Mobile |  | To match SMTC configuration/  |

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. |
| Intel | No | It’s up to NW implementation. |
| Xiaomi | No | It is up to NW implementation. |
| ZTE | No | NW implementation. |
| CATT | No | It is up to NW implementation. |
| Sony | No | It is up to NW implementation. |
| LGE | No | NW should ensure the gap is aligned with SMTC. |
| Samsung | No | Once SMTC window is determined based on UE assistant information, the measurement gap can be determined accordingly up to network implementation. |
| OPPO | No | It is up to NW implementation. |
| Spreadtrum | Yes | It is due to NW implementation. |
| ETRI | No | It is up to NW implementation |
| CMCC | No | Up to NW implementation may be enough. |
| vivo | See comment | From our perspective, it’s up to NW implementation to ensure that the gap is aligned with SMTC window to be measured. |
| Nokia |  | Agree this should be configured together with SMTC in NW-based solution. Then, for a short term, there may be the alignment ensured. However, we are concerned with so many measurement gaps introduced in parallel (which definitely will impact the scheduling flexibility).  |

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. |
| Intel | At least the assistance information related part  |
| Xiaomi | At least agreements on UE assistance information can be reused. Other agreements on SMTC need further discussion and we can wait for the progress on SMTC. |
| ZTE | We understand it is up to RAN4 to decide the gap and there is an ongoing RAN4 WI on concurrent gap which aims to define multiple gap/gap patterns. We can identify the NTN specific requirements for the concurrent gap with the detailed solution or RAN2 impact discussed under agenda item 8.22 for NR and MR-DC gap enhancements. |
| CATT | At least the assistance information related part |
| Sony | Agree with MediaTek. |
| LGE | Agree with Ericsson. |
| Samsung | Agree with Xiaomi. |
| OPPO | Agree with Xiaomi. |
| Spreadtrum | The agreements for UE assistance information can be reused. |
| ETRI | Agree with MeidaTek. |
| CMCC | All agreements about SMTC so far may be considered. |
| vivo | We share the same views with MediaTek, assistance information is needed for the NW to configure the measurement gaps. |
| Nokia | Agree that at least the UE assistance information shall be used for proper measurement gap configuration.  |
| Rakuten Mobile | Agree with Ericsson. |

# 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 1121. 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 |