3GPP TSG RAN WG2 Meeting #113bis-e R2-17xxxxx

**Electronic meeting, 12th-20th April 2021**

**Agenda item:** 8.12.3.1

**Source:** Intel Corporation

**Title:** Summary of offline 106 - [NTN] SMTC and gaps - first round

**Document for:**  Discussion and decision

# Introduction

The intention is to continue the email discussion [post113-e][108][1] as part of the offline Summary of offline 106 - [NTN] SMTC and gaps with the following scope.

* Initial scope: Continue the discussion on p3.1, p7 and p12 and p13 from [R2-2102866](file:///C:\Data\3GPP\Extracts\R2-2102866_post113-e_108_NTN_SMTC_MeasGap.docx) [1].
* 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): **Wednesday 2021-04-14 22:00 UTC**
* Initial deadline (for rapporteur's summary in R2-2104365): **Thursday 2021-04-15 02:00 UTC**
  + Proposals marked "for agreement" in R2-2104365 not challenged until Thursday 2021-04-15 14:00 UTC will be declared as agreed via email by the session chair.
  + For the rest the discussion will continue in a second round of the offline discussion until Monday 2021-04-19. Further details on the scope/intended outcome/exact deadlines to be announced by the session chair after Thursday 2021-04-15 14:00 UTC.

This discussion also considers the agreements taken in this RAN2#113bis-e meeting (copied here below) and the inputs provided by companies in the related email discussion #108 [1] (report summary for the selected proposals is included in Annex for quicker reference) as well as in the related TDocs [2]-[9].

*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.*

# Discussion

## SMTC configuration

RAN2 agreed to enhance the SMTC configuration for Rel-17 NTN. This section aims to discuss key questions raised and further clarify on the proposed solution aiming to find a common agreeable solution.

Some companies raised the concern that the support of multiple SMTC configurations with multiple measurement objects is already possible from legacy signaling. Moreover, it was also clarified that if several neighbour cells with same SSB frequency belong to different satellites, multiple SMTCs have to be provided in order to detect SSB from different satellites. On other hand, legacy operation only allows up to 2 SMTC configurations.

1. For Rel-17 NTN, do you agree to enable the usage of one or more SMTC configuration(s) e.g. with one or more offset(s) or SMTC periodicity/duration associated to each SMTC configuration? If not, please explain your concern or aspect to further clarify.

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| **Company’s name** | **Yes/No** | **Company’s comments (if any)** |
| Samsung | Yes/No | The offset concept can potentially be used with enhanced version of legacy signaling |
| MediaTek | Yes (Different Satellite) | Each SMTC window can be configured for each neighbor satellite after compensating for propagation delay difference. |
| Huawei, HiSilicon | Yes | In current spec, the SMTC is configured per MeasObjectNR, and we understand the discussion point is actually whether to allow more than 2 SMTC configurations for one MeasObjectNR.  But if it aims to add more offset or periodicity for one SMTC configuration, we see there is no expansion room for IE SSB-MTC. |
| Lenovo | Yes | An offset or duration for each neighbour satellite with different propagation delay to UE can be considered. |
| Qualcomm | Yes |  |
| Apple | Yes |  |
| Spreadtrum | Yes |  |
| CMCC | Yes | SMTC configuration should match the propagation delay. |
| ZTE | Yes, for some cases | We share similar understanding with HW that the discussion point is whether to allow more than 2 SMTC configurations per MO.  We understand additional SMTC configuration is needed for the case when configuring UE to measure neighbor cells deployed in the same frequency but served by satellite in orbits varying greatly. |
| Rakuten Mobile | Yes | Agree with Mediatek. |
| Xiaomi | Yes | In NTN system, the propagation delay difference between serving satellite and neighboring satellites may be quite larger. One or more SMTC configuration(s) can be better applied to NTN system with different and large propagation delay. |
| LGE | Yes | Since NTN cells on the same frequency, that have different orbit, can have different propagation delay, the SSB burst of neighbour NTN cell may be invisible within the measurement window configured based on the timing of PCell. In order for SSB bursts transmitted with different propagation delay to appear within different measurement window, separate measurement window with different timing should be configured for cells having different propagation delays. |
| Ericsson | yes |  |
| ITRI | Yes | Each SMTC offset can be configured for a group of cells for a valid time period. Network may provide multiple SMTC configuration to UE. |
| ETRI | Yes | We share the view that more than 2 SMTC configuration per MO can be supported in Rel-17 NTN. |
| Nokia | Not necessary | Please note this does not resolve the problem, as this has to be considered from the UE’s point of view. When the UE is configured with multiple SMTCs/offsets, these are valid for just a short period of time (as the satellites are moving fast). Thus, this would either require the NW to configure a high number of SMTCs/offsets or frequently reconfigure the UEs (somehow following their location), causing large signaling impact. |
| Vodafone | Yes |  |
| OPPO | Yes | Agree with MediaTek. |
| Intel | Yes |  |
| Convida | Yes | To address the issues associated with the different/larger propagation delays, and the satellite deployments, orbits, altitudes, etc., we suggest enabling the usage of one or more SMTC configuration(s). |
| Sequans | Yes |  |

1. If yes for Discussion point 1), do you agree that SMTC configuration can be associated with one or more cells (satellites), i.e. legacy signaling approach is maintained? If not, please explain your concern and/or preference.

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| **Company’s name** | **Yes/No** | **Company’s comments (if any)** |
| Samsung | Yes | We have two types of neighbors of the current serving cell for quasi-Earth-fixed beams: current physical neighbors of the serving cell for existing beams and upcoming/future neighbors for future beams that would cover the same geographic area. Furthermore, one SMTC configuration can be used to detect one set of cells and another SMTC configuration can be used to detect another set of cells. Finally, since propagation delays would be different for different sets of neighbor cells, including the timings for the validity of the SMT configuration would be quite important. For example, the UE can use one SMTC configuration to detect neighbor cells between t1 and t2 and another SMTC configuration to detect neighbor cells between t2 and t3. |
| MediaTek | Yes | Legacy signaling approach can be maintained to associate different SMTCs with different satellites. |
| Huawei, HiSilicon | Yes | In current IE SSB-MTC2, pci-List field is included to indicate which cell can use this SSB-MTC2. The same approach can be reused. |
| Lenovo | Yes | An offset or duration for each neighbour satellite with different propagation delay to UE for SMTC configuration. |
| Qualcomm | Yes | Up to network how it configures. |
| Apple | Yes | We can let the network configure this as mentioned by Qualcomm. |
| Spreadtrum | Yes | Legacy signaling approach can be reused. |
| CMCC | Yes | We could reuse legacy signaling framework, and extend the number of SMTCs for propagation delay difference between different neighbour satellite and serving satellite. |
| ZTE | FFS | We understand the signaling structure can be discussed after we agree on the solution direction. |
| Rakuten Mobile | Yes | But not clear what legacy signaling approach means in this case.  SMTC /Meas Gaps need to be defined dynamically. Not clear how it can be done with legacy signaling. |
| Xiaomi | Yes | SMTC configuration can be associated with one or more satellites to apply to different propagation delay. Legacy signaling approach can be the baseline for SMTC configuration in NTN. |
| LGE | No | The offset value is the only parameter that needs to be differently configured to cover SSB bursts transmitted with different propagation delay, so the parameter *periodicityAndOffset* can be associated with one or more cells. |
| Ericsson | yes |  |
| ITRI | Yes | It could be up to network configuration. |
| ETRI | Yes | One SMTC configuration can be used to measure one or more cells, the same as the legacy behavior. |
| Nokia | No | Per cell configuration does not help, as the delay would be still different for UEs located in different spots within that cell. So keeping the legacy or adding the same principle to the new solution does not help. |
| Vodafone | Yes | Legacy signaling can also be used |
| OPPO | Yes | Each SMTC configuration should be associated with a cell group with similar propagation delay difference compared with that for serving cell. |
| Intel | Yes |  |
| Convida | Yes | We agree that SMTC configuration can be associated with one or more NTN cells (satellites). |
| Sequans | Yes |  |

1. If yes for Discussion point 1), do you have any preference on how to define the multiple SMTC configurations considering e.g.
2. Offset(s)
3. SMTC periodicity/duration
4. Others

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| --- | --- | --- |
| **Company’s name** | **Option(s)** | **Company’s views** |
| Samsung | c [can be used with a and b] | One SMTC configuration can be used to detect one set of cells and another SMTC configuration can be used to detect another set of cells.  Include the timings for the validity of the SMT configuration so that the UE can use one SMTC configuration to detect neighbor cells between t1 and t2 and another SMTC configuration to detect neighbor cells between t2 and t3. |
| MediaTek | a) | Using an offset is necessary to match different RTTs experienced by different satellites. |
| Huawei, HiSilicon | a | Since the intention is to sync up with different satellites, we think offset is more useful than other parameters. |
| Lenovo | a) | We prefer an offset for each neighbour satellite with different propagation delay to UE. Periodicity may not be flexible in configuration. |
| Qualcomm | (a) + (b) | This is not only providing (b). Only (a) or both (a) + (b). And (a)/(a)+(b) is already possible to signal (without any change in signaling). |
| Apple | a |  |
| Spreadtrum | a | It is enough to use different offset for satellite with different propagation delay. |
| CMCC | a + b | We seek to allow one offset or SMTC periodicity/duration to be associated to one neighboring satellite group. And the neighboring satellites within the group own similar propagation delay difference to serving satellite. |
| ZTE | a + c | If we go for the direction to allow SMTC configuration per satellite, we would prefer to have full flexibility in the configuration, including offset, periodicity, duration, etc.  For option a), we understand it would be a new offset cater for the differential delay, which is also useful. |
| Rakuten Mobile | a + b | We agree with CMCC that one offset and/or SMTC periodicity/Duration can be associated with neighboring satellite group (for particular time) |
| Xiaomi | a) | Option a) is a simple way and NW can configure different offsets associated with different neighboring satellites based on the propagation delay difference between serving satellite and these neighboring satellites. Option a) is enough for SMTC configuration in NTN systems. |
| LGE | Option A |  |
| Ericsson | Depends how question is understood | Signaling should enable one SMTC per list of PCIs to enable SMTC “per satellite”. FFS how many different SMTC UE can be configured simultaneously.  For each SMTC associated with a list of PCIs, one should be able to configure independently offset, periodicity and duration.  Then one SMTC can be, once configured, shifted by offset by the network to accommodate changes in the propagation delay. The UE should not do any offset scaling for the configuration. (UE is free to measure outside of the window if it can but SMTC is as configured by network) |
| ITRI |  | Offset can be utilized to handle the propagation delay difference between satellites. |
| ETRI | Option a and b | Multiple SMTC window can be defined with offsets to cover the different propagation delay. Each SMTC window can have the same periodicity and duration. Different SMTC periodicity and duration also can be used with offsets. |
| Nokia | c) | One SMTC configuration and the UE is allowed to shift its measurement window in time once it discovers the SSBs are shifted by more than a configurable threshold. |
| Vodafone | a + b | the Offset and Periodicity should the starting point , and other parameters could be added if found necessary |
| OPPO | a | The offset value for each SMTC configuration depends on the propagation delay difference for the cells associated with this SMTC configuration compared with that for serving cell |
| Intel | a |  |
| Convida | a) and b) | Multiple SMTC configurations can be defined per NTN cell(s) types, e.g., HAPS, LEO, MEO, GEO and altitudes with consideration of the propagation delay delta(s). General methods to address these propagation delay deltas via option A or B are both acceptable solutions. |
| Sequans | a) and/or b) |  |

1. For option (a) of Discussion point 3), do you have any preference on how to define the offset(s) e.g. in relation to the propagation delay of the serving cell (satellite) and neighbor cells (satellite(s)) and multiple SMTC configurations? Note: this discussion point aims to clarify the solution details although the question might be more related to stage-3 discussion.

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| **Company’s name** | **Company’s views** |
| Samsung | We suggest the use of the serving cell as the timing reference and make use of propagation delay differences between (i) UE-serving cell delay and (ii) UE-a set of neighbor cells with similar distances. We should have different sets of neighbor cells based on propagation delay differences. |
| MediaTek | The offset is calculated by the network using differences in RTT between serving and neighbor satellites at cell edge. This is then used to appropriately configure SMTC on the serving cell using serving cell timings. |
| Huawei, HiSilicon | The exact value can be configured by network, and existing IE SSB-MTC can be reused. |
| Lenovo | Configured by network considering the delay difference between serving and neighbor satellites, which could be obtained by UE assistance information. |
| Qualcomm | This is up to network whether it provides them considering different satellites or different RATs or different cells and their differential delays. |
| Apple | Leave it up to network to configure. |
| Spreadtrum | gNB may configure SMTC based on the UE assistance information. |
| CMCC | The offset could be configured by NW considering different RTT. |
| Rakuten Mobile | UE report the delay difference based on neighbor cells ephemeris. |
| Xiaomi | NW can configure different offsets based on the propagation delay difference between serving satellite and different neighboring satellites. The propagation delay difference can be reported by UE. |
| LGE | The parameter *periodicityAndOffset* can be associated with one or more cells. |
| Ericsson | Offset is per SMTC configuration for a list of PCIs. Offset can be tuned by network. |
| ITRI | The serving cell timing is adopted for timing reference. Offset can be configured based on the propagation delay difference between serving and the interest cells. UE assistant information may be needed. |
| ETRI | The offsets per SMTC are configured by the network based on UE assistance information of differential propagation delay to neighbor cells. |
| Vodafone | The offset is a network related configuration and also RTT of the orbiting satellite (depending on the altitude above the ground etc.) |
| OPPO | The offset should be configured explicitly by network. How to configure the offset depends on network implementation. |
| Intel | We share the view from other companies that this can be left up to network implementation. |
| Convida | We suggest determining a timing relationship between serving and neighbor NTN cell(s) based on the propagation delay delta. This could be further determined with UE assistance/measurements such as (DL timing measurements from different NTN cells, etc.). This may enable the UE to calculate the timing offset to compensate the propagation delay difference between the serving NTN cell and neighboring NTN cell(s). |
| Sequans | Configured by the network. |

1. For option (b) of Discussion point 3), do you have any preference on how to define the different/additional SMTC periodicity/duration? Note: this discussion point aims to clarify the solution details although the question might be more related to stage-3 discussion.

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| **Company’s name** | **Company’s views** |
| Samsung | No specific preference as long as we have (i) time validity of SMTC configurations for different sets of neighbor cells and (ii) multiple cells of a given set sharing the same SMTC for search for signaling efficiency and effective neighbor search. |
| MediaTek | We do not see a reason why the SMTC periodicity or duration would change for different satellites in the same network. |
| Huawei, HiSilicon | We figure we only need to support different offset values, and other parameters can be the same. |
| Lenovo | We prefer an offset for each neighbour satellite with different propagation delay to UE. Periodicity may not be flexible in configuration. |
| Qualcomm | It is (a) + (b), meaning if multiple SMTC configurations are needed, current signaling structure already allows network to configure two measurement objects for two different satellites whether SSBs are in same frequency or not. Now in those two MOs, only offsets can be different, and periodicity/duration can be same. |
| Apple | From our view too, only offset should be sufficient. |
| Spreadtrum | Only offset is needed. |
| CMCC | We seek to allow one SMTC periodicity/duration to be associated to one neighboring satellite group. And the neighboring satellites within the group own similar propagation delay difference to serving satellite. |
| Rakuten Mobile | Based on UE feedback on number of Neighbors with different delay variations. |
| Xiaomi | We prefer using different offsets for SMTC configuration, which is a simple and sufficient way. |
| Ericsson | For each SMTC associated with different list of PCIs, one should be able to configure independently offset, periodicity and duration. This is controlled by network. |
| ITRI | May not need to enhance the configuration of periodicity and duration. |
| ETRI | Different SMTC periodicity and duration also can be used with offsets. |
| Nokia | We think multiple periodicities/durations for SMTC are not needed. |
| Vodafone | SMTC Periodicity would change / alter depending on the position of the satellite and its orbit above the ground.  Fixed SMTS periodicity could work provided the movement of the satellite is predictable and constant |
| OPPO | We don’t see any motivation to support multiple SMTC periodicity/duration configuration. |
| Convida | We suggest the different/additional SMTC periodicity(ies)/duration(s) are determined/defined based on, e.g., satellite ephemeris, NTN cell type, perhaps some UE assistance, etc.  Based on this information, the network and UE can establish timing relationship(s) between serving and neighbor NTN cells to determine appropriate SMTC configurations and any associated offsets (Note that this would also apply for option a) of Discussion point 3). Some additional definition for the SMTC configuration(s) may include a validity time (e.g., time of day) associated with the SMTC configuration(s), e.g., when neighbor NTN cell(s) are or will be visible to the UE. These aspects should be FFS, but the NTN SMTC config can be defined in RRC, similar to legacy smtc IEs and/or reuse that construct. Please see [8] for further details. |
| Sequans | It seems offset could be enough. |

1. Do you agree that SMTC configuration is adjusted to accommodate the multiple/different propagation delays explicitly? If yes, should the adjustment be performed by the UE and/or by the network?

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| **Company’s name** | **Yes / No** | **UE/NW (if yes)** | **Company’s comments (if any)** |
| Samsung | No |  | As long as the network configures SMTC configurations valid for certain time periods, the UE can effectively search for neighbors and reliably detect suitable neighbors. |
| MediaTek | Unclear | NW | Unclear what “explicit” means here. We assume the network adjusts the SMTC configurations taking into account propagation delays of serving and neighbor cells. |
| Huawei, HiSilicon |  | NW | From spec perspective, we could introduce more offsets or more smtc configurations for one MeasObjectNR, and network can update the configuration accordingly. |
| Lenovo |  | NW | Agree with Huawei that the offsets can be updated in one configuration. Adjustment by NW is preferred as the UE behavior should be controlled by NW. If adjustment is performed at UE, it is necessary to let NW know the adjustment. |
| Qualcomm | Yes | Both UE/NW | Network can signal whenever it thinks adjustment is needed. |
| Apple |  | NW |  |
| Spreadtrum | Yes | NW | Adjustment is due to gNB. |
| CMCC |  | UE/NW | As a baseline, NW can reconfigure more offsets or more SMTC configurations according to different propagation delay difference between serving satellite and neighboring satellite. Further, to reduce the overhead of frequent reconfiguration signaling, a scaling factor is indicated in the configuration, UE could adjust the SMTC configuration with the factor and the preconfigured function specified in the spec.  Alternatively, if the SMTC configuration is adjusted by UE, UE should report to NW to keep an alignment. |
| ZTE | / |  | We understand the question is about the dynamic adjustment of offset, which would be dynamically updated based on the movement of satellite. And we think the adjustment should be clearly known by both UE and NW, since the NW should avoid the scheduling during the gap.  If the adjustment is performed by UE, then some assistant information should be reported to NW to let network be aware of the adjustment.  If the adjustment is performed by NW, then some kind of reconfiguration is required as well. |
| Rakuten Mobile | No | Both | Configured by gNB based on UE feedback. |
| Xiaomi | Yes | NW | Considering the movement of satellites and UE, the adjustment of SMTC can be supported.  In RAN2#112e, “RAN2 understanding that UE shall not be forced to detect the SSB burst outside the corresponding configured SMTC window in NTN, just like the principle in TN.” has been agreed. If UE is allowed to perform the adjustment of SMTC, it means that the UE will detect the SSB burst outside the corresponding SMTC window which is configured by NW. Even though UE report the adjustment of SMTC to NW, NW may not agree to adjust the SMTC window to the location which UE decided. So, we support NW preform the adjustment of SMTC.  UE can inform the network if certain neighbor cells which cannot be detected in the configured SMTC window to help NW to adjust the SMTC configuration. |
| LGE | Yes | NW, based on UE reporting | Basically, NW should be able to calculate the propagation delay using the location of the NTN cells and configure the multiple offsets of the measurement window based on the calculated propagation delays.  However, the calculation may have some error, or the offset update may be delayed, so UE should be able to detect the configuration error based on the measurement results. If UE detects that the SSB is not fully detected within the configured measurement window, the UE should inform the network of the measurement failure and some useful information, e.g. SFTD, to re-configure the window. |
| Ericsson | Yes | Network | The UE should not do any offset scaling for the configuration autonomously.  Network can adjust the offset and RAN2 can further discuss how. |
| ITRI | Yes | NW | NW can adjust and re-configure SMTC configuration when it is considered as necessary. |
| ETRI | Yes | Both | NW can configure offset and SMTC configuration as a baseline. UE can adjust the offset in the same measurement gap. |
| Nokia |  | NW and UE | Not sure what ‘explicitly’ refers to? We agree this should happen in a NW controlled way (even if the UE adjusts by itself, this is compliant with previously provided configuration). Please do not call it ‘autonomous’. |
| Vodafone | Yes | NW | Please see comment in previous question: SMTC periodicity needs fine tuning depending on the movement of the Satellite and its orbit avove the Earth |
| OPPO | Yes | NW | SMTC configuration should be adjusted based on explicit signaling from network. |
| Intel | No | NW | In our understanding the propagation delay is calculated by NW and provided to UE implicitly |
| Convida | Yes | UE/NW | We think that the propagation delay does not necessarily need to be explicit (unclear exactly what is meant by explicit), but based on some of the procedures/criteria as discussed in 5), e.g., an offset based on NTN cell type/ephemeris data. The NW can adjust the SMTC configuration(s) with some possible UE assistance/reporting. Please see [8] for further details. |
| Sequans |  | NW | The SMTC configuration will be sent by the NW. |

1. Is there other topics to discuss as part of the SMTC configuration enhancements?

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| **Company’s name** | **Company’s views** |
| Samsung | Discuss the usability of (i) sharing a given SMTC configuration per set of neighbor cells and (ii) specifying time validity of SMTC configurations to avoid frequent SIB changes and frequent UE processing. |
| Convida | Some of the Stage 3 details in discussion points 1-6 are FFS and require further RAN2 discussion. |
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## Measurement gap configuration

1. Do you agree that network should be able to configure multiple measurement gap patterns to a given UE for Rel-17 NTN scenarios?

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| **Company’s name** | **Yes/No** | **Company’s comments (if any)** |
| Samsung |  | We should try to minimize measurement gaps. Let’s discuss this further. |
| MediaTek |  | Ideally the number of measurement gaps should be minimized. However, if multiple neighbor satellites exist, it will be difficult to avoid this scenario, unless SSBs are transmitted every 5ms. We need to discuss if we need to optimize for such scenarios. |
| Huawei, HiSilicon |  | More analysis is needed as measurement gap has significant impact on user experience. We need to decide how many SMTC configurations are needed, then to see if one GAP can cover all of them. |
| Lenovo | Depends | We can revisit this after decision on SMTC configuration and see if one gap can work. |
| Qualcomm | Yes | This would probably be needed. But we agree, the repetition duration of the gap needs to be larger to avoid interruption. |
| Apple |  | Agree with Huawei and Samsung. |
| Spreadtrum | Yes | If SMTC configurations are not aligned, current GAP mechanism may be enhanced. |
| CMCC |  | Measurement gap configuration should also consider the propagation delay difference between neighboring satellite and serving satellite. |
| ZTE |  | Similar view as Huawei and Samsung.  In addition, we are still interested in slight measurement gap length extension, e.g. no longer than 10ms.   * If UE is configured to measure neighbor cells served by the same satellite or a satellite with similar orbit to the serving satellite, slightly extension of the gap window would be helpful. * And extension of gap length would also be useful to address the differential delay caused by satellite movement so that NW does not need to update the gap configuration frequently. |
| Rakuten Mobile | Yes | In certain cases, network would have to configure multiple Measurement gaps to avoid resource wastage by Gap period extension. |
| Xiaomi | Yes | Multiple measurement gap patterns is a flexible method and can be configured to UE for different neighbor satellites. Appropriate configuration can effectively reduce the influence of UE transformation resources. How to configure multiple properly measurement gaps for different propagation delay can be determined by network implementation. |
| LGE | Yes | For the same reason as SMTC window. |
| Ericsson | yes | Gap configuration should mirror the SMTC configuration. Thus:  Need to have one GAP config per list of PCIs to enable SMTC “per satellite”. FFS how many different GAP config UE can be configured simultaneously.  For each GAP config associated with different list of PCIs, one should be able to configure independently offset, periodicity and duration.  Then one GAP config can be, once configured, shifted by offset by the network to accommodate changes in the propagation delay. The UE should not do any offset scaling for the configuration. |
| ITRI |  | Considering network can determine preferred candidate cells, one measurement gap at a time may be sufficient. However, more analysis may be needed. |
| ETRI | Yes | Multiple measurement gaps for a UE can be configured by the network depending on network deployments. |
| Nokia | No | We think the solution for measurement gaps should be in fact aligned with what is decided for SMTC. So perhaps we can conclude SMTC first. |
| Vodafone | Yes | This is a good idea as the orbit of the satellite may fluctuate OR different satellite cluster / system with differing orbit is used  Therefore, a flexible mechanism should be made available to the UE to compensate for different orbital fluctuations |
| OPPO | Yes | The legacy single measurement gap window cannot cover the large range of propagation delay difference. |
| Intel | Yes | We think multiple measurement gaps is beneficial but are ok on continue discussion after progressing on SMTC configuration part. |
| Convida | Yes | This is consistent with legacy NR behaviour where multiple gap patterns may be supported and configured by the network for e.g., FR1 and FR2. |
| Sequans | Yes | Likely this would be needed to align with SMTC. |

1. If yes for Discussion point 8), do you have any preference on how to handle RAN2 work considering related RAN4 ongoing work on this same topic?
2. RAN2 waits for RAN4 progress aiming to re-use the same framework of the solution
3. RAN2 informs RAN4 on the assumption that RAN4’s solution can also apply to Rel-17 NTN scenario
4. RAN2-centric solution is considered to enable multiple measurement gap patterns for NTN.
5. Others approach.

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| **Company’s name** | **Option(s)** | **Company’s views** |
| Samsung | d | Let’s seek company responses and identify main proposals for further discussion. RAN2 can drive the effort without waiting for RAN4. |
| MediaTek |  | We need to first discuss if we optimize measurement gaps to support multiple neighbor satellites. |
| Huawei, HiSilicon |  | Postpone this discussion. |
| Lenovo |  | Postpone until decision on SMTC configuration. |
| Qualcomm | d | Simply ask RAN4 on the impact of multiple SMTC configurations and measurement gaps. |
| Apple | d | Postpone this discussion. |
| Spreadtrum | d | Agree with Qualcomm |
| CMCC | d | Postpone the discussion. |
| Rakuten Mobile | d | First finalize options/approaches and then discuss with RAN4 |
| Xiaomi | d | Postpone this discussion. |
| LGE | d | Agree with Qualcomm |
| Ericsson | d | Agree w QC |
| ITRI |  | Postpone this discussion. |
| Nokia | a) or d) | Assuming RAN4 really works on the topic and does not e.g. wait for the input from our side. If that is the case, then RAN2 can focus on SMTC. |
| Vodafone | d | Agree with Qualcomm and await response from RAN4 |
| OPPO | b |  |
| Intel | a, b | If RAN2 agrees to enable “multiple measurement gap patterns” for NTN, we are open to both options a) or b), but have slightly preference to avoid c). On other hand, we are also ok to post-pone this discussion until RAN2 concludes on multiple SMTC configurations and there is also some progress on RAN4 for multiple measurement gap patterns. |
| Convida | c/d | We should have a discussion on RAN2 preference(s) first on how to handle this work as it is within our scope/objectives and then coordinate/inform RAN4 of our decisions. |
| Sequans | a) or d) |  |

## UE assistance

1. Do you support to define UE’s location related information as part of the new UE assistance? If yes, do you have any preference on how UE’s location is known by UE considering, e.g.:
   1. Based on GNSS.
   2. Based on RTT measurement.
   3. Based on coarse location information represented by the TAC/TAI mapped from the geographical area.
   4. Other means.

|  |  |  |  |
| --- | --- | --- | --- |
| **Company’s name** | **Yes/ No** | **Option(s)** | **Company’s comments (if any)** |
| Samsung | Yes | a and d | The UE position can be used by SMTC and several other operations (e.g., Timing Advance, Scheduling, TA/Paging Management, country-borders for 5GC selection). Some UE vendors have concerns about the UE consuming significant processing power for determining the UE position by continuously or frequently observing GNSS. Hence, RAN2 can invest some time to discuss (i) how frequently idle/inactive/connected UEs need to observe the GNSS to determine the UE position (e.g., less frequently for idle/connected state and more frequently for connected state), (ii) position report signaling (RRC, MAC CE), and (iii) report format (e.g., absolute or relative), and (iv) need for “transformed” position coordinates instead of actual coordinates when the security has not been activated. The network and the UE know the confidential reference point coordinates.  Example Solutions.  1. Use of a new MAC CE and/or new compact “UE Position” IE in existing RRC signaling messages.  2. Rule-based update from the UE (e.g. “distance between the last reported position and current position exceeds a threshold,” periodic UE position reporting).  3. Incremental or relative UE position to reduce signaling overhead. X’=X - Xref, Y’=Y - Yref, and Z’=Z – Zref, where X, Y, and Z are absolute position coordinates and Xref, Yref, and Zref are absolute reference position coordinates (to be broadcast by the gNB).  4. Transformed UE position when security has not yet been activated. X’’=X - Xsec, Y’’=Y - Ysec, and Z’’=Z – Zsec, where X, Y, and Z are absolute position coordinates and Xsec, Ysec, and Zsec are absolute reference position coordinates of a security reference point (known to HSS and UE; intra-network signaling for AMF to learn about this reference point). |
| MediaTek | No |  | UE location information is unnecessary. If propagation delay at cell edge is compensated, all UEs at cell edge will have correct measurement timing. Only UEs at cell edge need to perform handover and require accurate measurement timing. |
| Huawei, HiSilicon | No |  | Discussion on TA reporting is still ongoing, and we can wait. And we also see SFTD measurement result can support this case effectively. |
| Lenovo | No |  | UE location info is not always available (e.g. privacy concerns and UE allowance is needed). It can be replaced by reporting delay difference. |
| Qualcomm | Yes | a+b | Based on GNSS and satellite information, RTT can be determined. Multiple RTT reporting is the simple and has least impact. |
| Apple | No |  | This is a severe privacy concern for UE. Further regulatory laws passed recently might prohibit this kinds of approaches. The timing compensation parts are still being discussed in RAN1 so we should wait for their response before deciding that we need either of these two reports. |
| Spreadtrum | No |  | UE location is the privacy issue. we agree with Lenovo that reporting delay difference from UE point of view is simple solution. |
| CMCC | No |  | Pls. to see our comments DP.11. |
| ZTE | No |  | We understand that SFTD measurement can be reused for this case (i.e. SFTD measurement is sufficient for the SMTC and Gap configuration). |
| Rakuten Mobile | No |  | UE location information is unnecessary, However the |
| Xiaomi | No |  | Agree with Apple and Spreadtrum. Considering UE privacy, UE location report may have some risk. |
| LGE | No |  | New reporting is not necessary for UE location information. |
| Ericsson | yes | A + c | UE location as accurate as possible is useful. UEs are supporting GNSS thus there is no reason to not to use it. We do not support RTT measurement based option.  Additionally, UE reporting which TAC it has selected out of multiple broadcasted is useful for the network. |
| ITRI | Yes | b | UE GNSS information may not be available. RTT measurement could assist network to estimate UE the service link propagation delay difference between the serving and neigibouring cells. |
| ETRI | No |  | No need to have the fine information. |
| Nokia |  | a) or c) with comments | Assuming just CONNECTED mode UEs are considered for such reporting. GNSS or other methods providing the location information with sufficient accuracy can be supported (e.g. c) if it is sufficient). |
| Vodafone | unclear | --- | Unclear whether the location information is necessary |
| OPPO | No |  |  |
| Intel | Neutral | a, b, c |  |
| Convida | Yes | all (with comments) | Option a) should be one of the options as the NTN work item already assumes GNSS support. Coarse location based on other measurements/operations may also be sufficient and, a-c are not exhaustive options for UE assistance as mentioned by Samsung. RAN2 should discuss these potential solutions further. |
| Sequans | FFS |  |  |

1. Do you support to define UE’s propagation delay related information as part of the new UE assistance? If yes, do you have any preference on how it is defined considering, e.g.:
   1. An absolute value based on propagation delay from neighboring cells.
   2. A relative value based on the SFTD.
   3. Other means.

|  |  |  |  |
| --- | --- | --- | --- |
| **Company’s name** | **Yes/ No** | **Option(s)** | **Company’s comments (if any)** |
| Samsung | No | TA Reporting | No need if we already have suitable TA reporting |
| MediaTek | No |  |  |
| Huawei, HiSilicon | No |  | Same comments as for Q10 |
| Lenovo | Yes | No preference | The key for UE assistance is to let the serving know the propagation delay difference. The UE assistance can include the information of its propagation delay difference between serving and neighbor satellites, or its propagation delay to neighbor satellites. The information can be defined as absolute time or derived from other existing results e.g. TA for compensation. |
| Qualcomm | Yes | RTT | RTT is sufficient. See response in DP 10. |
| Apple | No |  | Same comments as Discussion Point 10. |
| Spreadtrum | Yes |  | Agree with Lenovo. |
| CMCC | Yes | c | Our concern is whether we need limit to SFTD. More general information, i.e. propagation delay difference information should be also considered. |
| ZTE | / |  | For this case, SFTD measurement seems sufficient (i.e. no additional assistant information is needed). But if RTD will be reported anyway, it can be reused here as well. |
| Rakuten Mobile | Yes | c | Agree with Lenovo. The key is to let the gNB know about the delay difference between serving and neighbor sattelites.  This reporting can be further reduced, if trigger point is introduced. |
| Xiaomi | Yes | c | Agree with Lenovo and Rakuten Mobile.  **Option c) An absolute value based on propagation delay difference between serving cell and neighbor cells.**  Option c) can be used directly to configure measurement gap without any calculation. |
| LGE | Yes | Option B | We wonder how reliable the propagation delay measured by UE is, and whether the UE can measure it better than NW. Considering the standardization efforts the new measurement, e.g. option a, can be considered only when it is clearly shown that the existing measurement is not enough to solve the problem.  Whichever option is adopted, the UE reporting should be minimized. For instance, UE reports the assistance information only when the target NTN cell is not properly measured within the configured measurement window. |
| Ericsson | No |  | We support the location reporting which is delay related information. There is no reason to provide same information in different forms. |
| ITRI | Yes | RTT | Same comment as for Discussion point 10. |
| ETRI | Yes | b | SFTD measurement can be re-used. |
| Nokia | No |  | Assuming such information is known thanks to TA reporting and GNSS, no other means needed.? Besides that, we think the UE’s location is probably a better and simpler choice instead of obtaining the delay values towards multiple cells (which would change continuously as the satellites are moving).  Another aspect concerns the service link delay versus feeder link delay: the serving cell would need to know also the FL delay component; UE’s measurements can likely give just a rough estimate. |
| Vodafone | Yes | RTT | this piece of UE assistance information needs further clarification |
| OPPO | Yes | propagation delay difference reporting | We think UE could report service links’ propagation delay difference between neighboring satellite and serving satellite, which can help network to take it into account when configuring SMTC and measurement gap. |
| Intel | Yes | a, b |  |
| Convida | Yes | Option c | Some of the UE assistance methods provided in Discussion point 10 and TA report may already address UE-specific propagation delay. |
| Sequans | FFS |  |  |

# Report: summary and proposals

Section to be updated by rapporteur

1. xxx
2. xxxx.

# Conclusion

The observations captured are the following:

**Observation 1.** xxxx.

The proposals captured are the following:

**Proposal 1.** xxx

# Annex: companies’ point of contact

|  |  |  |
| --- | --- | --- |
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# Reference

1. R2-2102866, Report of [post113-e][108][NTN] SMTC and measurement gap, Intel Corporation.
2. R2-2103057, Multiple SMTC configurations, Qualcomm Incorporated.
3. R2-2103182, Discussion on measurement in NTN, Xiaomi Communications.
4. R2-2103336, Post-[108][NTN] views on SMTC and measurement gaps, Nokia, Nokia Shanghai Bell.
5. R2-2103356, Discussion on updating the timing for SMTC and measurement gap configuration, ITRI.
6. R2-2103362, Measurement window enhancements for NTN cell, LG Electronics Inc.
7. R2-2103700, Discussion on SMTC/Gap enhancements for NTN, CMCC.
8. R2-2104145, SMTC and MG configuration for NTN, Convida Wireless.
9. R2-2104200, Measurement enhancement for NTN, ETRI.

# Annex

The summary report of [post113-e][108] [1] related to the proposals 3.1, 7, 12, and 13 is copied below for reference.

## SMTC configuration

### Option 2) “enhancements of SMTC configuration”

19 companies support this option 2) “enhancements of SMTC configuration” (APT, Nokia, OPPO, LGE, MediaTek, Qualcomm, Ericsson, Sony, Lenovo, Xiaomi, CMCC, Rakuten, Thales, Samsung, CATT, Intel, Magister, ITRI, ZTE), and 2 companies do not support this option (Huawei, HiSilicon).

* Qualcomm, Huawei, and HiSilicon explain that multiple SMTC configurations with multiple measurement objects (as per this option) is already possible from legacy signaling. Huawei and HiSilicon also clarify that if several neighbour cells with same SSB frequency belong to different satellites, multiple SMTCs have to be provided in order to detect SSB from different satellites. ZTE clarifies that options 2.a) and 2.b) aim to provide more than one SMTC configurations per measurement object (i.e. per frequency). **Rapporteur**: adds that legacy operation only allows up to 2 SMTC configurations, and suggests that option 2.a) is re-phrased in proposal below to capture explicitly this proposed new operation.

**Option 2.a)** **Multiple SMTC configurations with multiple offsets**

13 companies preferred option 2.a) Multiple SMTC configurations with multiple offsets (APT, OPPO, MediaTek, Sony, Lenovo, CMCC, Rakuten, Thales, Samsung, Intel, Magister, ITRI, ZTE)

* MediaTek explains that it support this option a) for different satellites, i.e. each SMTC window can be configured for each neighbour satellite after compensating for propagation delay difference.
* Ericsson explains that the adjust of SMTC should be done in a deterministic way e.g. UE is configured with few possible adjustment options and UE then indicates which one it uses.
* Sony explains that either multiple SMTC configurations per neighbour satellite or a list of cells needing offsets. This should be enabled configuring the cells with an offset value.
* Lenovo explains that the offset should at least refer to the propagation delay difference between serving satellite and neighbor satellite(s).

The following argument was explained by not supporting company for option 2.a):

* Sony explains that multiple SMTC configurations may not be suitable from resource utilisation point of view.

**Option 2.b) Single SMTC configuration per group cell**

7 companies prefered option 2.b) Single SMTC configuration per group cell (APT, OPPO, Ericsson, Sony, Samsung, ITRI, ZTE).

* APT clarifies their support for multiple SMTC windows either per cell or per satellite.
* Samsung clarifies that a set of neighbor cells may correspond to a set of cells of one satellite, or a set of cells of multiple satellites with similar propagation delay differences. Different sets of neighbor cells will have different SMTC configurations which would reduce signaling. In addition, timestamp information could be included as to indicate the validity of the configuration provided to UE.
* ITRI supports network controlled SMTC configuration with enhanced SMTC to support cell specific or frequency specific time drifting of SMTC window (to bear up the propagation delay change according to satellite moving).
* ZTE points that should understand the typical scenarios and the expected propagation delay differences before discussing whether the configurations should be group per satellite, per cell or per a list of cells.

The following arguments were explained by not supporting companies for option 2.b):

* APT and CMCC explain that a single SMTC window may not cover the propagation delay difference between serving satellite and neighbor satellite.
* Nokia explains that individual SMTC configuration per cell (i.e. not per frequency) is not a feasible approach, as the same cell would still be measured with different propagation delay by different UEs.
* Rakuten explains that this increasing the SMTC window size (without understanding of required extension) will result in resource PRB wastage.

The following companies consider options 2.a) and 2.b) as the same kind of enhancement (OPPO, Ericsson, Samsung).

**Option 2.c) Other approaches**

* Nokia, Xiaomi and CATT explain that UE should be allowed to shift its observed window by a configurable offset and notify the network about the shift, to ensure synchronization. **Rapporteur**: this solution is discussed as part of section 2.4.3 “UE updates SMTC window based on relative movement of neighbor cell’s SSB” (with its report summary in section 2.6.4.3) and the corresponding UE assistance in section 2.4.2 (with its report summary in section 2.6.4.2).
* Qualcomm supports the enhancement of single SMTC configuration with multiple offsets. **Rapporteur**: as explained above the description of option 2.a) is re-phrased in proposal below to capture explicitly this operation.
* Ericsson, Huawei, HiSilicon and ZTE suggest extending the lengths of the SMTC window.
* Ericsson proposes that UE informs to the network if certain PCI(s), of the ones configured in the *measConfig*, cannot be detected at all. This assistance information would be helpful for the network to provide an updated SMTC/gap config to measure the missing PCI(s). **Rapporteur**: the solution is discussed in section 2.4.2 as part of the corresponding UE assistance (with its report summary in section 2.6.4.2).
* Xiaomi supports having an SMTC configuration per UE and per NTN cell/group cell. **Rapporteur**: as explained above the description of option 2.a) is re-phrased in proposal below to capture this operation as part of FFS.

**Rapporteur:** The following proposals are suggested taken into consideration companies’ views provided. Note that the description of options 2.a) and 2.b) are merged and re-phrased in proposal below aiming to include all the related comments provided.

**Proposal 3.** [To agree] [19/21] Enhancements of the SMTC configuration is supported for Rel-17 NTN.

**Proposal 3.1.** [To agree] [13/21] To enable the usage one or more SMTC configuration(s) with one or more offset(s) associated to each SMTC configuration in order to account for the different propagation delays. FFS if SMTC configuration can be associated with one or more cells and/or with one or more satellites. FFS how to define the offset in relation to the propagation delay of the serving satellite and neighbor satellite(s). FFS the details on how multiple SMTC configurations work in relation to the new offsets (e.g. whether one or more offset(s) associated to each SMTC configuration).

**Proposal 4.** [FFS] [4] FFS whether to slightly extend the lengths allowed for the SMTC window.

## Measurement gap configuration

### Solution 3) Multiple measurement gap patterns (discussion point 8))

13 companies support to enable solution 3) multiple measurement gaps (APT, Nokia, OPPO, LGE, MediaTek, Qualcomm, Xiaomi, CMCC, Rakuten, Thales, Samsung, Intel, Magister), and 8 companies support not to enable solution 3) (Ericsson, Sony, Lenovo, CATT, Huawei, HiSilicon, ITRI, ZTE).

* Nokia indicates that it should be defined associated rules when each configuration is applied.
* MediaTek points that solution 3) mainly address scenarios with different satellites.

The following arguments were explained by supporting companies for solution 3):

* It could lead to less interruption in UL/DL transmissions.
* It allows efficiently handle the measurement of different satellites with proper configuration.
* RAN2 should consider related work ongoing in RAN4 to enable multiple measurement gaps in Rel-17 NR.

The following arguments were explained by not supporting companies for solution 3):

* Ericsson indicates that having different gap patterns per satellite may result in a flexible varying pattern when looking at the union of gaps pattern which may be preferable for network scheduling.
* Sony clarifies that specification may need to describe how to choose the specific pattern.
* Lenovo points that multiple measurement gaps limit the resource a UE can use for data tx/rx.
* CATT explains that the propagation delay cannot be assumed static due to the movement of the satellites.

**Rapporteur:** The following proposal is suggested taken into consideration companies’ views provided:

**Proposal 7.** [To agree] [13/21] Multiple measurement gap patterns are supported for Rel-17 NTN.

## How network configures SMTC and measurement gap configuration

### Option b) UE assistance for network to properly (re)configure the SMTC and/or measurement gap (discussion point 13))

19 companies support option b) “UE assistance for network to properly (re)configure the SMTC and/or measurement gap” (APT, OPPO, LGE, Qualcomm, Ericsson, Sony, Lenovo, Xiaomi, CMCC, Rakuten, Thales, Samsung, CATT, Intel, Huawei, HiSilicon, Magister, ITRI, ZTE) and 2 companies do not support option b) (Nokia, MediaTek).

**Option b.1) UE reports location information**

9 companies support option b.1) (APT, Qualcomm, Ericsson, Thales, Samsung, CATT, Intel, Magister, ZTE).

* APT explains that NW can obtained rough UE location can be obtained via multiple RTT measurements if there are UE privacy concerns.
* ZTE explains that UE’s location might be known/defined e.g. based RTT or coarse location info represented by the TAC/TAI mapped from the geographical area UE).

The following arguments were explained by not supporting companies:

* MediaTek indicates that this information is unnecessary.
* Xiaomi, CMCC and Rakuten have concerns due to the UE privacy risk.

**Option b.2) UE reports propagation delay from neighboring cells**

8 companies support option b.2) (APT, OPPO, Lenovo, Xiaomi, CMCC, CATT, Intel, ITRI).

* APT clarifies that feeder link delay will be provided by NW.
* OPPO explains that this option can address the concern about UE privacy.
* Lenovo clarifies that UE reports its calculation for delay difference (or the propagation delay to neighbour)
* CATT points that frequent reporting may be needed due to the change of the propagation delay with the movement of the satellite.

**Option b.3) Other UE assistance information.**

* Nokia suggest that UE can report the adjustments on the observed window as UE has applied based on its UE own measurements of the propagation shift. **Rapporteur**: this enhancement is also supported by Xiaomi and CATT in section 2.2.2 (as explained in its report summary provided in section 2.6.2.2), and by ZTE in section 2.4.3 “UE updates SMTC window based on relative movement of neighbor cell’s SSB”. The related proposal below addresses the UE assistance and leaves the discussion on whether UE can do the change on its own to section 2.4.3 “UE updates SMTC window based on relative movement of neighbor cell’s SSB” (with its report summary in section 2.6.4.3).
* Sony, Xiaomi and Intel suggest that UE reports measurement gap changes might be helpful based on its calculations.
* Ericsson, Xiaomi, Rakuten and Intel propose that UE informs to the network if certain PCI(s), of the ones configured in the *measConfig*, cannot be detected at all. This assistance information would be helpful for the network to provide an updated SMTC/gap config to measure the missing PCI(s). **Rapporteur**: similar enhancement is also supported by LGE in section 2.2.2 (as explained in its report summary provided in section 2.6.2.4).
* Qualcomm and Samsung indicate that it would be useful if UE can report its TA (e.g. in Msg5).
* Rakuten explains how UE could update SMTC autonomously (considering neighbour cells ephemeris and UE’s location). Rakuten also explains how UE calculates the propagation delays to obtain the desirable change . **Rapporteur:** the solution is discussed as part of section 2.2.4 (with its report summary in section 2.6.2.4).
* Samsung suggests to report neighbor cell measurements.
* Huawei, HiSilicon, Qualcomm suggest that UE report SFTD periodically. **Rapporteur:** propagation delay reporting and SFTD aims to address the same kind of information (where propagation delay is absolute value and SFTD is relative value). Updated related proposal below to include this.

**Rapporteur:** The following proposal is suggested taken into consideration companies’ views provided:

**Proposal 11.** [To agree] [19/21] New UE assistance is defined in Rel-17 NTN for network to properly (re)configure the SMTC and/or measurement gap.

**Proposal 12.** [To discuss] [9/21] To discuss if a UE can report location information. If this reporting is agreed, FFS how UE’s location is known by UE (e.g. based on GNSS and/or RTT measurement and/or coarse location info represented by the TAC/TAI mapped from the geographical area UE); and, FFS how frequent this information is exchanged (e.g. periodically vs upon request).

**Proposal 13.** [To discuss] [11/21] To discuss if a UE can report propagation delay related information. If this reporting is agreed, FFS whether this information is defined as an absolute value based on propagation delay from neighboring cells or relative value based on the SFTD; and, FFS how frequent this information is exchanged (e.g. periodically vs upon request).

**Proposal 14.** [FFS] FFS if the following new UE reporting is defined:

**Proposal 14.1.** [FFS] [7] To allow a UE to report desirable adjustments on its measurement gap window based on UE’s own measurements of the propagation delay shift.

**Proposal 14.2.** [FFS] [5] To allow a UE to inform the network if certain PCI(s), of the ones configured in the measConfig, cannot be detected at all. This assistance information would be helpful for the network to provide an updated SMTC/gap configuration to measure the missing PCI(s).

**Proposal 14.3.** [FFS] [2] To allow a UE to report TA (e.g. in Msg.5).

**Proposal 14.4.** [FFS] [1] To allow a UE to report neighbor cell measurements.