**3GPP T****SG-RAN WG2 Meeting #116bis-e draft-R2-21xxxxx**

**E-Meeting: January 17-25, 2022**

**Agenda item: 8.10.1**

**Source: Qualcomm Incorporated**

**Title: [AT116bis-e][109][NTN] Reply LSs to RAN4 and RAN1**

**Document for: Discussion and Decision**

# Introduction

RAN4 has sent two LSs to RAN2 asking several questions regarding measurement and mobility in [1] and [2]. Corresponding draft reply LSs in [3] and [4] are uploaded to the offline folder 109. This document collects feedback for the draft reply LSs to RAN1 and RAN4 as per the following offline discussion.

* [AT116bis-e][109][NTN] Reply LSs to RAN4 and RAN1 (QC)

 Scope: Draft Reply LSs to RAN1 and RAN4 based

 Intended outcome: Draft reply LSs

 Deadline (for companies' feedback): Tuesday 2022-01-25 04:00 UTC

 Deadline (for draft LS in R2-2201741 and R2-2201742): Tuesday 2022-01-25 08:00 UTC

# Discussion

## Draft reply LS to the [1] on NR NTN Neighbor Cell and Satellite Information

In [1], the main question is what are the required parameters that need to be provided to UE for IDLE mode and connected mode measurements and mobility in NTN. The parameters can be grouped into two as shown below in the table 1.

|  |  |
| --- | --- |
| **For NTN UE measurements, e.g. neighbor cell measurement within- or inter-satellite:**(A1) Neighbor cell Ephemeris information and the format, e.g. PVT format or Keplerian format(A2) Common TA(A3) Validity timer information for neighbor cell measurements, e.g. if it is different from that for serving cell open loop TA control* Would the timer length, if provided, be different from that for serving cell? For example, a required accuracy of service and/or feeder link delay information for neighbor cell measurement may not need to be as accurate as that for serving cell open loop TA control.

(A4) The amount of frequency compensation, if DL frequency compensation for the service link Doppler is applied(A5) DL Polarization information | **For NTN UE mobility, e.g. target cell measurement, synchronization, and (conditional) handover within- or inter-satellite:**(B1) Target cell Ephemeris information and the format, e.g. PVT format or Keplerian format(B2) Common TA(B3) Validity timer information for target cell mobility, e.g. if it is different from that for serving cell open loop TA control(B4) The amount of frequency compensation, if DL frequency compensation for the service link Doppler is applied(B5) DL and UL Polarization information(B6) K\_offset |

A draft reply LS to the [1] on NR NTN Neighbor Cell and Satellite Information is provided in [3]. Rapporteur thinks RAN1-107e has made the conclusion that DL frequency compensation by gNB for the service link Doppler is not supported in Release 17, therefore, (A4) and (B4) are not needed.

Also, RAN2#116 has made the agreement that RAN2 assumes FL delay is known to and compensated by the network. RAN2 also assumes the UE needs to have neighbour cell ephemeris for the propagation delay estimation.

However, in case the network does not compensate the feeder link delay for the SSBs of the neighbor cell, then the UE will have to be informed on this.

1. Do you agree that if the network does not compensate the feeder link delay for the neighbor cell, then (A2) Common TA and drift rates should also be provided to UE for neighbor cell measurement?

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Comments (if No, please elaborate the reason) |
| MediaTek | No | We already agreed that this is compensated by the network. The UE cannot be expected to do this. In Connected mode the network is always expected to provide neighbor satellite information. There is not enough time to introduce such optimizations. |
| OPPO | No  | Common TA is not equal to feeder link delay. Common TA refers to the delay between satellite and reference point (RP) which is not necessarily located at GW according to RAN1 discussion. We think in this case feeder link delay should be provided to UE for neighbour cell measurement.  |
| Nokia | No | We are also a bit puzzled why Common TA shall be provided if there is no FL compensation? Agree with OPPO and MTK. |
| Qualcomm | Yes | Satellite ephemeris (service link timing) alone is not sufficient for time variant timing offset tracking of SSBs of the neighbor cell if there is no feeder link compensation. Without feeder link delay and timing drifting information, UE will suffer hugely in terms of power.@MediaTek and @Nokia, RAN1 has agreed and we are also agreeing to broadcast TA common drift parameters in SIBX. This is option given to network if the network does not want to compensate the feeder link, in which case the UE will have to do.This is for serving cell. But this serving cell can be neighbor cell for some other UEs in the nearby cells, then how those other UEs will know the drifting parameters for measurement?Yes as per RAN2 assumption, the network can compensate the feeder link in which case the TA common drift parameters are not needed to be broadcast and the UE does not need to do anything for feeder link. |
| vivo | No | For RRC\_CONNECTED mode, we share a similar view with MediaTek, and following the previous RAN2 agreements is sufficient, i.e., RAN2 assumes FL delay is known to and compensated by the network.For RRC\_IDLE mode, perhaps the FL delay of the neighbour cells need to be signalled to the UE (but not the common TA itself). |
| Xiaomi | No | We think the feeder link delay compensation is useful for UE to measure SSB. But we already agreed that the network compensates the feeder link delay, so the feeder link delay compensation should be left to network implementation. |
| Huawei, HiSilicon | No | In our understanding, the following agreement (on NW compensation of FL delay) is in the context of SMTC assistance information. If the assistance information is in the form of propagation delay, the UE does not need to consider feeder link delay when reporting.*3. RAN2 assumes FL delay is known to and compensated by the network. RAN2 also assumes the UE needs to have neighbour cell ephemeris for the propagation delay estimation.*Regarding whether FL delay is needed, 1) For connected mode, we think it is not needed. If RAN2 decides the SMTC assistance information is in the form of UE location, then FL delay of neighbour cells does not need to be provided to the UE. If it is defined in the form of propagation delay difference, anyway the NW can perform the compensation.2) For Idle/Inactive mode UE, since it is agreed that UE can perform autonomous adjustment of SMTCs, FL delay is needed for the adjustment.*1. Regarding UE-based solution for SMTC adjustments, UE autonomously adjust the SMTCs based on location and ephemeris. FFS whether NW assistance information is provided.*We also share the view of Oppo that FL delay does not equal to common TA. |
| Intel | No | Common TA and drift rates are used for uplink timing pre-compensation, but regarding neighbor cell measurement UE can perform downlink synchronization by SSB. |

RAN1 has agreed two formats for ephemeris (1) PVT and (2) Keplerian (orbital parameters). Rapporteur thinks the PVT is used mainly for connected mode for UL synchronization while orbital parameters can be used as long term information for neighbor cell measurements.

This means, the PVT is used for short term and orbital parameters is used for long term and their validity duration can be different. In this case, the UE may need to be configured with different validity durations for PVT and orbital parameters as mentioned in (A3) and B(3).

1. Do you agree that the network may configure validity duration of the orbital parameters of satellite ephemeris to be longer than that of the PVT of satellite ephemeris as what pointed out by (A3) and B(3)?

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Comments (if No, please explain) |
| MediaTek | No | We cannot make such assumptions or thinking in RAN2 to categorize ephemeris formats. This is for RAN1 to decide and they agreed on both the formats. So, either of the formats can be used.  |
| OPPO |  | Could be, but this should be up to RAN1 to decide. |
| Nokia | In general yes | Rapporteur’s thinking here is reasonable, but we also agree with preceding comments that this is perhaps up to RAN1. |
| Qualcomm | Yes | We are ok to leave this question to RAN1. But we cannot assume PVT is used for serving and neighbor satellite. In fact, PVT is not needed for neighbor satellites. |
| vivo | No | RAN1 does not decide that the network may configure two separate validity duration of orbital parameters and PVT of satellite ephemeris until now. In our understanding, only a single validity duration for satellite ephemeris is sufficient. But if the majority think the two separate validity duration are needed, we are ok to ask RAN1 to decide. |
| Xiaomi | No | RAN1 don’t decide to introduce two validity durations for different ephemeris data, and we think one duration is sufficient.  |
| Huawei, HiSilicon | Maybe, but | Same view with MediaTek that RAN2 cannot make this assumption. |
| Intel | No | In current RRC parameter list from RAN1, only one is *ntnUlSyncValidityDuration* defined. |

Followings are questions from [1] and response from [3].

**Question-1: Would the parameters listed above be relevant to measurements and mobility? If the answer is dependent on satellite types, e.g. GSO and NGSO, and RRC state, what would be the answers to the respective satellite types?**

RAN2 answer: For measurement purpose, SMTCs, ephemeris, epoch time and DL polarization information would be relevant regardless of satellite types and RRC state.

RAN2 has agreed the assumption that feeder link delay is known to and compensated by the network. However, if network does not compensate the feeder link, common TA drift parameters of the neighbour cells are also provided to UE.

For handover, a UE would need those parameters listed in the LS regardless of satellite types except (B3) and (B4).

RAN2 assumes the UE can be configured with a validity duration of the orbital parameters (i.e., Keplerian format) of ephemeris of the neighbor cell to be longer than that of the PVT parameters of the serving cell. However, other information like common TA will have same validity duration for neighbor cell and the serving cell, i.e., (A3) and (B3) will be known to the UE.

RAN1-107e had made the conclusion that DL frequency compensation by gNB for the service link Doppler is not supported in Release 17, therefore, (A4) and (B4) are not needed.

1. Do you agree with the response to the Question 1?

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Your suggestion |
| MediaTek | No | We cannot write the statement “However, if the network des not compensate…. Provided to UE”, as it violates RAN2’s agreement and assumption that feeder link delay is known to and compensated by the network.Similarly, we cannot include the statement like “RAN2 assumes the UE can be configured with a validity duration of the orbital parameters (i.e., Keplerian format) of ephemeris”. As we mentioned RAN1 has agreed that either of the Keplerian format or PVT could be used for serving cell. |
| OPPO | No | As commented in DP1 and DP2. |
| Nokia | No | The highlighted parts are not OK, as commented in the preceding questions.  |
| Qualcomm | Yes | But if TA common drift parameters are broadcast by the neighbor cell, then UE would need to know for measurements. We agree, according to RAN2 assumption, the neighbor cell should not be broadcasting common TA drift parameters.But serving cell may use PVT and neighbor cell may use orbital parameters, why they would have same validity duration? But ok to leave (A3) and (B3) to RAN1 to answer. |
| vivo | No | Referring to our response on Q1, we cannot include the statement “However, if network does not compensate the feeder link, common TA drift parameters of the neighbour cells are also provided to UE”.Referring to our response on Q2, we cannot include the statement “RAN2 assumes the UE can be configured with a validity duration of the orbital parameters (i.e., Keplerian format) of ephemeris of the neighbor cell to be longer than that of the PVT parameters of the serving cell”. In addition, we would like to clarify that only the agreements about ephemeris information (i.e., A1and B1) are concluded in RAN2; other parameters (e.g., (A5) DL Polarization information and (B5) DL and UL Polarization information) are actually discussed and concluded in RAN1, and whether they are used for measurements as well may not reflect in RAN2 Spec either. So perhaps asking RAN1 to provide a reply towards such parameters is better? |
| Xiaomi | No | The feeder link delay compensation should be left to network implementation as RAN2 agreed and ephemeris issues should be discussed by RAN1 firstly. |
| Huawei, HiSilicon | No | 1) On the 1st paragraph: we don't think SMTC should be mentioned since it is not included in the parameters listed by RAN4;2) On the 2nd paragraph: we don’t think the RAN2 agreement on NW compensation should be mentioned. As stated in Q1, the agreement is in the context of SMTC assistance information. NW does not necessarily compensate the FL delay of neighbour cells in cases like RACH towards target cell or Idle UEs autonomous SMTC adjustment.3) The 3rd and 5th paragraphs look ok. 4) On the 4th paragraph: agree with Nokia it should be removed. |
| Intel | No | As commented in DP1 and DP2. |

Question-2: Would there be parameters that are not listed but necessary for measurements and mobility from RAN2 perspective? If the answer is dependent on satellite types, e.g. GSO and NGSO, and RRC state, what would be the answers to the respective satellite types?

RAN2 answer: For neighbor cell measurement, the parameters indicated in the response to the Question 1 are sufficient.

But following additional parameters are also needed for handover.

 (B6): For fixed cell, neighbor cell stop time and reference location.

 (B7): Epoch time of the ephemeris for the neighbor cell

 (B8): drift rates for common TA,

 (B9): Kmac (to determine UE-gNB RTT and perform RACH to target),

 (B10) beam information (e.g., cell reference point and radius of satellite beam).

1. Do you agree with the response to the Question 2?

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Your suggestion |
| MediaTek | No | B8 (drift rates for Common TA) is not needed. The need for B10 (beam information) is also not clear. |
| OPPO | No | A2 (common TA) is not needed. Instead, feeder link delay is needed.For handover, cell-specific K\_offset is also needed. |
| Nokia | No | B10 – is it something new, compared to the beam information provided in the legacy HO? B7 is needed as a part of HO command?  |
| Qualcomm | Yes | B8 (drift rates for Common TA) depends on whether feeder is compensated by the target cell.B10 is mainly for moving cell. B7 should come together with ephemeris of the neighbor cell.For Handover, ok to add cell-specific K\_offset. |
| vivo | No | For B6, neighbor cell stop time is not needed, and this is now under [Offline-102], Round-2, where the majority actually doesn’t think this is needed. B8 (drift rates for common TA) is not needed. B10 may not be needed since there is no RAN2 agreement for beam information, but final confirmation is pending RAN1 decision (so at least in this reply LS, RAN2 cannot include this information). |
| Xiaomi | No | The neighbour cell stop time in B6 is not needed since we only agree the stop time can be used for neighbour cell measurement. B8 is not needed since the feeder link delay is compensated by the network.We also don’t discuss the beam information in RAN2. |
| Huawei, HiSilicon | No | 1) SMTC should be mentioned since it is not included in the parameters listed by RAN4;2) On B6: Cell stop time and reference location are not only for handover, but also for measurements;3) On B7: We don’t think it’s necessary to introduce an epoch time specifically for neighbour cell ephemeris. The epoch time for serving cell ephemeris can be referenced;4) On B9: We think Kmac is not only useful for handover, but also useful for measurements if Idle mode UEs want to perform autonomous SMTC adjustment;5) On B10: There is no RAN2 agreement on this. And the cell reference point is duplicated with B6. |
| Intel | No | B6 and B10 are only for idle mode. B7-B9 are needed for handover as UE needs to perform uplink pre-compensation, but regrading measurement they seems to be unnecessary to take into account. |

Question-3: Would the parameters be available to UE, e.g. provided by serving cell, for measurements and mobility? If the answer is dependent on satellite types, e.g. GSO and NGSO, and RRC state, what would be the answers to the respective satellite types?

RAN2 answer: Yes.

1. Do you agree with the response to the Question 3?

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Your suggestion |
| MediaTek | yes |  |
| OPPO | Yes |  |
| Nokia | Yes |  |
| Qualcomm | Yes |  |
| vivo | Yes |  |
| Xiaomi | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Intel | Yes  |  |

Questions-4: What would be the expected UE behavior from the perspective of handover, measurement, and measurement reporting if any or all of the information listed above is not provided to the UE by a serving cell or if any of all of the provided information cannot be used by the UE because, e.g. the validity timer expires? If the answer is dependent on satellite types, e.g. GSO and NGSO, and RRC state, what would be the answers to the respective satellite types?

RAN2 answer: RAN2 assumes all the information needed for measurement and handover would be provided to the UE by the network. If any of the information is not available or is not valid, then the UE would have to acquire the system information of the target or neighbor cell which is not desirable from power consumption point of view.

1. Do you agree with the response to the Question 4?

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Your suggestion  |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Nokia | Yes | If this concerns the dedicated signalling in connected mode then we agree. |
| Qualcomm | Yes |  |
| vivo | Yes |  |
| Xiaomi | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Intel | Yes  |  |

## Draft reply LS to the [2] on Multiple SMTCs for NR NTN

The LS in [2] mentions this.

*As RAN4 RRM requirements are highly depended on SMTC configuration details, it is critical how many SMTCs can be concurrently activated and thus in use in defining measurement requirements. Besides, there are additional aspects on which RAN4 needs more input from RAN2 to begin defining relevant RRM requirements in detail. Thus, RAN4 would like to kindly ask RAN2 the following questions:*

A draft reply LS to the [2] on Multiple SMTCs for NR NTN is provided in [4]. Followings are questions from [2] and response from [4].

(Q1) Would there be any association information between SMTC and Cell/SSB-IDs and/or Satellite?

RAN2 answer: The association between SMTC and satellite is left to network implementation. The association between SMTC and the Cell will be signalled in newly introduced SMTC list (*SSB-MTC4List-r17*). For each SMTC, this list includes a list of cells that are following the signalled offset in *SSB-MTC4List-r17*. Existing SSB-MTC is still the baseline SMTC configuration.

RAN2 is also discussing on providing a list of cells the satellite is serving in the system information and RAN2 will further update on the progress.

1. Do you agree with the response to the Q1?

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Your suggestion  |
| MediaTek | Yes |  |
| OPPO | Yes  |  |
| Nokia | Not entirely | This mapping for SMTCs should actually associate them with the satellite (as this timing will likely differ between satellites). Cell IDs won’t help if there is no possibility to determine the cell id to satellite mapping.  |
| Qualcomm | Yes | We agree it would be better to map SMTC to satellite. |
| vivo | Yes |  |
| Xiaomi | Yes |  |
| Huawei, HiSilicon | No | The last sentence can be removed since there is not enough support for this according to the offline [102]. |
| Intel | Yes | Also agree with Huawei that “The last sentence can be removed” |

(Q2) Would there be any dynamic mechanism enabling/disabling or activating/deactivating the configured SMTCs for one measurement object?

RAN2 answer: RAN2 has agreed that there is no dynamic mechanism to activate and deactivate a configured SMTC.

1. Do you agree with the response to the Q2?

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Your suggestion  |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Nokia | Yes |  |
| Qualcomm | Yes |  |
| vivo | Yes |  |
| Xiaomi | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Intel | Yes  |  |

(Q3) Would the legacy SMTC lengths be re-used for NTN SMTC configuration, i.e. no additional NTN specific new SMTC lengths?

RAN2 answer: Yes

1. Do you agree with the response to the Q3?

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Your suggestion  |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Nokia | Yes |  |
| Qualcomm | Yes |  |
| vivo | Yes |  |
| Xiaomi | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Intel | Yes  |  |

(Q4) Would configuring multiple SMTCs overlapping with each other in the time domain for the same measurement object be allowed? If yes, would the SMTCs be allowed to be activated concurrently?

RAN2 answer: Yes. All the configured SMTCs can be used in parallel and may overlap in time domain for the same measurement object. There will be optional UE capability reporting whether UE is able to use 4 SMTCs in parallel. However, RAN2 is still discussing whether UE needs to report UE capability to use 2 SMTCs in parallel. Also, RAN2 is discussing UE-based solution whether a UE is allowed to select a SMTC among configured multiple SMTCs. RAN2 will further update on the progress.

1. Do you agree with the response to the Q4?

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Your suggestion  |
| MediaTek | Yes |  |
| OPPO |  | It seems the above answer does not address the issue on overlapping in time domain. I guess this should be allowed. |
| Nokia |  | Agree with OPPO, the answer should be simplified and focused on the actual question (‘’Yes, can be used in parallel and may overlap’’), instead of sharing details concerning the number of SMTCs and what RAN2 may decide on the UE capabilities.  |
| Qualcomm | Yes | This can be revised based on progress. |
| vivo | Yes |  |
| Xiaomi |  | Agree with Nokia. |
| Huawei, HiSilicon | No | There’s no agreement on overlapping SMTCs so far, but we don’t mind making a decision in this offline that it can be overlapped.Agree with Nokia we don't need excessive details. |
| Intel | Yes  |  |

(Q5) Whether and how would a valid time information of SMTC be defined?

RAN2 answer: RAN2 is discussing this as part of UE-based solution on the use of SMTCs. RAN2 will further update on the progress.

1. Do you agree with the response to the Q5?

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Your suggestion  |
| MediaTek | Yes |  |
| OPPO |  | We think this relates to the update of SMTC-related parameters, e.g. how to update the SMTC’s offset value for connected mode UEs and how to provide the updated ephemeris information. |
| Nokia | No | We agree with OPPO, the intention of this question was perhaps different – will there be a time validity mechanism for controlling the SMTC config? |
| Qualcomm | Yes | In any case, there is no agreement so far on this. |
| vivo | Yes |  |
| Xiaomi | No | This question may be intended to ask the valid time of SMTC configuration and not associated with UE-based solution. For example, if SMTC has been configured with a valid time, the SMTC configuration becomes invalid after the valid time. |
| Huawei, HiSilicon | No | We can simply reply that currently RAN2 has not introduced valid time for SMTCs. |
| Intel |  | It’s necessary to clarify that UE-based solution on the use of SMTCs is only for idle mode. And for NW based solution there is no valid time as NW can re-configure SMTC if needed. |

(Q6) Would the periodicities of multiple SMTCs configured by an MO be identical?

RAN2 answer: With newly introduced signaling (*SSB-MTC4List-r17*), only offset will be signalled differently, and periodicity and duration of the multiple SMTCs are identical for an MO.

1. Do you agree with the response to the Q6?

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Your suggestion  |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Nokia | Yes |  |
| Qualcomm | Yes |  |
| vivo | Yes |  |
| Xiaomi | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Intel | Yes |  |

(Q7) RAN4 would also like ask for clarification on the interpretation of “in parallel” in the LS R2-2109219 below, e.g. does it mean multiple SMTCs can be activated and in use simultaneously and the SMTCs can overlapping with each other?

RAN2 answer: Yes. See response to Q4.

1. Do you agree with the response to the Q7?

|  |  |  |
| --- | --- | --- |
| Company name | Yes/No | Your suggestion  |
| MediaTek | Yes |  |
| OPPO |  | But response to Q4 does not address the overlapping issue. |
| Nokia | Yes, but | Answer to Q4 should be revised.  |
| Qualcomm | Yes | Q4 answer can be revised. |
| vivo | Yes |  |
| Xiaomi | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Intel | Yes |  |

# Conclusion

TBD..

# Reference

[1] R2-2200129, “LS on NR NTN Neighbor Cell and Satellite Information (R4-2120309; contact: Qualcomm)”, To:RAN2 Cc:RAN1, RAN2#116bis-e, January 17-25, 2022.

[2] R2-2200128, “Reply LS on Multiple SMTCs for NR NTN (R4-2120308; contact: Qualcomm)”, To:RAN2, RAN2#116bis-e, January 17-25, 2022.

[3] Draft-R2-2201742, “Reply LS on NR NTN Neighbor Cell and Satellite Information”, To:RAN4 Cc:RAN1, RAN2#116bis-e, January 17-25, 2022.

[4] Draft-R2-2201741, “Reply LS on Multiple SMTCs for NR NTN”, To:RAN4, RAN2#116bis-e, January 17-25, 2022.