**3GPP TSG-RAN WG2 Meeting #119bis-e R2-2210855**

**Online, 10th-19th October, 2022**

**Agenda Item: 6.10.4.2**

**Source: Samsung**

**Title: Summary of [AT119bis-e][113][NR-NTN] epoch time and validity timer (Samsung)**

**Document for: Discussion and Decision**

# Introduction

This document is to summarize main proposals from the following contributions submitted under the A.I. 6.10.4.2 on NR NTN RRC connections, mainly covering aspects related to epoch time and validity timer.

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| 1. R2-2210466 Discussion on Epoch Time Samsung Research America discussion Rel-17 NR\_NTN\_solutions-Core
2. R2-2209799 Clarification on validity of the UL sync info Apple discussion Rel-17 NR\_NTN\_solutions-Core
3. R2-2210411 Discussion on epoch time Huawei, HiSilicon discussion Rel-17 NR\_NTN\_solutions-Core
4. R2-2210729 NTN Configuration at Handover and CHO Sequans Communications discussion Rel-17 38.331 NR\_NTN\_solutions-Core R2-2208659
5. R2-2209528 On timer T430 for Rel-17 NR NTN Ericsson discussion Rel-17
6. R2-2209850 Discussion on configuration of satellite information for handover ASUSTeK discussion Rel-17 38.331 NR\_NTN\_solutions-Core
7. R2-2209851 Discussion on T430 handling upon going to RRC\_IDLE ASUSTeK discussion Rel-17 38.331 NR\_NTN\_solutions-Core
8. R2-2209852 Clarification on validity timer for serving cell ASUSTeK discussion Rel-17 38.331 NR\_NTN\_solutions-Core
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# 2. Contact information

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| Company | Delegate contact |
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# Discussion

## 3.1 Serving cell

### Epoch time in the future

In the current TS 38.331, the procedure related to SIB19 acquisition is specified as follows.

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| 5.2.2.4.21 Actions upon reception of *SIB19*Upon receiving *SIB19*, the UE shall:1> start or restart T430 for serving cell with the timer value set to *ntn-UlSyncValidityDuration* from the subframe indicated by *epochTime*;NOTE: UE should attempt to re-acquire *SIB19* before the end of the duration indicated by *ntn-UlSyncValidityDuration* and *epochTime* by UE implementation.5.2.2.6 T430 expiryThe UE shall:1> if T430 for serving cell expires and if in RRC\_CONNECTED:2> inform lower layers that UL synchronisation is lost;2> acquire *SIB19* as defined in clause 5.2.2.3.2;2> upon successful acquisition of *SIB19*:3> inform lower layers that UL synchronisation is obtained; |

One issue discussed related to this procedure is that upon the UE acquires SIB19, the UL sync info (i.e., ephemeris, common TA parameters) may be invalid for a period of time before the SFN/subframe indicated by the epochTime, if the indicated epochTime is in the future. Then if T430 expires before the indicated epoch time, UE could be stuck with no valid UL sync info between the expiring time and the indicated epoch time. This issue was discussed in RAN2#119-e, and RAN2 agreed to wait for RAN1’s related discussion on backward propagation, i.e. whether the UL sync information is applied by the UE upon SIB19 acquisition or upon the indicated epoch time if the indicated epoch time is in the future. However, there is no consensus in RAN1 after extensive discussion.

[1] and [2] discuss this issue and propose to solve/avoid this issue by NW/UE implementation. In [2], the issue is discussed for connected UE and idle/inactive UE separately. And it is proposed that for the IDLE/INACTIVE UE, it’s up to UE implementation to acquire the SIB19 before T430 expiry.

Also note that in RAN2#119-e, the following agreement was already made.

Agreements:

1. It is left to UE implementation on how UEs in RRC\_IDLE/RRC\_INACTIVE re-acquire SIB19 for serving cell’s satellite assistance information.

**Question 1: Do companies agree that for the IDLE/INACTIVE UE, it’s up to UE implementation to acquire the SIB19 before T430 expiry?**

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| **Company** | **Agree/disagree** | **Additional comments** |
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It is also stated in [2] that for the IDLE/INACTIVE UE,

* If there is no attempt to initiate the RRC connection, this issue will not cause any problem;
* If the UE intends to initiate the RRC connection, if the gap length, i.e. duration between T430 expiry and epoch time in the future, is small then the issue could be ignored; if the gap length is big, we can leave it to UE implementation about whether UE could assume the UL sync is valid or not.

**Question 2: Do companies agree that for the IDLE/INACTIVE UE, it’s up to UE implementation whether UE assumes the UL sync info (i.e. ephemeris, common TA parameters) is valid during the gap between T430 expiry and the indicated epoch time in the future?**

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| **Company** | **Agree/disagree** | **Additional comments** |
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For the CONNECTED UE, it is stated in [2] that since NW can provide the NTN UL sync config via the RRC dedicated signaling (via ReconfigWithSync or the dedicated SIB19 delivery), this case can be avoided by the appropriate NW implementation. For connected UE, if the UE cannot acquire SIB19 due to no common search space configured with an active BWP, the NW sends UL sync info via dedicated RRC signal. In this case, the NW can ensure that the UL sync info is valid upon UE receives the dedicated RRC signal, so that the issue of future epoch time can be avoided.

**Question 3: Do companies agree that for the CONNECTED UE, if the UE cannot acquire SIB19 due to no configured common search space** **with an active BWP, it is up to the NW implementation to ensure the UL sync info in the dedicated RRC message is valid upon UE receives the message?**

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| **Company** | **Agree/disagree** | **Additional comments** |
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In another case for connected UE, i.e., if the UE can acquire SIB19, it is also proposed in [1] that the gap duration between T430 expiry and epoch time in the future can be avoided by by appropriate NW and UE implementation. The NW can indicate the epoch time for the start of the next validity duration that is no later than the end of the current validity duration. On the other hand, as captured in the NOTE, a smart UE should attempt to reacquire SIB19 before T430 expiry in a way that the epoch time of the new assistance information is before the expiry time.

**Question 4: Do companies agree that for the CONNECTED UE, if the UE can acquire SIB19, which of the following options is agreeable to solve the issue of epoch time in the future?**

* **Option 1: It is up to the NW implementation to ensure the UL sync info is always valid by providing the NTN UL sync info to UE via dedicated signaling?**
* **Option 2: It is up to NW and UE implementation that the epoch time of the next validity duration acquired in SIB19 is before the current T430 expiry.**
* **Option 3: other**

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| **Company** | **Option** | **Additional comments** |
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### Clarification for 5.2.2.4.21

In the current TS 38.331, the UE sets the length of T430 for serving cell to the value of *ntn-UlSyncValidityDuration* and(re)start the T430 from the subframe indicated by *epochTime*.

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| 5.2.2.4.21 Actions upon reception of *SIB19*Upon receiving *SIB19*, the UE shall:1> start or restart T430 for serving cell with the timer value set to *ntn-UlSyncValidityDuration* from the subframe indicated by *epochTime*;NOTE: UE should attempt to re-acquire *SIB19* before the end of the duration indicated by *ntn-UlSyncValidityDuration* and *epochTime* by UE implementation. |

However, the UE could receive multiple ntn-UlSyncValidityDuration and epochTime in SIB19, i.e., for serving cell and for neighbour cells. It is proposed in [8] to clarify in clause 5.2.2.4.21, ntn-UlSyncValidityDuration and epochTime for the serving cell (receiving in SIB19) are applied for T430 for serving cell.

**Question 5: Do companies agree in clause 5.2.2.4.21, clarification is needed that *ntn-UlSyncValidityDuration* and *epochTime* for the serving cell are applied for T430 for serving cell?**

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| **Company** | **Agree/disagree** | **Additional comments** |
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The text proposal to TS 38.331 is proposed in [8] for the clarification on UlSyncValidityDuration and epochTime for serving cell T430.

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| 5.2.2.4.21 Actions upon reception of *SIB19*Upon receiving *SIB19*, the UE shall:1> start or restart T430 for serving cell with the timer value set to *ntn-UlSyncValidityDuration* for the serving cell from the subframe indicated by *epochTime* for the serving cell;NOTE: UE should attempt to re-acquire *SIB19* before the end of the duration indicated by *ntn-UlSyncValidityDuration* and *epochTime* by UE implementation. |

**Question 6: If Q5 is agreed, do companies agree to adopt the TP in R2-2209852?**

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| **Company** | **Agree/disagree** | **Additional comments** |
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### T430 upon entering RRC\_IDLE

In [7], T430 upon entering RRC\_IDLE is discussed as follows. Currently, the UE would stop running timers including T430 upon going to RRC idle mode as following text in TS 38.331.

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| 5.3.11 UE actions upon going to RRC\_IDLEThe UE shall:[…]1> stop all timers that are running except T302, T320, T325, T330, T331 and T400;[…] |

This means the UE does not maintain T430 upon entering RRC idle mode even the satellite assistance information is still valid. The satellite assistance information provided in SIB19 would be applied in both RRC idle/inactive mode and RRC connected mode. The UE would perform UE-based SMTC adjustment based on the satellite assistance information in RRC idle mode. In the last RAN2 meeting, it was agreed to left UE implementation on how to re-acquire SIB19 for serving cell in RRC idle/inactive mode and how to re-acquire SIB19 for neighbour cells. The T430 should be handled in RRC idle/inactive mode by UE implementation. Therefore, it is proposed that the UE should not stop T430 upon going to RRC idle mode.

**Question 7: Do companies agree that UE should not stop T430 upon going to RRC\_IDLE.**

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| **Company** | **Agree/disagree** | **Additional comments** |
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## Neighbour cell

### Clarification on epoch time

In [3], the epoch time for neighbour cell is discussed. In the current TS 38.331, the field description for *epochTime* is as follows.

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| ***epochTime***Indicate the epoch time for the NTN assistance information. When explicitly provided through SIB, or through dedicated signaling, *EpochTime* is the starting time of a DL sub-frame, indicated by a SFN and a sub-frame number signaled together with the assistance information. The reference point for epoch time of the serving satellite ephemeris and Common TA parameters is the uplink time synchronization reference point. If this field is absent, the epoch time is the end of SI window where this SIB19 is scheduled. This field is mandatory present when provided in dedicated configuration. If this field is absent in *ntn-Config* provided via *NTN-NeighCellConfig* the UE uses epoch time from the serving satellite ephemeris, otherwise the field is based on the timing of the serving cell, i.e. the SFN and sub-frame number indicated in this field refers to the SFN and sub-frame of the serving cell. In case of handover, this field is based on the timing of the target cell, i.e. the SFN and sub-frame number indicated in this field refers to the SFN and sub-frame of the target cell. This field is excluded when determining changes in system information, i.e. changes to *epochTime* should neither result in system information change notifications nor in a modification of *valueTag* in SIB1. |

Based on previous agreements and the field description, it is clear that:

1. If epoch time for neighbour cell is absent in *ntn-Config* provided via *NTN-NeighCellConfig*, the UE uses epoch time for serving cell;
2. If epoch time for serving cell is absent, the epoch time is the end of SI window where this SIB19 is scheduled;

However, if both epoch time for serving cell and epoch time for neighbour cell are absent, it is unclear whether the UE can use the end of SI window where this SIB19 is scheduled as the epoch time for the neighbouring cell.

**Question 8: Do companies agree that if both epoch time for serving cell and epoch time for neighbor cell are absent, the epoch time for neighbor cell is the end of SI window where this SIB19 is scheduled?**

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| **Company** | **Agree/disagree** | **Additional comments** |
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In RAN1 #110, the following agreements were achieved:

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| **Agreement**For serving cell if EpochTime is indicated explicitly by a SFN and subframe number, the UE considers this frame to be the current SFN or the next upcoming SFN after the frame where the message indicating the Epoch time is received. For neighbor cell if EpochTime is indicated explicitly by a SFN and subframe number, the UE considers this frame to be the frame nearest to the frame where the message indicating the Epoch time is received. |

In RAN2#119bis-e, the following agreement is made.

Agreements:

1. In the field description of epochTime, include RAN1’s agreement on the interpretation of the SFN indicating the epoch time for serving cell and neighbor cell

The issues raised for neighbor cell epoch time in [3] is that if epoch time for neighbor cell is absent, and the epoch time for serving cell is reused, which rule will the UE follow to determine the SFN? For this issue, it is stated in [3] that since the serving cell epoch time is reused, the UE should comply with the SFN determination for serving cell.

**Question 9: Do companies agree that if epoch time for neighbor cell is absent, and the serving cell epoch time is reused for neighbor cell, UE considers the indicated SFN to be current SFN or the next upcoming SFN after the frame where the message indicating the Epoch time is received?**

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| **Company** | **Agree/disagree** | **Additional comments** |
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## 3.3 Target cell

### Epoch time for target cell

The interpretation of explicit epoch time, i.e. the indicated SFN and subframe number, for the target cell in HO/CHO is discussed in [1], [2], and [3]. In [3], it is noted that in RAN2#118-e, the following agreement was made.

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| Agreement: 1. During HO, the target cell’s epoch time (i.e. SFN and subframe number) is based on target cells’ timing.
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This means the epoch time (SFN and the subframe number) refers to the SFN and sub-frame of the target cell. UE can read the MIB message of the target cell to obtain the SFN during handover. Considering the SFN wraps around every 10.24s, the association between the SFN indicated by the epoch time and the SFN where the MIB is acquired is ambiguous for the UE. This is similar to the ambiguity for serving/neighbour cell epoch time, for which RAN1 agreement was made.

Then for the target cell, the SFN indicated by the epoch time may be same as the SFN where the MIB of target cell is acquired; the SFN indicated by the epoch time may be previous frame of the SFN where the MIB is acquired; the SFN indicated by the epoch time may be next frame of the SFN where the MIB is acquired. Or UE can directly read the SIB19 of the target cell during the handover and ignore the epoch time in HO command.

It is also proposed in [2] that UE considers the target cell as the neighbor cell to decide the reference frame/SFN of the epochTime, so that potential delay in waiting UL sync info to be valid can be avoided.

**Question 10: In case of HO, which of the following options is preferred?**

* **Option 1: if target cell EpochTime is indicated explicitly by a SFN and subframe number, the UE considers this frame to be the current SFN or the next upcoming SFN after the frame where the MIB of target cell is firstly acquired.**
* **Option 2: if target cell EpochTime is indicated explicitly by a SFN and subframe number, the UE considers this frame to be the current SFN or the previous SFN before the frame where the MIB of target cell is firstly acquired**
* **Option 3: if target cell EpochTime is indicated explicitly by a SFN and subframe number, the UE considers this frame to be the frame nearest to the frame where the MIB of target cell is firstly acquired.**
* **Option 4: the UE directly read the SIB19 of the target cell and ignore the epoch time in HO command.**
* **Option 5: if target cell EpochTime is indicated explicitly by a SFN and subframe number, the UE considers the frame to be the frame nearest to the frame where the message indicating the Epoch time is received**
* **Option 6: other**

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**Question 11: In case of CHO, which of the following options is preferred?**

* **Option 1: if target cell EpochTime is indicated explicitly by a SFN and subframe number, the UE considers this frame to be the current SFN or the next upcoming SFN after the frame where the MIB of target cell is firstly acquired.**
* **Option 2: if target cell EpochTime is indicated explicitly by a SFN and subframe number, the UE considers this frame to be the current SFN or the previous SFN before the frame where the MIB of target cell is firstly acquired**
* **Option 3: if target cell EpochTime is indicated explicitly by a SFN and subframe number, the UE considers this frame to be the frame nearest to the frame where the MIB of target cell is firstly acquired.**
* **Option 4: the UE directly read the SIB19 of the target cell and ignore the epoch time in HO command.**
* **Option 5: if target cell EpochTime is indicated explicitly by a SFN and subframe number, the UE considers the frame to be the frame nearest to the frame where the message indicating the Epoch time is received**
* **Option 6: other**

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### Validity duration for target cell

In the current TS 38.331, ntn-UlSyncValidityDuration-r17 is mandatory present for SIB19, and optionally present otherwise. This means, validity duration can be absent in dedicated RRC configuration, which can be reconfigurationWithSync for target cell. In this case, the UE needs to know how to set T430 upon handover even when ntn-UlSyncValidityDuration is absent. In [6], it is proposed to reuse the validity duration for the serving cell in SIB19.

**Question 12: Do companies agree that if validity duration is absent in reconfigurationWithSync for target cell, serving cell validity duration in SIB19 is reused?**

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| **Company** | **Agree/disagree** | **Additional comments** |
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### Use SIB19 for HO/CHO

In [4], whether UE can use SIB19 for HO/CHO is discussed. It is pointed out that at RAN2#119e meeting, the following related agreements related to target cell were reached.

Agreements:

1. During HO/CHO execution upon applying target cell configuration, UE should:

a. Stop the current T430 (if it is running);

b. Start T430 for the target cell as indicated by ntn-UlSyncValidityDuration and epochTime of the target cell

2. RAN2 understands that the UE can use assistance information of neighbour cells in SIB19 for mobility purposes in RRC Connected. FFS if this needs to be captured in Stage2 and whether something needs to be captured for RRC idle

For CHO, the NW has no knowledge of when the actual handover will take place. Typically, the validity of NTN-config might be around 1minute, while the CHO might be executed much later. It is then generally not possible for the NW to provide a NTN-config that be valid at the time of CHO execution in the HO message. Without valid target cell NTN-config, the UE has to acquire SIB19 of target cell, or the UE can use neighbour cell assistance information from serving cell SIB19 if the target cell is part of the neighbour cells listed in SIB19.

In the HO case, it can be expected that the target NTN-config is included in the HO message. However, there seems no reason to restrict this for CHO only and it would simplify specification and device implementation to keep common behaviors between CHO and HO.

Based on these considerations, it is proposed in [4] that UE should be able to use the target cell NTN-config IE from SIB19 for HO purpose.

**Question 13: Do companies agree that UE can use the target cell NTN-config IE from SIB19 for HO and CHO?**

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Furthermore, in CHO framework, the UE needs to decode the HO message only upon CHO execution. It might be preferable to keep this behavior and avoid a requirement to read the HO message before execution. In such case, it could be up to NW/UE implementation to provide/keep reading SIB19 up to date so that the target NTN-config is valid at the time of CHO execution.

**Question 14: If Q13 is agreed, do companies agree that it is up to NW/UE implementation to provide/keep SIB19 up to date so that the target cell NTN-config in SIB19 is valid at the time of CHO execution?**

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In the current TS 38.331, T430 for the target cell is captured as follows, wherein the validity duration and epoch time included in reconfigurationWithSync is applied by UE for target cell T430.

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| 5.3.5.5.2 Reconfiguration with syncThe UE shall perform the following actions to execute a reconfiguration with sync.1> stop timer T430 if running;1> start timer T430 with the timer value set to *ntn-UlSyncValidityDuration* from the subframe indicated by *epochTime*, if included in the *reconfigurationWithSync* for serving cell;1> if the AS security is not activated, perform the actions upon going to RRC\_IDLE as specified in 5.3.11 with the release cause '*other*' upon which the procedure ends; |

If UE can use target cell NTN-config in SIB19 for HO/CHO, the following TP is proposed.

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| 5.3.5.5.2 Reconfiguration with syncThe UE shall perform the following actions to execute a reconfiguration with sync.1> stop timer T430 if running;1> start timer T430 with the timer value set to *ntn-UlSyncValidityDuration* from the subframe indicated by *epochTime*, according to the target cell NTN-config;1> if the AS security is not activated, perform the actions upon going to RRC\_IDLE as specified in 5.3.11 with the release cause '*other*' upon which the procedure ends;NOTE: target cell NTN-config might be from *reconfigurationWithSync* or SIB19 |

**Question 15: If Q13 is agreed, do companies agree to adopt the TP in R2-2210729 for TS 38.331 clause 5.3.5.5.2?**

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| **Company** | **Agree/disagree** | **Additional comments** |
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### T430 related to HO

In [5], T430 handling related to HO failure is discussed as follows. If UE ends up performing re-establishment procedure due to HO failure, at this point the T430 timer has been started for the target cell as it was started in 5.3.5.5.2 when executing reconfiguration with sync. Thus, when initiating the re-establishment procedure, the UE needs to stop T430 for the target cell and, after the cell selection procedure, restart T430 with the timer value from the source cell or from the new serving cell depending on which cell is selected in the cell selection procedure.

**Question 16: Do companies agree that when initiating the re-establishment procedure due to HO failure, the UE stops T430 for the target cell?**

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| **Company** | **Agree/disagree** | **Additional comments** |
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Upon UE selecting a suitable cell in RRC re-establishment procedure, the UE has to acquire SIB19 if the selected cell is an NTN cell and start T430 timer for the serving cell. The following two options are proposed in [5] to specify this UE behaviour.

**Question 17: Which option is preferred to specify UE behaviour upon UE selecting a suitable NTN cell in RRC re-establishment procedure?**

**Option 1: specify procedural text in in Clause 5.3.7.3.**

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| 5.3.7.3 Actions following cell selection while T311 is runningUpon selecting a suitable NR cell, the UE shall:1> ensure having valid and up to date essential system information as specified in clause 5.2.2.2;1> if the selected cell is an NTN cell:2> acquire SIB19 as defined in clause 5.2.2.3.2;1> stop timer T311;**…****<<omitted>>** |

**Option 2: capture in the note in Clause 5.2.2.4.21**

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| 5.2.2.4.21 Actions upon reception of *SIB19*Upon receiving *SIB19*, the UE shall:1> start or restart T430 for serving cell with the timer value set to *ntn-UlSyncValidityDuration* from the subframe indicated by *epochTime*;NOTE: UE should attempt to re-acquire *SIB19* before the end of the duration indicated by *ntn-UlSyncValidityDuration* and *epochTime* or if timer T430 is stopped by UE implementation. |

**Option 3: other**

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| **Company** | **Option**  | **Additional comments** |
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Furthermore, the timer table in clause 7.1.1 needs to be updated to capture the new starting and stopping conditions for T430 in HO/CHO.

**Question 18: To update the start and stop condition of T430, do companies agree to adopt the following TP in R2-2209528?**

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| T430 | Start or restart from the subframe indicated by *epochTime* upon reception of SIB19, or upon reception of *RRCReconfiguration* message including *reconfigurationWithSync*, or upon conditional reconfiguration execution i.e. when applying a stored *RRCReconfiguration* message including *reconfigurationWithSync* | Upon reception of *RRCReconfiguration* message including *reconfigurationWithSync* , or upon conditional reconfiguration execution i.e. when applying a stored *RRCReconfiguration* message including *reconfigurationWithSync* | Perform the actions as specified in 5.2.2.6. |

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| **Company** | **Agree/disagree** | **Additional comments** |
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# 4. Summary and Proposals

This section summarizes the main proposals:

# 5. References

1. R2-2210466 Discussion on Epoch Time Samsung Research America discussion Rel-17 NR\_NTN\_solutions-Core
2. R2-2209799 Clarification on validity of the UL sync info Apple discussion Rel-17 NR\_NTN\_solutions-Core
3. R2-2210411 Discussion on epoch time Huawei, HiSilicon discussion Rel-17 NR\_NTN\_solutions-Core
4. R2-2210729 NTN Configuration at Handover and CHO Sequans Communications discussion Rel-17 38.331 NR\_NTN\_solutions-Core R2-2208659
5. R2-2209528 On timer T430 for Rel-17 NR NTN Ericsson discussion Rel-17
6. R2-2209850 Discussion on configuration of satellite information for handover ASUSTeK discussion Rel-17 38.331 NR\_NTN\_solutions-Core
7. R2-2209851 Discussion on T430 handling upon going to RRC\_IDLE ASUSTeK discussion Rel-17 38.331 NR\_NTN\_solutions-Core
8. R2-2209852 Clarification on validity timer for serving cell ASUSTeK discussion Rel-17 38.331 NR\_NTN\_solutions-Core