3GPP TSG-RAN WG2 Meeting #115 Tdoc R2-2109025

Electronic, August 9th - 13rd 2021

Agenda: 8.10.3.3

Source: Ericsson

Title: [Pre115-e][103][NTN] Summary of AI 8.10.3.3 - CHO and NTN -TN mobility aspects only (Ericsson)

Document for: Discussion, Decision

# 1 Introduction

This feature summary for 8.10.3.3 includes

1. include proposals to further progress on CHO

2. the discussion on TN/NTN service continuity

* [AT115-e][103][NTN] CHO and NTN -TN mobility aspects (Ericsson)

Scope: Continue the discussion on the proposals in [R2-2109025](file:///C:\Data\3GPP\RAN2\Inbox\R2-2109025.zip)

Intended outcome: Summary of the offline discussion with e.g.:

* + - List of proposals for agreement (if any)
    - List of proposals for further discussion
    - List of proposals that should not be pursued (if any)

Initial deadline (for companies' feedback): Thursday 2021-08-19 1000 UTC

Initial deadline (for rapporteur's summary in R2-2108890): Thursday 2021-08-19 1600 UTC

Proposals marked "for agreement" in R2-2108890 not challenged until Friday 2021-08-20 1000 UTC will be declared as agreed via email by the session chair (for the rest the discussion will further continue offline until the CB session in Week2).

SMTC and measurement gap related discussion is not in this summary.

# 2 Conditional HO for NTN

### 2.1 CHO location trigger definition and RRM location event

Both CHO and RRM location reporting event trigger are discussed jointly as earlier concluded by RAN2. Related agreement from RAN2113:

Agreements:

3. The location in location-based CHO execution triggering for NTN describes the distance between the UE and the reference location of the cell (serving cell or the target cell). FFS what the reference location of the cell is (e.g cell center or other) and how this is provided to the UE

Related agreement from RAN2114:

Agreements via email (from offline 104):

1. Support CHO location trigger as the distance between UE and a reference location which may be configured as the serving cell reference location or the candidate target cell reference location. FFS if combination can be allowed.
2. The reference location for the event description is defined as cell center.

**Configuration details of the location trigger event**

Definition of the reference location may be related to serving cell or candidate target cell or it may be a combination. In last meeting it was agreed that reference location may be serving cell or target cell reference point and the combination is FFS. When the reference location is either serving or candidate target cell reference location and a distance, the shape of the triggering threshold is s sphere. When the threshold is combination of serving and candidate target, a line defines the triggering threshold and “cell shape” becomes a polygon.

For serving and candidate target cell reference points the natural event descriptions that follow are:

***condEvent L1: Distance between UE and the PCell’s reference location becomes larger than threshold.***

***condEvent L2: Distance between UE and the Conditional reconfiguration candidate becomes shorter than threshold.***

Related company proposals listed here:

*There are multiple reference points defined per cell to be jointly used for determining the cell center in NTN[7]*

*The joint configuration of reference locations for source and target cell for CHO execution triggering in NTN is supported in Rel-17.[7]*

*It is supported the UE distance difference of the target cell and the service cell (the combination of the) as the CHO location trigger condition.[3]*

*Both serving cell reference location and the candidate target cell reference location need to be provided to the UE.[4]*

*The location information of cell center can be a part of ephemeris information for location based CHO triggering event.[17]*

*Network provides either serving cell or target cell reference location for location-based CHO.[8]*

*The UE shall perform CHO evaluation while the distance between the UE and the cell center is lower than a threshold, based on the measurement results. If the CHO evaluation satisfies the cell quality condition, the UE executes CHO to the cell.[12]*

*The reference location of the PCell and each conditional reconfiguration candidate cell should be configured to UE.[28]*

*A new measurement quantity refers to the distance to the reference location, i.e. the cell center, should be introduced.[28]*

*Decide if the location based CHO trigger is with respect to the centre of the serving cell or the target cell.[25]*

*What information to be provided in CHO configuration, system information etc need to await further progress in ephemeris discussions.[25]*

*Aligned with CHO, the location-based measurement event triggering for NTN is based on the distance between the UE and a cell center (for serving cell and/or for neighbor cells).[29]*

*As the agreement already supports serving or target cell reference location, the FFS is only about whether a combination is supported.*

1. Discuss whether combination of serving and target cell reference location is supported for location report trigger event and for CHO location trigger

**Question 1 Should combination of serving and target cell reference location be supported for location report trigger event and for CHO location trigger?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/no** | **Comments** |
| Lenovo | Yes | It could be an A5-like event: Distance between UE and the serving is greater than threshold1 and/or distance between UE and the target is less than threshold2. |
| MediaTek | Yes | The combination can also be used for location trigger. |
| Ericsson | yes | Would provide more flexibility |
| ZTE | Yes | It cound be like A3/A5 event as we proposed below:   * condEvent L3: Distance between UE and the PCell’s reference location becomes offset larger than the distance between UE and the Conditional reconfiguration candidate. * condEvent L5: Distance between UE and the PCell’s reference location becomes larger than absolute threshold1 AND the distance between UE and the Conditional reconfiguration candidate becomes shorter than absolute threshold2. |
| OPPO | Yes |  |
| Thales | Yes |  |
| vivo | Yes | From our perspective, our preference is to only consider A3-like and A5-like events as in the legacy way. It can be seen that both serving cell reference location and the target cell reference location need to be supported, at least A5-like trigger event is used. |
| CATT | YES | We can’t preclude the alternative of combination of serving and target cell reference location, which is like the A3 or A5 event condition of RRM measurement. It need be specified. Which event be used for UEs is depend on implementation. |
| Sony | No | The serving or target cell reference location should be enough. Not sure the additional benefits from the combination one. |
| Xiaomi | Yes | Combination of serving and target cell reference location should be supported for CHO location trigger.  How to configure CHO location trigger, including configuration serving or target cell reference location alone or combination can be up to NW implementation.  Similar to radio-based event, configuration serving cell reference location alone for location trigger is like the description of A1 and A2, configuration target cell reference location alone for location trigger is like the description of A4, and combination both is like A3 and A5. |
| Nokia | Yes | It should be possible to use both the reference location of the serving and the target cell. The UE can then trigger the CHO when it is closer to the target than to the source. It would be also beneficial if UE’s movement direction could be taken into account (although this is more complicated to be specified). |
| Samsung | No | We assume configuration either serving cell reference location or target cell reference location would be sufficient. Combination of serving cell reference location and target cell reference location sounds good, but we are not convinced whether with the additional UE complexity and specification efforts, it is really required on top of configuration either serving cell reference location or target cell reference location. |
| LG | Yes | Location-based combination can be supported. |
| Qualcomm | No | Why do you want to make complicated triggering condition (see above Nokia, Samsung also agree with it)?  We are trying hard to reduce signaling overhead. There are proposals to move common parts from CHO command to broadcast message. Simply network does not need to signal both serving and target cell reference location information while either one reference location of target or serving cell works.  Why do you want to increase overhead for CHO signaling? |
| InterDigital | Yes | Similar to A3 and A5 radio-based event |
| Intel | Yes |  |
| Apple | Yes | Combination can definitely be used. |
| China Telecom | Yes | Similar with A3/A5 events |
| Huawei,HiSilicon | No | There is no agreement to support location report in NTN. Current R16 mechanism is only for MDT feature with User Consent.  But we agree location combination can be used for CHO trigger. |
| Turkcell | Yes | Combination of serving and target cell reference location can be used for location trigger. |
| KT | Yes |  |
| CMCC | Yes |  |
| Rakuten Mobile | Yes | It should be possible to provide both, If signalling load is a concern then operator can configure an event solely based on one of the trigger. |
| BT | Yes |  |
| Spreadtrum | Yes | Combination of serving and target cell reference location shall be suitable to trigger the handover. |
| NEC | Yes | We see the similarity between location based event to radio signal based events, so yes, combination of distances to serving cell and target cell should be considered. |
| ITRI | Yes | Similar to A3/A5 events. |

If combination of serving cell and candidate target cell reference locations are supported then there is variety of event descriptions that can be discussed. For example:

***condEvent L3: Distance between UE and the PCell’s reference location becomes offset larger than the distance between UE and the Conditional reconfiguration candidate.***

***condEvent L4: Distance between UE and the PCell’s reference location becomes larger than absolute threshold1 AND the distance between UE and the Conditional reconfiguration candidate becomes shorter than absolute threshold2.***

1. If combination is supported, start discussing event descriptions for the combination of reference locations

**Question 2 In case combination of serving and target cell reference location is supported for location report trigger event and for CHO location trigger, please express whether you support one of given examples of the event descriptions, CondEvent3 or CondEvenet4, or give an alternative?**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Support for Condevent3** | **Support for Condevent4** | **Other suggestions** |
| Lenovo | Yes | Yes | L3 is A3-like and L4 is A5-like. CondEvent3， CondEvent4 and CondEvent5 can be considered, which is up to gNB configuration. |
| MediaTek | No | Yes (assuming it is Condevent L4) |  |
| Ericsson | Not sure | yes | Simple is better |
| ZTE | Yes | Yes | Although we are fine with both condEvent L3 and condEvent L4, we understand configuring condEventL4 would be easier for NW. We can start with condEventL4. |
| OPPO | Yes | Yes |  |
| Thales | Not sure | Yes |  |
| vivo | Yes | Yes | Since the events are used to trigger CHO, we think only A3-like and A5-like events need to be considered as in the legacy way, and the above Condevent3 and Condevent 4 are just to imitate how A3 and A5 events are defined. |
| CATT | Yes | Yes | Condevent3 is simlar as A3, and Condevent4 is simlar as A5. |
| Sony | No | No | Unlike radio link quality, the distance comparison between serving and target cell is not adequent to trigger the handover. |
| Xiaomi | Yes | Yes | L3 is A3-like event and L4 is A5-like event. These two events is enough for the case of combination of serving and target cell reference location. We do not need to consider other new event for the combination, except for some special case. |
| Nokia | Not necessary | Yes | Cell-specific conditions can be checked independently (not cell against cell, as it would be for A3-like event). Of course, the combination with radio-based measurement event shall not be forgotten. |
| Samsung |  |  | No combination is preferred. |
| LG | No | Yes | Distance comparison by offset seems not reliable. |
| Qualcomm | No | No |  |
| InterDigital | Yes | Yes | Both could be supported and are similar to A3/A5 radio events. |
| Intel | No | Yes | ComdEvent4 seems simpler and fullfills the intended prurpose |
| Apple | No | See Comments | Provided it is always in conjunction with radio measurements. |
| China Telecom | Yes | Yes |  |
| Turkcell | Yes | Yes |  |
| KT | Yes | Yes |  |
| CMCC | Yes | Yes | Similar to A3 and A5 event, details depend on the NW configuration. |
| Rakuten Mobile | Yes | Yes |  |
| Spreadtrum | No | Yes |  |
| NEC | Not sure | Yes | But we are fine to provide all options in specification, and up to network to use it or not. |
| ITRI | Not sure | Yes | L4 is similar to A5 event. Distance offset may limit to the case of same beam footprint size. |

Another aspect of the event definition is the entry and leaving conditions as well as hysteresis and time to trigger. Both hysteresis and time to trigger has been proposed to be included in [25] and the TP provided in [28] also has those.

1. Both hysteresis and time to trigger is supported for location based trigger event

**Question 3 Please state if you support Proposal 3?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/no** | **Comments** |
| Lenovo | Yes | Hysteresis and TTT are necessary for a trigger event for robustness purpose. |
| MediaTek | Yes (GEO), No (LEO) | For LEO it is not necessary as the satellite’s speed will be much higher than UE’s speed. |
| Ericsson | yes | We discuss what is supported in standard, use is per implementation. Also, LEO has fixed beams where cells do not move like in moving beam case |
| ZTE | Yes | Agree with Lenovo that hysteresis and TTT are necessary for a trigger event for robustness purpose. |
| OPPO | Yes |  |
| Thales | Yes |  |
| vivo | Yes | Same as the legacy RSRP-based trigger event, hysteresis and time to trigger are used to avoid the ping-pong effect. |
| CATT | Yes |  |
| Sony | Yes |  |
| Xiaomi | Yes | Because of the movement of UE and satellites, if loaction-based trigger event has been configured without hysteresis and time to trigger, UE may frequently change the state of the location based event, such as from fulfilled to non-fulfilled or from non- fulfilled to fulfilled, which may result in ping-pong handover. |
| Nokia | Yes | Should be configurable |
| Samsung | Neutral | For radio measurement in traditional TN, the measurement result can be more dynamically fluctuated dependent on the environment, UE speed, etc., so both hysteresis and time would be helpful to report reliable measurement results. However for GNSS based UE location, we’re not sure whether same or similar level problem can happen or not. On the other hand, if we apply hysteresis and time, it can delay actual HO timing. |
| LG | Yes | Hysteresis and TTT should be introduced. |
| Qualcomm | No | This is not necessary when configured with existing A4/A3or A5 which contains the hysteris and TTT. |
| InterDigital | Yes |  |
| Intel | Yes |  |
| Apple | Yes for  GEO | Same understanding as MTK. For LEO, the satellite mobility should typically take the parameters worse irrespective of fixed or moving beams |
| China Telecom | Yes |  |
| Huawei,HiSilicon | Yes |  |
| Turkcell | Yes |  |
| KT | Yes |  |
| CMCC | Yes for GEO | Hysteresis and TTT is beneficail for GEO scenarios without high-speed movement of satellites. |
| Rakuten Mobile | Yes |  |
| Spreadtrum | Yes | Considering the robustness, hysteresis and time to trigger shall be used. |
| NEC | Yes |  |
| ITRI | Yes |  |

**Report content**

*Location-based measurement and RSRP/RSRQ measurement can be reported in the same RRC message to the network, no matter which (e.g. location-based or RSRP) measurement event is fulfilled.[1]*

*Location and radio measurement reports are at the same time.[5]*

*Piggyback location information in measurement report.[5]*

*UE should report the distance information to a cell in a measurement report triggered by a location-based measurement event.[29]*

*RAN2 to agree and discuss details of index based location reporting[25]*

The format of the location in the location report is assumed this is discussed in another AI (LCS).

The aspect that network can configure location report to be piggybacked to the measurement report message is already supported. RAN2 can discuss whether measurement reports can be configured to be piggybacked when location based event triggers.

1. Discuss whether measurement reports can be configured to be piggybacked when location based event triggers

**Question 4 Should RRM measurement result be piggybacked with location report when location based is event triggered, if so configured?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/no** | **Comments** |
| Lenovo | Yes | Piggybacking measurement reports upon location event can be configurable by NW. |
| MediaTek | Yes |  |
| Ericsson | Yes |  |
| ZTE | Yes |  |
| OPPO | Yes |  |
| Thales | Yes |  |
| vivo | Yes | RSRP based radio measurement result is important for NW to make the handover decision. Agree with Lenovo, piggybacking measurement reports upon location event can be configurable by NW. |
| CATT | Yes |  |
| Sony | Yes |  |
| Xiaomi |  | Beacuse location based event to trigger location report has not been agreed in NTN. **If the location based event in Q4 means using location information to trigger UE location report**, we need to discuss whether using location-based event to trigger UE location report can be supported first. If it was agreed, then we can discuss Q4.  We don’t support introducing a new location based event to trigger UE location report. We don’t need extra procedures to report UE location information.  For handover, UE don’t need to report UE location information to NW, if NW configured loaction based CHO event which is enough for UE to be handed over to target cell in NTN.  If UE location is required by the network, the existing procedure in spec has already supported UE location report by being piggybacked to RRM measurement report. |
| Nokia | Not necessary | As pointed out above, location information can be piggybacked in the radio-based measurement reporting. Standalone location reporting can also happen in the event-triggered manner. So that should be sufficient. |
| Samsung | Yes |  |
| LG | Yes |  |
| Qualcomm | Yes | We are open to discuss whether empty measurement report with location information is possible. |
| InterDigital | Yes | If so configured. |
| Intel | Yes |  |
| Apple | Yes |  |
| China Telecom | Yes | It is efficient to piggyback location report in RRM measurement. |
| Huawei,HiSilicon | No | Agree with Xiaomi, there is no conclusion for UE to send location report when location based event is triggered. In our understanding, if the location based event is triggered, the UE will report the corresponding measurement results. Whether the location info can be included depends on UE consent as in MDT. |
| Turkcell | Yes |  |
| KT | Yes |  |
| CMCC | Yes |  |
| Rakuten Mobile | NO | Agree with Huawei, Xiaomi there is no conclusion on UE to send location report when Location based event is triggered. |
| Spreadtrum | Yes |  |
| NEC |  | Trigger of measurement report and what to report could be discussed separately in our understanding, and we should reuse the current signaling as much as possible.  we think RRM measurement result should alway be included in measurement report regardless how the measurmenet report is triggered either by location-based event or signal level based event. |
| ITRI | Yes |  |

**Periodical reporting**

*Support event trigger and periodic location reporting of UE in NTN.[5]*

*RAN2 to discuss the feasibility of periodic location reporting as an addition to the event triggered based.[25]*

1. RAN2 to discuss whether periodic reporting of location should be supported for NTN.

**Question 5 Should periodic reporting be supported for location reporting?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/no** | **Comments** |
| Lenovo | No | There is no such need if we supported location event based triggering. |
| MediaTek | No | We do not see a strong justification for periodic location report. |
| Ericsson | yes | RRM can be configured also with periodic so we could follow the same here |
| ZTE | No | Location event based triggering would be sufficient. |
| OPPO |  | It is not clear what reporting quantity is referred to here. Is it the distance from reference point or UE location? |
| Thales | Yes |  |
| vivo | No strong view | In order to ensure the flexibility of network configuration, periodic reporting and event triggered reporting can be supported in RRC connected mode which is similar to TN. But we are also fine to go with only the event triggered manner, if the majority would like to go with this way for simplicity. |
| CATT | Yes | NW should compensate the SMTC based on the location. RRM can be configured also with periodic. Location reporting should align with RRM |
| Sony | Yes |  |
| Xiaomi | No | We don’t need extra procedures to report UE location information.  In spec, it has been supported that network can configure location report to be piggybacked to the measurement report message including event triggered and periodic report. We can reuse the existing procedures for location report in NTN. |
| Nokia | No | We think the signalling overhead would be too excessive, compared to the expected gains. Event-triggered is sufficient. |
| Samsung | Yes |  |
| LG | No | Periodic location reporting is not needed and location event-based triggering is enough. |
| Qualcomm | Yes | In some case, event trigger may not be sufficient. UE may be staying in wrong location without meeting any trigger condition (i.e., without reporting location for example threshold configured was not accurate to detect UE mobility). It is better to cover such cases with periodic reporting, though periodicit can be large. |
| InterDigital | No | Event-based triggers would be sufficient. However a type of periodic measurement reporting could be supported if location info is configured to be piggybacked onto a periodic measurement report. |
| Intel | No | It is not clear whether periodic reporting may be as useful when triggering reporting of location. If majority of companies support this, we wonder if this should be tie with other trigger event e.g. when UE is mobile |
| Apple | No |  |
| China Telecom | Yes | Agree with Ericsson. And we think it is useful for NW to make sure and update the latest CHO configuration. |
| Huawei,HiSilicon | No |  |
| Turkcell | Yes | Event based triggers may not be sufficient. |
| KT | No |  |
| CMCC | Yes | However, from our perspective, event trigger can be prioritized over periodic reporting. |
| Rakuten Mobile | No |  |
| Spreadtrum | No | Event triggering report is sufficient. |
| NEC |  | Is it already possible to configure periodic measurement report and ask to include location in the measurement report ? |
| ITRI | No | The overhead of periodic location report is high but the benefit seem to be not significant with comparing with event-based location report. |

### CHO time trigger definition

Related agreement from RAN2#113:

Agreements:

1. Timing information in CHO execution triggering for NTN describes the time after which the UE is allowed to execute CHO to the candidate target cell.

2. Working assumption: the timing information for CHO execution triggering in NTN is defined in the form of a timer/timers. This can be revised and a solution based on UTC/system frame number can be considered if problems are found (e.g. if the timer lacks accuracy due to RTT in NTN).

Related agreement from RAN2#114:

Agreements via email (from offline 104 – second round):

1. CHO time trigger event is defined as time duration [t1, t2] associated for each CHO candidate cell. The UE shall execute CHO to that candidate cell during the time duration, if all other configured CHO execution conditions will apply and there is only one triggered candidate cell.

To recap, RAN2 has agreed on *timing information* about candidate target cell after which CHO is allowed. Additionally, in following meeting RAN2 has agreed on *trigger event* which says UE shall execute CHO to that candidate cell during the time window denoted by [t1] and [t2] given the other configured triggers are fulfilled.

[t1] would then represent the earliest point in time when the UE can perform CHO to the candidate target cell. This is does not have to be same as *timing information* that was agreed at the RAN2#113bis meeting. The timing information may e.g. say when cell is available to know when earliest the cell can be measured and the [t1] may be the earliest time when to perform HO to that candidate target cell given other conditions are fulfilled.

[t2] represent the end of the time window, i.e. the latest point in time when the UE shall perform CHO to the candidate target cell.

One discussion point in the proposals brought to this meeting is whether to express the *timing information* and/or the *trigger event* with UTC times or timers or a combination.

Further, there is a suggestion to implement the time duration by providing the UE with two CHO configurations for the same candidate target cell, where the first CHO configuration would consist of two conditional events (MeasId’s), a time based condition event set to a value representing [t1] and a measurement based condition (A3, A4 or A5), and the second CHO configuration would consist of only one conditional event (MeasId), a time based condition event set to a value representing [t2]. The two CHO configurations will be evaluated separately by the UE. Consequently, if the condition (t ≥ t1 AND CondEventA3/A4/A5) is fulfilled in the first CHO configuration, the UE performs CHO to the candidate target cell. If the condition in the first CHO configuration is not fulfilled, the UE will perform CHO to the target candidate cell when the condition t > t2 is fulfilled in the second CHO configuration.

*RAN2 to clarify that t2 indicates the latest time when the UE is allowed to trigger CHO on the associated candidate cell.[4]*

*An absolute time value and a time offset can be used to describe [t1, t2]. An absolute time value (e.g., UTC) to indicate the start time (i.e., t1) and a time offset to indicate the valid time range allowing the UE to trigger CHO on the associated candidate cell (i.e., the length of time from t1 to t2).[4]*

*FFS RAN2 to discuss whether information related to when candidate target cell becomes available is a timer, UTC, or a time range[6]*

*In time-based CHO condition, timer value is provided to UE with respect to a reference time.[8]*

*Time duration for time-based CHO is defined as CHO validity period. CHO command is released after the time duration if the CHO command is not executed.[8]*

*For the time condition-based CHO, if cell quality condition and time period [t1, t2] is configured in CHO configuration, the UE performs CHO evaluation of the cell during the time period based on the measurement results and the UE shall execute CHO to the cell if the cell quality condition is satisfied as a results of CHO evaluation.[12]*

*RAN2 confirms that the time duration [t1, t2] for CHO execution condition is defined in the form of timers.[15]*

*When the UE receives the CHO configuration including time duration condition, UE starts the first timer T1. When the first timer T1 expires, the UE starts the timer T2.[15]*

*The UE can perform CHO when the timer T2 is running in the case that only time-based condition is configured for this candidate cell.[15]*

*UE starts the timer T1 but does not evaluate measurement-based condition immediately upon receiving the joint condition of timer-based condition and measurement-based condition.[15]*

*UE evaluates the measurement-based condition in the configured time duration.[15]*

*UE can perform CHO towards the corresponding candidate cell when the measurement-based condition is met in the configured time duration.[15]*

*For the time duration [t1, t2], t1 shall not be earlier than the time when candidate target cell becomes available and t2 shall not be later than the time when serving cell stops serving the area and the time when candidate target cell stops serving the area.[17]*

*RAN2 should discuss how to describe the time duration [t1, t2], such as two thresholds of UTC, two timers or one threshold of UTC and one timer.[17]*

*Implementation wise the time window denoted by [t1] and [t2] can be realized by providing the UE with two CHO configurations for the same candidate target cell where the first CHO configuration contains two condition events, a time based condition event [t1] and a measurement condition (A3, A4 or A5), and the second CHO configuration contains a single condition event, a time based condition event [t2].[25]*

*Define a time based CHO trigger event with the time expressed as an absolute time, or a system frame number, when the UE is to perform the CHO to the candidate target cell.[25]*

*The time event has entry condition only.[25]*

*The timing information for CHO execution triggering in NTN is defined in the form of UTC time.[28]*

*Down select from the following solutions to configure the timing information for CHO execution triggering in NTN:[28]*

* Solution 1: Two UTC time to indicate the start and end time of the candidate cell.*

* Solution 2: A start UTC time with a duration to indicate the valid time range of the candidate cell.*

1. RAN2 to discuss whether timing information and t1 are understood as different parameters or same .

**Question 6 Please state whether you agree that timing information of candidate target cell can be given in respective RRCReconfiguration message irrespective of time trigger event t1, t2?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/no** | **Comments** |
| Lenovo | Yes | The timing information of candidate target cell was agreed in the ptionaln for feeder/service link switch due to satellite movement, which is used to notify UE when a target cell stops serving. The time trigger event [t1, t2] as discussed hereby is for CHO, which is is used to indicate UE the time duration of evaluating CHO execution. |
| MediaTek | No | According to our understanding the tming information and t1 are the same. |
| Ericsson | Yes | It would be ptional if network can provde the info and it would only help UE about when to start measurements, or if extended it could be the period when target cell is appearing at all. T1 is set by network and definitely is not mandated to be when candidate target is going to be available. |
| ZTE | No | *RAN2#113e:Timing information in CHO execution triggering for NTN describes the time after which the UE is allowed to execute CHO to the candidate target cell.*  *RAN2#114e: CHO time trigger event is defined as time duration [t1, t2] associated for each CHO candidate cell. The UE shall execute CHO to that candidate cell during the time duration, if all other configured CHO execution conditions will apply and there is only one triggered candidate cell.*   * We understand the RAN2#114e agreement further explains the details of the RAN2#113e agreement with the t1 indicates the start time and t2 indicates the end time of a candidate target cell. * I remember there has been discussion in RAN2#113e on whether to have the start time or the end time or both while we finally agreed on the start time and left it open for the end time. With the further agreement in RAN2#114e, we actually confirmed to have both start time and end time for a candidate target cell. |
| OPPO | No | We understand they are the same. |
| Vivo | No | From our perspective, the *time information* argeed in RAN2#113bis-e is the same as *t1* agreed in RAN2#114e, which means the earliest time that the UE is allowed to perform HO to that candidate target cell given other conditions are fulfilled.  It is not necessary to introduce another timing information other than t1 and t2. If the question intends to ask whether another timing information is needed to perform measurement, then perhaps reusing t1 (e.g. as a starting time for measurement) is already sufficient. |
| CATT | Yes |  |
| Sony | No | Agree with Mediatek |
| Xiaomi | No |  |
| Nokia | No | Agree with some of the preceding comments. We think this question is irrelevant. As was commented by many during the pre-meeting thread, timing information was a general term used prior to clarifying at RAN2-114 that it is defined as time window [t1, t2]. Please remove the confusion from this discussion. |
| Samsung | No | We think the timing for CHO execution triggering is same as t1 to t2 (based on the wording timing for CHO execution). Note it does not mean all t1 to t2 for all candidate cells should be same. We understand each candidate cell can be configured with the different t1 to t2, but we don’t see the real need of additional timing on top of candidate cell specific t1 to t2. |
| LG | No | The agreement in RAN2#114e is further updated version of agreement in RAN2#113e that the stop timing [t2] is newly added. So the “timing information after which the UE is allowed to execute CHO to the candidate cell“ is same with [t1]. |
| Qualcomm | No | No timing information other than (t1,t2) is needed. |
| InterDigital | No |  |
| Intel | No | We understand that t1 and t2 are sufficient. |
| Apple | No | Agree with MTK |
| Huawei,HiSilicon | No | Agree with MTK |
| Turkcell | No | t1 and t2 are sufficient. |
| KT | No |  |
| CMCC | No | Since [t1, t2] is per candidate cell, it is enough for time trigger. |
| Rakuten Mobile | No |  |
| Spreadtrum | No | t1 and t2 are sufficient. |
| NEC | No | We think network will take into account the timing information to configure T1 and T2 |
| ITRI | No | We understand that the timing information and t1 are the same. |

Whereas the above proposal is about whether we keep the parameter within the RRCreconfiguration of the candidate target cell in addition to having time trigger in the RRM part of the configuration, which is now in current running CR, or that is removed.

Another discussion is the UE action at T2. The agreement says UE shall execute the CHO in the time window T1 to T2 which means by T2. However, there are interpretations where UE can only perform the CHO to candidate target cell within T1 to T2 and not after that.

1. RAN2 to discuss UE shall perform the CHO by T2 or whether at T” if UE has not made CHO UE forgets the configuration.

**Question 7 Please respond what is your view on how to understand T2?**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Company** | | **UE shall perform CHO at T2** | **UE shall forget CHO configuration at T2** | **Other suggestions** |
| Lenovo | | No | Yes with comments (confusing for ‘forget‘) | T2 is the latest time point that the UE can execute CHO. The UE may evaluate CHO condition (starting at T1) and is allowed to execute before T2. Once T2 expiry, UE is not allowed to perferm CHO based condition. According to the legacy, UE still keep CHO configuration even RLF happens because CHO recovery may be performed during re-establishment. My understanding is that at T2 if UE has not made CHO UE stops evaluating the condition but keep the CHO configuration.  Therefore, we suggest the following definition for T2.  UE is not allowed to perform CHO based on condition after T2. |
| MediaTek | | No | Yes | We see T2 as optional. If configured, then CHO needs to be performed between T1 and T2 and not outside this window. |
| Ericsson | | yes | no |  |
| ZTE | | No | See comments | * We understand the [t1, t2] actually describes the available time duration of a candidate target cell. * If all the other conditions configured for this candidate target cell is fulfilled within [t1,t2], UE will perform CHO but if other conditions are not fulfilled within [t1,t2], UE will not perform CHO and this candidate cell becomes unavailable after t2 and UE will not consider it anymore. |
| OPPO | | No | Yes |  |
| vivo | | No | See comments | If the current time is in the time duration [t1,t2] and other conditions are fulfilled (e.g., RSRP-based condition), the UE is allowed to trigger CHO on the candidate cell. If other conditions are not fulfilled, the UE is not allowed to trigger CHO on the candidate cell even if the T2 is reached. So, our understanding on T2 is that “the UE is only allowed to perform CHO on the associated candidate cell within [t1,t2] interval is reached. When t2 is reached (i.e. at t2) and after t2, the UE is not allowed to perform CHO on the associated candidate cell anymore.” There is no such a requirement that at T2 the UE shall/must perform CHO anyway.  Regarding what to do after T2, we are a bit confused about what the wording “forget” actually means. We assume it means that the UE shall release the related CHO configuration, with perhaps the reason that the NW will not reserve the resources for the associated candidate cell anymore. By reading companies‘ contributions, there is another way proposed that [t1, t2] is used to define the time interval when the UE performs CHO evaluation for the related candidate cell, which may mean after T2, the UE does not conduct CHO evaluation anymore. We think both are feasible ways, with difference in Spec impacts. We are fine with either way and open to discuss which is the final way to go with. |
| CATT | | No | Yes | In RAN2#113bis meeting, the time information described as:  a)       Time since when the UE can access the candidate CHO target cell--- (t1)  b)      Time until when the UE can access the candidate CHO target cell--- (t2)  c)       Time until when the source cell provides coverage  d)      Other  we think (b) is the initial understanding of t2. |
| Sony | | No | No | We think T2 is optional to configure. We think in general UE shall not delete CHO config |
| Xiaomi | | No | Yes |  |
| Nokia | | No, actually the latest at T2, when radio-based measurement condition is also met | Yes, after T2 it is not possible to handover to that cell. |  |
| Samsung | | Yes, but see comments | Yes | We think by T2 should be more correct (instead of at T2) and also it is the case when other triggering conditions are met. Our understanding is T1 to T2 is the allowed CHO execution time, then after T2 there is no reason the gNB still keeps the reserved resources for that UE. |
| LG | | No | See comments | As ZTE commented, we think that the [t1, t2] represents the expected time duration that the candidate cell is visible from the UE, from network’s perspective. So the UE can perform measurement on the cell since t1 and performing measurement in advance to t1 is not needed.  So we can say that the UE performs measurements and CHO evaluation during [t1, t2] and execute CHO based on the evaluation. The latest time the UE can execute CHO is t2.  It is not clear what “forget“ means, we can just say that the UE shall not execute CHO to the candidate cell since t2. |
| Qualcomm | | No | Yes | T2 can be understood as validity. After T2, the candidate target cell may release the reserved resource so there is no point for UE to execute the CHO for that target cell and keep storing it. |
| InterDigital | | No | Yes | T2 is the latest time point that the UE can execute CHO. The UE may evaluate CHO condition (starting at T1) and is allowed to execute before T2 as long as all other conditions are also satisfied. After T2, the CHO candidate is no longer valid and there is no reason for UE to further consider cell |
| Intel | | No | Yes | We share the view explained by Lenovo and MediaTek based on prevoius discussions on the topic. |
| Apple | No | | Yes | Agree with MTK. We see that the CHO is to be executed between t1 and t2. Since this information is unicast to the UE, the network can vary t1 and t2 additionally to ensure some load balancing so that a large number of UEs don’t execute the handover at the same time. |
| China Telecom | | No | Yes | UE performs CHO in NTN not only based on time but also RRM. After T2, the CHO configuration is not valid. |
| Huawei,HiSilicon | | No | Yes | We think that the T2 is the last time point for the UE to perform CHO execution. Therefore, after T2, the CHO configuration is invalid and the UE should delete it. |
| Turkcell | | No | Yes |  |
| KT | | No | Yes |  |
| CMCC | | No | Yes |  |
| Rakuten Mobile | | No | Yes |  |
| Spreadtrum | | No | Yes | UE may execute CHO in the window of (t1, t2). If condition is not met, CHO shall not be triggered. After t2, this CHO configureation shall be deleted, otherwise, t2 is not needed to be configured to UE. |
| NEC | | No | No | We prefer to only have one timer, if two timers are agreed, T2 should be optional or can be configured as infinite.  With two timers (T1 and T2), the meaning of T2 is very confusing:   1. **UE shall perform CHO at T2 regardless other configured condition:** thiscan be easily achieved by configuring timer only trigger, or by configuring a very low combined radio condition.   **UE shall forget CHO configuration at T2:** It seems not reasonable to delete/give up the CHO configuration if handover has not been triggered and deem necessary. |
| ITRI | | No | Yes | We understand the T2 indicates the last time point that the CHO condition is deemed as valid. |

1. RAN2 to discuss whether T1 and T2 should be expressed as UTC, timer, or a combination .
   1. Option 1: UTC time + duration/timer, e.g. 00:00:01 + 40s
   2. Option 2: Two UTC time to indicate the start (T1) and end time (T2) of the candidate cell, e.g. 00:00:01 + 00:00:41
   3. Option 3: Reference time + duration/timer，e.g. SFN =0 + 40s
   4. Option 4: Two timers, e.g. t1=301s + t2=341s.

**Question 8 Please state your preference for options a,b,c,d?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option a, b, c or d** | **Comments** |
| Lenovo | d | We should stick to the working assumption of using timer as we made( in RAN2#113bis) after several round email discussions:   * Working assumption: the timing information for CHO execution triggering in NTN is defined in the form of a timer/timers. This can be revised and a solution based on UTC/system frame number can be considered if problems are found (e.g. if the timer lacks accuracy due to RTT in NTN).   The timer-based option is extensively used in current RRC specification. And it can save the signalling from signalling overhead point of view comparing to UTC time-based solution. We suggest RAN2 to confirm this working assumption. There is no need to comeback and discuss this again. |
| MediaTek | c or d | We believe Options a and b will have significantly higher signalling overhead when comparing to Options c and d. |
| Ericsson | A or b | Timer is fluffy from network/system perspective |
| ZTE | A or B | Agree with Ericsson that UTC time would be more workable from NW’s perspective and interpreting UTC time costs almost nothing from UE side. |
| OPPO | A or b |  |
| vivo | a | The propagation delay can be very large and cannot be ignored in NTN. If the timing information for CHO execution trigger in NTN is configured via timer(s), NW has to take the propagation delay between UE and NW into consideration when configuring corresponding parameters. This may not only lead to the difficulty for the NW to figure out a proper value, but also result in the risk for misalignment between the UE and NW on the timer status, which can lead to potential problems.  So option 1 and option 2 are ok from our perspective. In addition, compared to option 2, option 1 is preferred from the view of signaling overhead. |
| CATT | A or B | We prefer Absolute time, e.g. UTC time, rather than reference time. Using reference time is more complex. Since network should configure the reference location considering the propagation delay and UEs may receive the CHO configuration at different time, time/timer based solution may be not so accurate. Absolute time, e.g. UTC time or SFN could be used to definitely indicate the time information, it is much easier and has nothing else issue. |
| Sony | A,b,d |  |
| Xiaomi | a or c | We prefer combination of a UTC time value and a timer or duration to express t1 and t2. The UTC value can be used to describe t1 and the start time of the timer or duration. T2 can be the time when the timer or duration expires.  For two timer, due to the high propagation delay in NTN, it is difficult for NW and UE to determine the same time value for t1 and t2. Using two timer may result in the risk for misalignment between the UE and NW.  Considering the signalling overhead, we prefer option a and c, which may have lower signalling overhead than option b. |
| Nokia | a or c | Signalling two UTC values could be too excessive in terms of the number of bits. Two timers may also be a bit inaccurate (propagation delay prior to UE receiving and initiating it). So, an absolute time + duration is probably the best choice. Thus, option a or option c is our preference. |
| Samsung | b | To us, b is simple and straightforward. |
| LG | A or B | Agree with Ericsson that UTC is more workable and timer will bring much complexity of the UE. |
| Qualcomm | c or a | No need to signal two UTC time values. Even UTC time is based on a specified reference point. So why not specify our own reference point to reduce signaling overhead. |
| InterDigital | B | Most simple option |
| Intel | c or d | We also think that signaling overhead with UTC time doesn’t justify the need given that option c/d is also working. |
| Apple | b or c | b has significant overhead compared to c. |
| China Telecom | A or B |  |
| Huawei,HiSilicon | A or c |  |
| Turkcell | A or B |  |
| KT | A or C |  |
| CMCC | A or b | UTC time brings low cost for UE side. |
| Rakuten Mobile | B |  |
| BT | A or B |  |
| Spreadtrum | C or D | For option A or B, UE is required to maintain the UTC timing, which is not necessary. |
| NEC | No strong opinion | We don’t see big difference |
| ITRI | a or b |  |

### 2.3 CHO trigger combinations

Related agreement from RAN2114:

Agreements online:

1. For CHO, joint configuration of location and RSRP as well as time and RSRP triggers are supported.

*We suggest that RAN2 consider a combination trigger that combines the individual triggers of “Inner Area of the Serving Cell” and “Neighbor Cell Signal Measurement” to create a combination trigger for enhanced reliability of handover.[2]*

*For CHO, configuration of location or time alone as execution condition is not supported.[1]*

*RAN2 declines the options that the network configures location or time CHO trigger without measurement trigger[6]*

*FSS- RAN2 to discuss whether timing the CHO can solve RACH congestion or additional methods are needed.[6]*

*FFS RAN2 to discuss whether RAN2 declines the options that the network configures location or time CHO trigger without measurement trigger[6]*

*Time-based event for CHO execution triggering in NTN is always configured with radio-based event (e.g. Ax, as defined in NR RRC).[7]*

*Location-based event for CHO execution triggering is always configured with radio-based measurement event (e.g. Ax).[7]*

*We suggest that RAN2 consider a flexible trigger framework that enables flexible combining of individual triggers to increase the reliability of handover in an NTN and to mitigate risks associated with new quantities and/or new type of deployment. One NTN-specific measurement event can suffice even when multiple trigger conditions are defined for flexibility.[2]*

*RAN2 is asked to consider how to combine the location- and radio-based execution conditions for NTN CHO.[7]*

*Time-based and location-based conditions are not configured simultaneously for a candidate cell.[8]*

*The time/location-based criterion is used as AND operation with either A4 or A3 or A5 event.[8]*

*RAN2 to consider additional location and timer parameters only in combination with existing measurement criteria. Independent new triggers without existing measurement triggers would lead to complicated CHO implementations that would need major specification overhauls.[10]*

*RAN2 to consider the following options for location reporting for evaluation of joint location and measurement CHO triggers.[10]*

*The network additionally needs to provide precision information on location measurements to ensure that UEs do not execute CHO criteria either too early or too late.[10]*

*Timer/location CHO trigger should be allowed to be configured independently.[18]*

*In conjunction with the range-based timer CHO criteria, for network load management, a randomization parameter within the timer is provided to the UE.[10]*

*In NTN CHO configuration, cell quality condition is mandatory and time condition is optional.[12]*

*When location condition is configured in CHO configuration, cell quality condition is mandatory and location condition is optional.[12]*

*Timer-based condition, in combination with one of CondEvent A3, CondEvent A4, CondEvent A5, CondEvent A3& CondEvent A5 can be supported in CHO execution condition as follows.[15]*

*UE performs CHO when both conditions including location-based condition and measurement-based condition are met.[15]*

*Location-based condition, in combination with one of CondEvent A3, CondEvent A4, CondEvent A5, CondEvent A3& CondEvent A5 can be supported in CHO execution condition as follows.[15]*

*A flexible framework for CHO trigger configuration should be supported and any standalone triggering events and trigger combinations can be considered in NTN, which can be configured by network implementation.[17]*

*The relationship (i.e. “and” or “or” ) among different CHO execution conditions, i.e. the R16 execution condition A3/A5, the newly introduced A4, location based condition, and time® based condition in NTN, should be configurable by the network and should be indicated to UE in CHO configuration.[28]*

*A location-based measurement event could be configured independently, or be configured to combine with a radio-based measurement event by the network.[29]*

1. RAN2 to discuss whether to support configurable CHO conditions for NTN operation.

**Question 9 Please give your view on whether to support configurable CHO conditions for NTN operation such that location, time and RRM are all optionally configured?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/no** | **Comments** |
| MediaTek |  | The Question does NOT match with the Proposal and seems to be a copy-paste typo from Question 6. Informed in reflector also. |
| Ericsson | yes | If RSRP is mandated it will cause delay in Hos which is will affect especially LEO Earth fixed. When the replacing cell is covering the same geographical area, it is enough UE can detect the cell. Thus, giving the timing info in CHO allows Ues to quickly access the new replacing cell. If RSRP measurement is demanded, even if threshold is set low, UE needs to filter the measurement for a period of time before it can even try the RSRP event. For other cells, true geographical neighbors, the network can always configure time/location + RSRP. When the flexibility is in the standard, the network vendor and operator can decide freely how to configure and it is not limited by RAN2 delegate views. |
| ZTE | Yes | * The relationship (i.e. “and” or “or” ) among different CHO execution conditions, i.e. the R16 execution condition A3/A5, the newly introduced A4, location based condition, and time® based condition in NTN, can be indicated from NW to UE to allow a flexible framework. * Having a flexible framework gives full flexibility for NW to configure CHO and we don’t need to spend much time discussing what is allowed and what is not. * Honestly, this is the first release of NTN over NR, it is hard to say which standalone condition or combination would be better than others. We can start with full flexibility and let ractice tell what is suitable for NTN. |
| Thales | Yes |  |
| vivo | No | We think either the location based conditions or the time based conditions should always be configured with RSRP based radio measurement events. Note that the radio link quality eventually decides whether the communication can really be performed or not. It makes no sense for the UE to trigger CHO only based on location based or time based conditions, if the radio measurement is actually not acceptable, because finally the UE will face HO failure. From this perspective, configuring only location based or time based conditions is not reliable, and thus should not be supported. |
| CATT | Yes | The configuration of CHO condition should base on the actual scenario. When the UE is moving out of the cell, the location-based condition is more useful. When the satellite is going to cover next area, the time-based condition is more useful. |
| Sony | Yes | This configuration should help addressing different scenarios |
| Xiaomi | Yes | Different triggers are suitable for different scenarios. How to configure the CHO trigger can be left to network implementation, which is a flexible way.   * For the scenario of feeder/service link switch, standalone time based CHO triggering event is enough. * Location based CHO triggering event alone can also work well in NTN due to the very small difference in RSRP/RSRQ between cell center and cell edge. |
| Nokia | No | Agree with vivo.  As we have already commented in the pre-meeting e-mail discussion: this has been discussed already multiple times, so making such a general proposal (as it is phrased now) does not help to progress the topic. Instead, we think this shall become more focused. When looking at the companies’ proposals preceding P9, it is somewhat clear the majority wants to have a radio-measurement based event as a default option for CHO triggering. And this may be combined with location or time based event (details to be discussed).  We suppose some companies are still confusing the CHO execution triggering with measurement report triggering. The latter could be perhaps done just on the basis of location/time only. But changing the cell shall be done when radio conditions are sufficient for taking such action. We wonder how would Ericsson address the issue of sudden physical blockage/obstacle, i.e. target cell temporarily encountering NLOS conditions while the time-based event triggers? |
| Samsung | See comment | Well, first we would like to understand what timing information really means here. If it is the timing for CHO execution triggering, we think it was already covered in Q6. Or if it is for measurement configuration (not CHO specific), our response is yes. |
| LG | No | Cell quality condition(RSRP/RSRQ) condition should be mandatory. In addition to the cell quality condition, time or location condition can be optionally configured, because a candidate cell may not be visible during given time period because of bad weather or line of sight. |
| Qualcomm | No | This is tricky question. On one hand such configuration (like time, location or both) can be up to network. But problem with this question is configuration of location-based condition should be together with some RSRP based event. |
| InterDigital | Yes, but | Time and/or location-based conditions should always be configured with a measurement-based condition. There must be a minimum radio quality to avoid RLF. |
| Intel | Yes | This would allow the network to better accomodate UE‘s operation for the different NTN deployments |
| Apple | No | Agree with Vivo and Nokia. Radio conditions should be the primary criteria. We have strong objection to independent location or timer based CHOs as we believe that the criteria can then be strongly linked to UE ephemeris discussions. |
| China Telecom | No | We think time/location should together with RRM in configuration. |
| Huawei,HiSilicon | Yes | In our understanding, both the location and time based event trigger are used for the reporting trigger condition. If triggered, the UE should report the RRM measurement results. Therefore, the network can configure the location/time based event trigger seperately. |
| Turkcell | Yes | Location and/or time based event trigger can be used for different cases. |
| KT | No |  |
| CMCC | No | Time-based and location-based should be configured with radio-based respectively. The link quality cannot be reflected without measurement results. |
| Rakuten Mobile | Yes | It should be upto network implementation. |
| BT | - | Does “No” means that they are all mandatory configured? |
| Spreadtrum | Yes | Time/location shall be combined with RRM based event. |
| NEC | Yes | We prefer to give more choices to network implementation. And we do feel different configurations fit different scenarios |
| ITRI | No | We think RRM measurements should always be configured. Location or time could be optional. |

### 2.4 Other CHO related proposals or further details

*FFS RAN2 to discuss whether it is feasible that UE keeps part of another gNB/cell configuration after accessing the target cell[6]*

*Stored conditional handover configurations is kept after conditional handover is executed.[18]*

*RAN2 consider CHO enhancement in NTN by introducing a new CHO execution command MAC CE and only condReconfigId needs to be carried in the new MAC CE.[1]*

*We suggest that RAN2 consider the use of an elliptical beam instead of a circular beam to reflect the practical beam coverage and to facilitate the selection of the correct cell by the UE during cell reselection and handover.[2]*

*Apply the following A3-like and A5-like events for the location-based trigger event for CHO:[4]*

*The time-based CHO trigger event, i.e. [t1, t2], of each candidate cell should also be considered, when the UE decides whether it can apply the CHO configuration of the selected cell during RRC connection re-establishment (in case attempCondReconfiguration is configured).[4]*

*RAN2 can consider supporting historical measurements to facilitate a predictive handover decision-making at the gNB to accelerate the overall handover.[2]*

*Support intra-handover user traffic transfer while the RA procedure for handover is ongoing to reduce the user traffic interruption in an NTN.[2]*

*We suggest that RAN2 consider enhancing the neighbor cell search procedure to significantly reduce the amount of processing at the UE. For example, RAN2 can explore the possibility of defining the Inner Area of the cell where the neighbor search by the UE can be eliminated all the time or for a significant percentage of time based on the type of the beam or the cell (i.e., Earth-fixed, quasi-Earth-fixed, or Earth-moving beams).[2]*

*We suggest that RAN2 consider the use of predictable satellite movements to create a compact Neighbor List and to introduce a cell movement-based offset in the measurement event criterion to enhance the reliability of handover (and cell reselection) in an NTN.[2]*

*We suggest that RAN2 consider various signaling modes such as broadcast, multicast/groupcast, and unicast to efficiently and quickly exchange handover signaling with UEs.[2]*

*The UE informs Source-gNB/cell about the selected Target gNB/cell before leaving the source cell so that radio resources in the source cell are not wasted. Furthermore, the Source-gNB can initiate an early HO CANCEL to non-selected gNBs to make more radio resources available in those gNBs. Additionally, the Source-gNB can do selective early status transfer & selective early packet forwarding to only one Target-gNB.[2]*

*FFS – RAN2 to discuss whether there is a need to optimize signalling overhead for HO/CHO.[6]*

*RAN2 is asked to support the mechanism, where the UE can be provided with CHO configurations for cells beyond the next cell change (future candidate cells).[7]*

*UE’s expected time of stay in the cell can be used for avoiding too early resource reservations.[7]*

*When accessing the new cell, UE may report it was configured with the chain of CHO configurations in one of the preceding cells.[7] Location-based CHO condition is configured per UE and time-based CHO condition is configured per candidate cell.[8]*

*In time-based CHO condition, a UE can be configured to store the CHO command of a candidate cell connecting to the same gateway/gNB with future execution time (i.e., the CHO command is executable in future time) even after successful CHO procedure.[8]*

*If multiple cells satisfy the CHO triggering condition simultaneously, the UE triggers CHO to the candidate cell with longest remaining service time period.[12]*

*RAN2 to support triggering event of measurement reporting based on the combination of location based event AND/OR measured signal strength based event.[14]*

*UE starts to evaluate location-based condition but does not evaluate measurement-based condition immediately upon receiving the joint condition of location-based condition and measurement-based condition.[15]*

*UE starts to evaluate the measurement-based condition after the location condition is met.[15]*

*RAN2 should study measurement initiation condition for non-serving cells based on location information, the following options can be considered.[17]*

*RAN2 to discuss the solution for signalling storm created by frequent handovers of all connected UEs in an NTN cell.[18]*

*Multiple target cells are included in the RRC reconfiguration message when AS security has been activated and SRB2 is setup and not suspended i.e DRB setup precondition is not required.[18]*

*Introduce event-triggered distance-based UE location reporting, e.g. triggered when the UE moves a distance exceeding a configured threshold since its last reported location.[25]*

*We suggest RAN2 to consider some solutions such as distributing UEs to access the same new cell(s) considering uplink signaling storms and access resources shortage due to a large number of UEs accessing the same new cell(s) almost simultaneously.[26]*

*The gain of signaling overhead reduction through the solution that broadcast handover signaling and information common to all the UEs may need to further evaluate due to the limited common signaling and information that can be extracted.[26]*

*In order to decrease signaling overhead during the whole HO procedure, we could consider a handover scheme that the UE does not perceive, where all the information about UE, including UE context, protocol configuration, UE variables, constants and timers etc. could be interacted between source gNB and target gNB beforehand.[26]*

*To ensure seamless handover, the source gNB needs to pre-evaluate the HO timing to transmit all the information of UE to the target gNB in advance.[26]*

*Condition event L1 and L4 should be introduced with the following ASN.1 structure taken as a baseline:[28]*

*If the network wants to trigger a conventional handover to one of the configured CHO candidate cells, one target cell indication (e.g. the candidate cell identity or index) can be included in the conventional HO command and UE should apply the corresponding condRRCReconfig.[28]*

# 3 TN NTN mobility

Related agreement from RAN2114:

1. For idle mode reselection, based on configuration NTN UE can prioritise TN over NTN. Configuration details FFS

Agreements via email (from offline 104 – second round):

1. Same CHO trigger conditions and RRM events can be used within NTN and NTN-TN mobility provided these are supported by the UE. NTN-TN means both “from NTN to TN (hand-in)” and “from NTN to TN (hand-in) and from TN to NTN (hand-out)”. FFS for enhancements.

### Connected mode

The proposals that are identified to be relevant for connected mode are the following:

*NTN can configure the TN measurement event for the UE which is going into the TN cell based on the rough location information [3].*

*Considering the minor influence on TN, it is proposed that the mechanism of handover from NTN cell to TN cell can reuse the legacy handover procedure based on RRM measurement with no location and time trigger condition [3].*

*The mechanism of handover from NTN cell to TN cell can reuse the legacy handover procedure, including HO and CHO based on RRM measurement with no location and time trigger condition.[3]*

*No limitations are specified for NTN-TN mobility thus same trigger conditions can be used within NTN and NTN-TN mobility. FFS for enhancements [6].*

*The exact applicability of CHO mechanisms to TN <-> NTN individual use cases shall be assessed by RAN2 [7].*

*NG based handover should be considered for NTN and TN service continuity [11].*

*NG based CHO should be considered for NTN and TN service continuity [11].*

*Location-based triggers that are introduced for NTN connected mode mobility can be reused for NTN to TN (hand-in) mobility [24].*

*No enhancements are needed for connected mode mobility from TN to NTN (hand-out) networks [24].*

*De-prioritize the enhancement TN-NTN mobility in connected mode [12].*

*Other solutions, for example, TA-based and elevation angles-based solutions discussed in SI and service requirement based solution, etc. should not be excluded for the NTN-TN mobility [27].*

*For some cases, it should consider switching connection of the UE to a non-terrestrial cell or terrestrial cell, even if the quality of service in the current cell is still good depending on the operator’s policy [27].*

*The NTN capable UE shall support service continuity between NTN and TN in connected mode. [30]*

*Handovers from TN to NTN should use legacy events, e.g., A2 event. On the other hand, handovers from NTN to TN may require an additional trigger, i.e., UE location information, apart from legacy events. [30]*

*In order to save UE battery, the network shall allow to activate/deactivate (trigger FFS) the survey of adjacent cells (measurements) for handover from NTN to TN (hand-in). [30]*

*The network should allow prioritization of intra-system over inter-system handover or vice e versa if they belong to different PLMN. [30]*

*The measurement reports of different values, e.g., RSRP and/or RSRQ should be used with new triggers, e.g., location and/or time, in CHO decisions. [30]*

The listed proposals does in some cases contain already agreed or implicitly agreed proposals, such as ”supporting service continuity between NTN and TN” and ”Handovers from TN to NTN should use legacy events, e.g., A2 event. ”. Out of the above 16 proposals, at least 8 of the proposals contain proposals that have either already been agreed, implicitly agreed or already supported. Outside of that, there 3 proposals that propose specific solutions, including introducing NG-based handover and NG-based CHO or NTN-TN mobility and TA-based and elevation-based solution for NTN-TN mobility but does not have more than one single company suggesting these.

Only one company discusses problems with previous agreements [7], stating that not all CHO mechanisms may be needed for TN->NTN and NTN->TN mobility.

Two companies are proposing that further enhancements are not needed. Furthermore it is noted that none of the contributions discuss detailed problems with current agreements, and given that there are very few meetings left and need for specification work, the following discussion point is suggested:

1. Discuss whether to down-prioritize further enhancements to connected mode NTN-TN

**Question 10 Please give your view whether further enhancements to NTN-TN mobility for connected mode should be down-prioritized from this release?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/no** | **Comments** |
| Lenovo | Neutral | It depends on the progress of NTN-NTN mobility, and we can check if the enhancements are applicable to NTN-TN mobility |
| MediaTek | Yes | For this Release, as shown in [R2-2108329](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Docs//R2-2108329.zip) [24] existing connected mode mobility procedures, including those defined for NTN are sufficient to deal with TN-NTN mobility. |
| Ericsson | yes |  |
| ZTE | Neutral | * Agree with Lenovo that we can check if the intra-NTN enhancements are applicable to NTN-TN mobility. * Proposals for NTN-TN mobility specific enhancements are still allowed but how far we can go depends on the progress. |
| OPPO | Yes |  |
| Thales | No | Both idle and connected mode mobility between NTN-TN should be considered in Rel-17 |
| vivo | No strong view | Agree with Lenovo. |
| CATT | Yes | We think nothing enhancement is needed in NTN-TN mobility. |
| Sony | No | We think NTN-TN mobility is an important feature. RAN2 may agree that no new enhancements are needed for connected mode mobility between TN and NTN but this should not imply that the feature is deprioritized. |
| Xiaomi | Yes |  |
| Nokia | Yes, due to the limited time | We think intra-NTN mobility should be specified properly. Then we may consider what exactly to do for NTN-TN case. In our [7] we have commented that not all intra-NTN solutions are fully valid for NTN-TN case (e.g. would there be reference location for TN cells?). This is why we ‚‘discuss problems‘ with previous agreements. |
| Samsung | Yes | We should make more progress for intra-NTN mobility first. Once it becomes stable, we can start NTN-TN mobility. Also note we already agreed at RAN2#111:  RAN2 to discuss about trigger(s) of TN / NTN mobility, once the Intra NTN mobility has sufficiently progressed. Intra NTN mobility refers to idle and connected mode mobility between NTN cells (e.g. intra or inter satellite).  So question is whether we already have sufficiently progress for intra-NTN mobility, which to us not yet. |
| LG | Yes | We already agreed to introduce time/location based CHO and it is enough to support NTN-TN mobility in connected mode. |
| Qualcomm | Yes |  |
| InterDigital | Yes | Intra-NTN mobility should be prioritized |
| Intel | Yes | Considering the time left to complete the WI, we suggest focusing the efforts on essential funciontality. If time allows it, we are ok coming back to address this. |
| Apple | No strong view |  |
| China Telecom | Yes |  |
| Huawei,HiSilicon | No strong opinion |  |
| Turkcell | No |  |
| KT | No  Strong view |  |
| CMCC | Neutral | Depends on the mobility discussion progress. |
| Rakuten Mobile | No | Both idle and connected mode related issues need to be discussed within Rel-17. |
| BT | No | NTN – TN mobility in connected mode is a key feature for operators. As we mention in our paper, R2-2108100, the fact that to fully integration between NTN – TN is not achieved, NTN will lose traction.  It is pending:   * Under which circumstances the UE connected to NTN starts the TN measurements and vice versa. |
| Spreadtrum | Neutral | Agree with Lenovo. |
| NEC | No strong opinion |  |
| ITRI | Neutral |  |

### Idle mode

The following proposals are addressing idle mode NTN-TN problems:

*In Release 17, the legacy priorities for IDLE mode are sufficient for cell reselections between TN and NTN [7].*

*Some mechanisms to control UE measurements should be considered for NTN and TN service continuity.[11]*

*The existing Idle-mode mobility framework is sufficient to address NTN-TN service continuity, including the prioritisation of TN over NTN. [24]*

*The NTN capable UE shall support mobility between NTN and TN in idle mode. [30]*

*RAN2 should considered rules for cancelling relaxed measurements when either camping on NTN or TN performing measurements on the opposite network. [31]*

*R16 based priority mechanisms can be reused to control inter-frequency NR-NTN and TN-NTN cell re-selection. [32]*

*RAN2 to discuss enhancements to signalling of TN neighbouring frequencies/cells in an NTN cell [33].*

*The gNB can indicate NTN-only zones to UEs [33].*

*The gNB can indicate groups of frequencies specific to restricted parts of the NTN cell coverage [33].*

*Assist information to initiate cell reselection measurements of TN cells for prioritizing TN over NTN shall be supported [34].*

*Reference location associated with the TN frequencies/cells shall be provided in cell reselection information to assist IDLE mode UE to perform cell reselection measurements for TN cells for prioritizing TN over NTN [34].*

*Serving cell’s system information should include an indication that whether a neighbour cell is an NTN cell or not [35].*

*There is no need to introduce explicit network scenario indication for neighbour cells [35].*

*NTN cell informs if the cell coverage overlaps with a terrestrial TN cell’s coverage. UE may ignore serving cell thresholds and perform TN cell measurements [35].*

*RAN2 agrees to enhance TS 38.304 with additional assistance information and enhancements, using TN cell (re)selection as a baseline and to update the running CR to include NTN cell timing and UE location assistance information for cell (re)selection [36].*

*RAN2 agrees to update the currently endorsed running TS 38.304 CR with additional assistance information and enhancements, including cell reselection priorities handling and measurement rules. An email discussion at RAN2#115e should commence to progress these aspects [36].*

Out of the listed proposals, three companies state that the current Release 16 mechanisms are enough to control the cell reselection between NTN and TN while two of the companies state that there should be some mechanisms to control the measurements where one of the proposal is more detailed towards measurement relaxation. Thus the question is whether the current idle mode features are sufficient enough to realize the agreement made in RAN2#115-e on idle mode NTN-TN mobility.

1. Discuss whether agreements for cell reselection mechanism made for NTN mobility are enough also for NTN-TN mobility.

**Question 11 Please state whether you agree that agreements for cell reselection mechanism made for NTN mobility are enough also for NTN-TN mobility?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/no** | **Comments** |
| Lenovo | Yes | There is no need to introduce new priority like network type, unless NTN can use the same frequency bands as TN. |
| MediaTek | Yes | The existing Idle-mode mobility framework is sufficient to address NTN-TN service continuity, including the rioritization of TN over NTN. |
| Ericsson | no | We need to check that TN network is prioritized as the capability to serve Ues via TN is much better. If too many Ues select NTN where TN could be selected it may happen that service quality is lowered to all those Ues. |
| ZTE | No | We are open to discuss enhancements for prioritization of TN over NTN or vice versa. |
| OPPO | No | We also think TN prioritization over NTN should be addressed. |
| Thales | No |  |
| vivo | Yes | The typical case in Rel-17 NTN would be the TN and NTN deployed on different bands. Therefore no additional enhancement is needed to realize the TN prioritization in this release. Relying on the existing cell reselection priority is already sufficient. |
| CATT | Yes |  |
| Sony | No | Network should make the UE aware of when to start performing the measurements on TN cells and not apply the serving cell criteria, when moving from an NTN cell towards a TN cell. |
| Xiaomi | Yes | Agree with MTK. For NTN-TN mobility, UE cannot be mandated to prioritize TN cells. Using existing cell selection /reselection procedures is more suitable for NTN-NT mobility in idle mode. |
| Nokia | Yes | Similar view to vivo. Perhaps not essential in the first release of NTN. |
| LG | See comments | This should be discussed in idle mode discussion, because we are discussing whether location-based idle mode mobility is needed. We think location condition is needed for NTN-TN idle mobility to prioritize TN to UEs at certan area. |
| Qualcomm | Yes |  |
| InterDigital | Netural | We can go with the majority. It may not be critical for this release, but we are open to further considering prioritization of TN. |
| Intel | Yes | Similar to Q10, we are ok re-opening this discussion if there is time within the WI after completing essential funciotnality. |
| Apple | Yes | Existing cell selection and re-selection procedures are sufficient. For cell selection, it is up to UE implementation. For re-selection, existing frequency based criteria are sufficient. There is no need to introduce any additional limitations beyond these. |
| China Telecom | No |  |
| Huawei,HiSilicon | No | Even with the assumption that the TN and NTN are deployed on different bands, considering the huge coverage area of NTN, it is possible that from the whole NTN cell perspective there are lots of TN neighbours but for some area within the NTN cell there may be no TN neighbour.  If we always prioritize the TN frequency, it brings uncessary and massive power consuming for UEs in this area to perform the measurements for TN freq. |
| Turkcell | No |  |
| KT | Yes |  |
| CMCC | No |  |
| Rakuten Mobile | Yes |  |
| BT | No | At least following points needs to be addressed:   * It is not clear how TN neighbours of NTN are indicated and vice versa. * It is not clear how TN or NTN is prioritized. * It is not clear when to start/stop neighbour measurements of TN when the UE camps in a NTN cell. |
| Spreadtrum | No | TN cell shall be selected with higher priority, otherwise, too many UEs caming in the NTN cell is not a good choice. |
| NEC | No | We should check UE will measure and reselect to TN cell once it is available for better service, at the same time not to consume too much power to scan unnecessarily. Due to the big cell size difference between NTN and TN cell, existing or newly agreed mobility mechanism between NTN may not be enough for NTN-TN mobility. |
| ITRI | No | UE needs to determine the starting of performing TN cell measurements, also needs to alleviate power consumption of searching all the TN frequencies when prioritizing TN over NTN. |

Another set of proposals addresses the signaling of neighbour frequencies/cells in NTN->TN mobility. One of the issues is related to the fact that the coverage area of a satellite cell may cover a large amount of TNs. This causes issues with the number of cells needed to be evaluated and the signaling overhead to signal neighbouring cells.

1. Discuss whether enhancement is needed to address the problem of performing idle mode mobility from NTN to TN in terms of power consumption and signaling efficiency.

**Question 12 Please state whether enhancements are needed to address power consumption issues and signaling in case an NTN covers multiple TNs?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/no** | **Comments** |
| Lenovo | Neutral | We can check if there is any other issue after finishing cell reselection mechanism for NTN. |
| MediaTek | No | It’s important to have a working system in the first release. Enhancements can be looked at in the future releases. |
| Ericsson | neutral |  |
| ZTE | neutral | Agree with lenovo that we can check after the cell reselection mechanism for NTN is clear. |
| OPPO | Neutral | We can live with a simple release as starting point. |
| Thales | Neutral |  |
| vivo | Yes | A beam-specific solution can be considered based on RAN1 agreements. Since the structure of multiple beams in one cell is supported by related agreements in RAN1, the NW can configure beam-specific information for cell reselection purposes to reduce power consumption. |
| CATT | Neutral | Maybe needed. |
| Sony | Yes | Power consumption and signalling overhead are not negligible without proper measures. |
| Xiaomi | Neutral |  |
| Nokia | - | Probably not essential in the first NTN release. |
| LG | Neutral | When current idle mode issues become clear, then we can further check this. |
| Qualcomm | Yes | It is helpful if network can provide additional information on reference location for TN measurement. |
| InterDigital | No | Agree with MTK |
| Intel | No | Similar to Q10, we are ok re-opening this discussion if there is time within the WI after completing essential funciotnality. |
| Apple | No | Not needed in R17 atleast. |
| China Telecom | neutral |  |
| Huawei,HiSilicon | Yes | Actually, these issues exist. If there is enough time, we can consider the location/time based for TN measurement. |
| Turkcell | Neutral | We may not need it in R17. |
| KT | Yes |  |
| CMCC | Neutral | Depends on R17 progress. |
| Rakuten Mobile | Yes | This issue can be tackled within R17.. |
| BT | Yes | As indicated above |
| Spreadtrum | Yes | The location information of TN cell is helpful for UE power saving. |
| NEC | Yes | For TN network, we have many mechanisms to make sure lower power consumption during idle mode e.g. serving cell criteria and relaxed measurement, this may not workable considering mixed of NTN and TN deployment.  Moreover, to evaluate a large number of TN frequencies/cells in idle mode over a huge coverage area all the time will not only impact power efficiency, signalling overhead but also impact the performance. |
| ITRI | Yes | We think power consumption issue needs to be addressed. |

### 3.4 Other

A number of proposals have been gathered in the other section:

*For NTN capable UE, the following UE types shall be considered for NTN-TN mobility [30]*

*Handheld UE power class 3 and power class 2*

*Mounted UE on a building or moving platforms, e.g., aircrafts, trains, vessels, or vehicles. Examples of such UE can be ESIM and VSAT*

This is UE capability and type related discussion and should happen in RAN1.

# 4 Conclusions

Based on the discussion in the previous sections we propose the following:

[Proposal 1 Discuss whether combination of serving and target cell reference location is supported for location report trigger event and for CHO location trigger](#_Toc80107780)

[Proposal 2 If combination is supported, start discussing event descriptions for the combination of reference locations](#_Toc80107781)

[Proposal 3 Both hysteresis and time to trigger is supported for location based trigger event](#_Toc80107782)

[Proposal 4 Discuss whether measurement reports can be configured to be piggybacked when location based event triggers](#_Toc80107783)

[Proposal 5 RAN2 to discuss whether periodic reporting of location should be supported for NTN.](#_Toc80107784)

[Proposal 6 RAN2 to discuss whether timing information and t1 are understood as different parameters or same .](#_Toc80107785)

[Proposal 7 RAN2 to discuss UE shall perform the CHO by T2 or whether at T” if UE has not made CHO UE forgets the configuration.](#_Toc80107786)

[Proposal 8 RAN2 to discuss whether T1 and T2 should be expressed as UTC, timer, or a combination .](#_Toc80107787)

[a. Option 1: UTC time + duration/timer, e.g. 00:00:01 + 40s](#_Toc80107788)

[b. Option 2: Two UTC time to indicate the start (T1) and end time (T2) of the candidate cell, e.g. 00:00:01 + 00:00:41](#_Toc80107789)

[c. Option 3: Reference time + duration/timer，e.g. SFN =0 + 40s](#_Toc80107790)

[d. Option 4: Two timers, e.g. t1=301s + t2=341s.](#_Toc80107791)

[Proposal 9 RAN2 to discuss whether to support configurable CHO conditions for NTN operation.](#_Toc80107792)

[Proposal 10 Discuss whether to down-prioritize further enhancements to connected mode NTN-TN](#_Toc80107793)

[Proposal 11 Discuss whether agreements for cell reselection mechanism made for NTN mobility are enough also for NTN-TN mobility.](#_Toc80107794)

[Proposal 12 Discuss whether enhancement is needed to address the problem of performing idle mode mobility from NTN to TN in terms of power consumption and signaling efficiency.](#_Toc80107795)

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