3GPP TSG-RAN WG1 Meeting #114e Tdoc R2-2106526

May 19th - 23rd 2021

Agenda: 8.10.3.3

Source: Ericsson

Title: Feature summary for 8.10.3.3

Document for: Discussion, Decision

# 1 Introduction

* [AT114-e][104][NTN] CHO aspects and service continuity (Ericsson)

Initial scope: Discuss the proposals from [R2-2106489](file:///C:\Data\3GPP\Extracts\R2-2106489%20%20%5bPre114-e%5d%5b104%5d%5bNTN%5d%20Summary%208.10.3.3%20-%20CHO%20and%20service%20continuity%20(Ericsson).docx)

Initial intended outcome: Summary of the offline discussion with e.g.:

* + - List of proposals for agreement (if any)
    - List of proposals that require online discussions
    - List of proposals that should not be pursued (if any)

Initial deadline (for companies' feedback): Friday 2021-05-21 10:00 UTC

Initial deadline (for rapporteur's summary in R2-2106526): Friday 2021-05-21 14:00 UTC

Proposals marked "for agreement" in R2-210656 not challenged until Monday 2021-05-24 10:00 UTC will be declared as agreed via email by the session chair.

For the rest the discussion will continue online in the Monday CB session.

R2-2106526 [Offline 104] CHO aspects and service continuity Ericsson discussion Rel-17 NR\_NTN\_solutions-Core

This feature summary for 8.10.3.3 includes

1. include proposals to further progress on CHO

2. kickoff the discussion on TN/NTN service continuity

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 last meeting is:

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

Here we attempt to progress on the FFSs within the previous agreement which is done based on related input within RAN2#114 contributions.

Definition of the reference location may be related to serving cell or candidate target cell or it may be a combination. Also, there is a suggestion to use UE’s (reference) location. 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.

*The distance between UE and reference point of the serving cell is used in location-based CHO condition.[11]*

*Location-based CHO execution triggers are based on distance from UE to serving cell center.[25]*

*Multiple location-based measurement events for NTN could be defined, and the distance in each of the location-based measurement events could be the distance to either a serving cell or a neighbor cell.[8]*

*Location-based CHO execution triggering describes a region in which UE is allowed to execute CHO to the candidate target cell.[25]*

*In location-based triggering condition, UE’s reference point for location is used to calculate the distance. FFS how to update UE’s reference point.[11]*

*Location based CHO triggering event can be configured based on a geographical area scope referring to the cell coverage information for satellite cells with irregular shape.[13]*

Based on the above, the below proposals are suggested for discussion.

1. Discuss whether shape of CHO trigger area is
   1. The distance between UE and the serving cell reference location
   2. The distance between UE and the candidate target cell reference location
   3. Combination of a) and b)

**Question 1 Which option is preferred?**

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| **Company** | **Option** | **Comments** |
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1. Discuss whether UE’s reference location can be considered as an alternative for location based RRM event.

**Question 2 Whether UE’s reference location can be considered as an alternative for location based RRM event?**

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| **Company** | **Yes/no** | **Comments** |
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Related to the definition of the reference location, the following proposals are presented

*For location-based measurement, cell center is considered as reference location and can be part of ephemeris.[1]*

*Location-based CHO execution triggers are based on distance from UE to serving cell center.[25]*

*The reference point of cell could be cell centre or a list of beam centres, and beam radius is also provided by network.[14]*

Based on the above, the below proposals are suggested for discussion.

1. Discuss whether the reference location is
   1. Center of a cell
   2. Center of a beam or beams

**Question 3 Which option is preferred?**

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| **Company** | **Option** | **Comments** |
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Other location CHO or RRM related proposals that may be selected for discussion if time allows.

*The location event includes hysteresis and TTT[23]*

*In NTN, serving cell centre coordinates are broadcast via system information.[25]*

*Reference location of the cell used for CHO execution triggering purposes should be given in RRC Reconfiguration (HO command).[3]*

*For at least LEO with earth moving cells, serving cell centre coordinates are periodically updated and associated with a timestamp. FFS periodicity of update.[25]*

*RAN2 is asked to confirm a reference location of the cell, used for location-based CHO execution triggering, indicates a location on Earth surface, within cell coverage.[3]*

For location based event reporting the following proposals were presented

*Location-based measurement and RSRP/RSRQ measurement can be reported in the same RRC message to the network, no matter which measurement event is triggered.[1]*

*UE is allowed to report (in measurement report) the distance to a cell in addition to the measured signaling strength of the cell.[8]*

*The UE location information report should be supported in NTN[19]*

*For UE location reporting to the network, the UE location information is piggybacked to the measurement report message.[19]*

*For UE location reporting, the network configures to include the UE location information in the measurement reporting configuration.[19]*

*Discuss what kind of NTN-specific UE location information can be included in the UE location reporting. Consider sending LS to other WG to define contents of the UE location information for NTN.[19]*

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. Further the format of the location information should be discussed. It is possible to try to define a less granular and lighter location information suitable for NTN.

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

**Question 4 Whether measurement results can be piggybacked with location report?**

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| **Company** | **Option** | **Comments** |
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1. Discuss the format of the location report
   1. Follow the existing format for location information
   2. Discuss if a less granular and lighter location information suitable for NTN is defined.

**Question 5 Preferred format for location report?**

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| **Company** | **Option** | **Comments** |
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Other location RRM related proposals.

*UE location information is provided to the RAN in order to allow the network to select a proper PLMN in accordance with UE’s physical location.[17]*

*UE location information is provided to network when it is in RRC\_CONNECTED in order to allow an NG handover in accordance with its physical location.[17]*

*RAN2 to discuss the feasibility of periodic location reporting as an addition to the event triggered based.[23]*

*Discuss whether explicit request by the network to immediately report UE location information is needed, in such as UEInformationReq message.[19]*

1. RAN2 to discuss whether periodic or request/response type of location reporting should be supported for NTN.

**Question 6 Whether periodic or request/response type of location reporting should be supported for NTN?**

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| **Company** | **Opinion** | **Comments** |
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### 2.2 CHO time trigger definition

Related agreement from last meeting are:

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).

In the Release-16 study item the issue of simultaneous RACH attempts to target cell was concluded to be an issue and time based CHO mechanism was recognised as one possible solutions for the situation. In worse case this may eliminate any access attempt to that cell when RACH issues accumulate. This was also recognized by some companies now

*RAN2 to discuss the solution for signalling storm created by frequent handovers of all connected UEs in an NTN cell.[16]*

*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.[29]*

According to the agreement from the RAN2#113bis meeting, the timing information in the time/timer based CHO trigger event describes the time after which the UE is allowed to perform CHO to a given candidate target cell. This information is basically telling when it is worth for the UE to start detecting and measuring a given candidate target cell. As stated in the agreement, after this time the actual CHO event is evaluated which is then with current framework one or two events (MeasID) configured for that candidate target cell. Note that UE can be configured with up to 8 candidate target cells that may be same or different as per current signalling structure.

In the contributions submitted to RAN#114 the following proposals were presented:

*The trigger timer/timers can be configured based on the feeder/service link switch timing.[13]*

*The serving cell time information should also be considered in CHO execution triggering for NTN, e.g. time until when the source cell provides coverage.[2]*

*RAN2 to adopt absolute time based new CHO trigger, i.e. based on UTC or system frame number.[14]*

*The timing information for CHO execution triggering in NTN is defined in the form of UTC time.[22]*

*Define an event with the enter condition a time expressed as absolute time, or in system frame number, when the UE is to perform the CHO to the target cell.[23]*

*For soft feeder-link switch, a UTC time-based CHO execution trigger is introduced and combined with a low-threshold A4 trigger.[26]*

*Confirm the RAN2#113bis working assumption: the timing information for CHO execution triggering in NTN is defined in the form of a timer/timers.[3]*

*For general mobility case, confirm the following working assumption: the timing information for CHO execution triggering in NTN is defined in the form of a timer/timers.[26]*

*In time-based CHO condition, timer value is provided to UE with respect to a reference time.[11]*

*RAN2 confirms that the timing information for CHO execution triggering in NTN is defined in the form of a timer/timers.[21]*

*Timer-based condition is configured per prepared target cell i.e., it is within condExecutionCond. It is up to network implementation that the timer is linked to serving cell switch-off/leavingtime or neighbouring cell switch-on/coming up time.[24]*

*Timer-based condition can be ‘time range’. UE evaluates whether the measurement-based condition is met or not in the time range.[21]*

*Validity time of a CHO command is not needed.[11]*

*The timing information in CHO triggering condition consists of start time point and end time point. During the time period, the UE is allowed to execute CHO to the candidate cell. After the time period, the can stop the measurement until the next appearance.[19]*

*Two timers can be used to describe ‘time range’. UE evaluates whether the measurement-based condition is met or not when the first timer expires and the second timer is running. Namely, the first timer is the agreed time after which the UE is allowed to execute CHO to the candidate target cell.[21]*

*Timing information in CHO execution triggering for NTN also describes the time after which UE cannot access candidate target cell (i.e. the end time of a candidate target cell).[22]*

1. RAN2 to discuss how the time based CHO should work and what is the relevant information UE needs for efficient operation.

**Question 7 Please give your view on how the time based CHO should work and what is the relevant information UE needs for efficient operation?**

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| **Company** | **Operation** | **UE information** |
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1. RAN2 to discuss how to address the issue of RACH congestion in a target cell.

**Question 8 Please give your view on how the time based CHO should work and what is the relevant information UE needs for efficient operation?**

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| **Company** | **Operation** | **UE information** |
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1. RAN2 to discuss whether information related to when candidate target cell becomes available is a timer, UTC, or a time range.

**Question 9 Please give your view on whether information related to when candidate target cell becomes available is a timer, UTC, or a time range?**

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| **Company** | **option** | **comment** |
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### 2.3 CHO trigger combinations

Several companies have expressed their views on whether time or location trigger for CHO can be configured flexibly or whether those shall be mandated with RSRP trigger.

6 companies are supporting flexible trigger condition configurations

*CHO signalling should be flexible enough to support any combined conditions or standalone condition, it is left to network implementation to configure timer/location/radio condition alone or in combination.[24]*

*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.[27]*

*Down select from the following solutions to configure the timing information for CHO execution triggering in NTN:[22]*

*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(r) based condition in NTN, should be configurable by the network and should be indicated to UE in CHO configuration.[22]*

*A location-based measurement event could be configured independently, or be configured to combine with a radio-based measurement event by the network.[9]*

*It can be further discussed that the location-based measurement event can be configured to combine with all the existing radio-based measurement events.[9]*

*For the scenario of feeder/service link switch, time-based CHO triggering event can be configured without RSRP/RSRQ related event.[13]*

*Timer/location CHO trigger should be allowed to be configured independently.[16]*

8 companies to mandate the network to configure RSRP trigger together with time or location trigger. It is noted that since Rel 99 network can trigger HO without any RSRP measurements. Also DC secondary cell addition is possible without any RSRP measurements.

*Location-based event for CHO execution triggering is always configured with radio-based measurement event (e.g. Ax).[3]*

*Timer-based event for CHO execution is always configured with radio-based measurement event (e.g. Ax).[3]*

*Timer- or location-based events for NTN are either linked in the specification with radio measurements based events (e.g. Ax) or always configured jointly with radio measurements based events (e.g. Ax).[3]*

*Timer-based event cannot be combined with location-based event for the same CHO candidate cell evaluation criteria. Any of these shall be always linked with the radio measurement based events.[3]*

*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.[21]*

*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.[21]*

*Time-based or location-based triggering shall be always combined with RSRQ/RSRP events (A4) for CHO triggering or measurement report triggering.[2]*

*Location-based event is always configured together with RSRP/RSRQ-based event, and CHO is executed when both events are fulfilled.[1]*

*For soft feeder-link switch, a UTC time-based CHO execution trigger is introduced and combined with a low-threshold A4 trigger.[26]*

*The time/location-based criterion is used as AND operation with either A4 or A3 or A5 event.[11]*

*In the NTN CHO configuration, cell quality condition should be mandatorily configured in the CHO triggering condition.[19]*

*In addition to the cell quality condition, time condition or location condition can be optionally configured.[19]*

*Location-based CHO execution triggering is always configured with a measurement-based trigger.[25]*

Two companies proposed to discuss and study which should RAN2 allow new triggers to work alone.

*RAN2 to discuss whether to allow new CHO trigger to work alone.[14]*

*We suggest that RAN2 evaluate the suitability of various candidate measurement quantities as standalone and/or combination triggers (e.g., RSRP, elevation angle, time since last handover, distance-to-the-cell center, and so on) for traditional handover and conditional handover in an NTN.[27]*

1. RAN2 to understand joint configuration of location and RSRP as well as time and RSRP triggers are supported.

**Question 10 Please give your view on whether joint configuration of location and RSRP as well as time and RSRP triggers should are supported?**

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| **Company** | **option** | **comment** |
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1. RAN2 to discuss whether RAN2 declines the options that the network configures location or time CHO trigger without measurement trigger.

**Question 11 Please give your view on whether RAN2 declines the options that the network configures location or time CHO trigger without measurement trigger? Reasoning is needed**

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| **Company** | **option** | **reasoning** |
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There was one proposal related not configuring time and location together and no arguments why these should be considered together, thus

*Time-based and location-based conditions are not configured simultaneously for a candidate cell.[11]*

1. RAN2 not to consider further joint location and timer based trigger

**Question 12 Please give your view on whether RAN2 further discusses how to combine location and time trigger?**

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| **Company** | **option** | **reasoning** |
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RAN2 declines the options that the network configures location or time CHO trigger without measurement trigger

### 2.3 Other CHO related proposals or further details

On concatenated CHO. The idea here is that UE does not need to start all over the trigger evaluations and some companies also think the CHO configuration could be kept. However, as the target cell is responsible of the UE’s RRC configuration after the HO and that configuration including the possible CHO commands is given in the original CHO command.

*Stored conditional handover configurations is kept after conditional handover is executed.[16]*

*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). Details of the procedure can be left FFS.[3]*

*In time-based CHO condition, a candidate cell connecting to the same gateway/gNB with future execution time is stored even after successful CHO procedure.[11]*

1. RAN2 to discuss whether it is feasible that UE keeps part of another gNB/cell configuration after accessing the target cell.

**Question 13 Please give your view on whether it is feasible that UE keeps part of another gNB/cell configuration after accessing the target cell? Reasoning is needed**

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| **Company** | **option** | **reasoning** |
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1. RAN2 to discuss how to enhance the efficiency of the potential need to concatenate HOs in NTN. E.g. by UE not to discard filtered measurements after successful HO.

**Question 14 Please give your view on how to enhance the efficiency of the potential need to concatenate HOs in NTN. E.g. by UE not to discard filtered measurements after successful HO? Reasoning is needed**

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| **Company** | **opinion** | **reasoning** |
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Signalling overhead. In below several different considerations regarding signalling overhead are presented

*What information to be provided in CHO configuration, system information etc need to await further progress in ephemeris discussions.[23]*

*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.[29]*

*To reduce HO signalling overhead, some common configurations, e.g. t304 and spCellConfigCommon, can be delivered to UEs in a broadcast manner.[1]*

*We suggest that RAN2 consider various signaling modes such as broadcast, multicast/groupcast, and unicast to efficiently and quickly exchange handover signaling with UEs.[27]*

*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.[29]*

1. RAN2 to discuss whether there is a need to optimize signalling overhead for HO/CHO.

**Question 15 Please give your view on whether there is a need to optimize signalling overhead for HO/CHO? Reasoning is needed**

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| **Company** | **opinion** | **reasoning** |
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List of proposals that may be discussed if time allows

*Location-based CHO condition is configured per UE and time-based CHO condition is configured per candidate cell.[11]*

*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.[16]*

*AN2 discuss whether multiple conExecutionCond can be configured for one conRRCReconfig[24]*

*RAN2 to discuss how to select target cell when multiple triggered cells exist:[14]*

*If multiple cells within timing information satisfy CHO triggering condition, the UE triggers CHO to the candidate with longest remaining service time.[19]*

*UE can report neighbour cells related assistance information to help network select CHO candidate cells.[13]*

*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.[29]*

*RAN2 can consider supporting historical measurements to facilitate a predictive handover decision-making at the gNB to accelerate the overall handover.[27]*

*Support intra-handover user traffic transfer while the RA procedure for handover is ongoing to reduce the user traffic interruption in an NTN.[27]*

*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 in an NTN.[27]*

*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.[27]*

*UE will transmit assistance information when the difference between network’s configuration and UE’s own measurement is above a pre-defined threshold.[18]*

*Permission from UE is needed for the network to collect the UE location information for the purpose other than SON/MDT. If the UE location information is collected for other purpose, the UE consent for SON/MDT cannot be reused and a similar but independent procedure for permission should be considered.[19]*

*Measurement based CHO is prioritized over other mechanisms by RAN2 for NTN.[6]*

*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.[22]*

*RAN2 consider CHO enhancement in NTN by introducing CHO activation command.[1]*

# 3 TN/NTN service continuity

### 3.1 Connected mode

The following proposals for service continuity were presented

*For NTN capable UE, both UE types shall be considered for NTN-TN mobility[5]*

*The UE capable of NTN shall support mobility between NTN and TN.[5]*

*No enhancements are needed for connected mode mobility from TN to NTN (hand-out) networks.[7]*

*Handovers from TN to NTN should use legacy events, e.g., A2. On the other hand, handovers from NTN to TN may require an additional trigger, e.g., UE location, apart from legacy events.[5]*

*Location-based triggers that are introduced for NTN connected mode mobility can be reused for NTN to TN (hand-in) mobility.[7]*

*The new trigger conditions for handover as described in TR 38.821 could also be considered for the NTN-TN service continuity.[30]*

Based on the above set of proposals the following discussion points are suggested

1. NTN capable UE shall support NTN-TN mobility

**Question 16 Please give your view on whether NTN capable UE shall support NTN-TN mobility**

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1. No limitations are specified for NTN-TN mobility thus same trigger conditions can be used within NTN and NTN-NT mobility

**Question 17 Please give your view on whether same trigger conditions can be used within NTN and NTN-NT mobility**

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| **Company** | **opinion** | **reasoning** |
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### 3.2 Idle mode

As the capacity of NTN will be limited given the large cell size and considering the RSRP of NTN cells might be better than the RSRP of TN on the same area, the idle mode operation for service continuity need to be discussed.

*No enhancements are needed for Idle-mode mobility to address NTN-TN service continuity.[7]*

*Ping-pong between TN and NTN shall be avoided.[5]*

*RAN2 confirms that UE prioritises TN over NTN.[15]*

Based on the above set of proposals the following discussion points are suggested

1. NTN UE prioritises TN over NTN

**Question 18 Please give your view on whether Proposal 18 NTN UE prioritises TN over NTN?**

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1. Discuss whether and what kind of idle mode enhancements are needed in order to realise the TN prioritization

**Question 19 Please give your view on whether and what kind of idle mode enhancements are needed in order to realise the TN prioritization**

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| **Company** | **opinion** | **reasoning** |
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### 3.3 UE battery consumption

The discussion for UE battery consumption is relevant for both connected and idle mode measurements. In the contributions submitted to RAN2#114 one proposal is for connected mode where certain measurements could be activated or deactivated. For idle mode, the proposal is to use parameter values to control when UE can relax with measurements.

*In order to save battery, it should be possible to activate/deactivate (trigger FFS) the survey of adjacent cells (measurements) for handover from NTN to TN (hand-in).[5]*

*RAN2 to discuss the need to specify a new parameter setting to initiate and to stop the UE measurements for handover from NTN to TN (hand-in).[5]*

*RAN2 to discuss the enhancement to avoid UE to measure TN neighbour cells when it is in NTN only area.[15]*

These proposals are a good starting point to gather further views how UE battery consumption could be considered in NTN and TN NTN power consumption.

### 3.4 Other

In regard of the following proposals it is suggested to discuss the nehancements first and then try to asses whether there is enough support for flexibility or further enhancements are needed.

*The network should provide enough flexibility to be capable of prioritizing between intra-system or an inter-system handover.[5]*

*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.[30]*

# 4 References

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