**3GPP TSG-RAN WG2 Meeting #123Draft R2-2306951**

**Incheon, South Korea, May 22 – 26, 2023**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
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|  |  | **CR** | **-** | **rev** | **-** | **Current version:** | **17.4.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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| ***Title:***  | Running CR for R18 IoT NTN  |
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| ***Source to WG:*** |  |
| ***Source to TSG:*** |  |
|  |  |
| ***Work item code:*** | IoT\_NTN\_enh-Core |  | ***Date:*** | 2023-06-22 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** |  |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
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| ***Reason for change:*** | Introduction of the Release-18 IoT NTN enhancements in stage 2.  |
|  |  |
| ***Summary of change:*** | 23.21.1 Explanation of disabled HARQ feedback and HARQ mode B added. 23.21.2.2 Suspension of RLM during GNSS measurement added. 23.21.4.2 Additional triggers for CHO added. New section “23.21.4.X Measurements” added |
|  |  |
| ***Consequences if not approved:*** | The Relase-18 IoT NTN enhancements are not supported.  |
|  |  |
| ***Clauses affected:*** | To be updated |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 36.321 CRxxxx, TS 36.331 CRyyyy  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** | Additions after RAN2#122.  |

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| START OF CHANGE |

## 4.12 Support of Non-Terrestrial Networks

E-UTRAN supports radio access over non-terrestrial networks for BL UEs, UEs in enhanced coverage and NB-IoT UEs. Support for non-terrestrial networks encompasses platforms that provide radio access through Geosynchronous orbits (GSO), Non-Geosynchronous Orbit (NGSO), which includes Low-Earth Orbit (LEO) and Medium Earth Orbit (MEO) or High Altitude Platform Systems (HAPS).

The Figure 4.12-1 below illustrates an example of a Non-Terrestrial Network (NTN) providing non-terrestrial access by means of an NTN payload and an NTN Gateway, depicting a service link between the NTN payload and a UE, and a feeder link between the NTN Gateway and the NTN payload.



Figure 4.12-1: Overall illustration of an NTN

NOTE: Figure 4.12-1 illustrates an NTN; RAN4 aspects are out of scope.

The NTN payload transparently forwards the radio protocol received from the UE (via the service link) to the NTN Gateway (via the feeder link) and vice-versa. The following connectivity is supported by the NTN payload:

- An eNB may serve multiple NTN payloads;

- An NTN payload may be served by multiple eNBs.

NOTE: In this release, the NTN-payload may change the carrier frequency, before re-transmitting it on the service link, and vice versa (respectively on the feeder link).

For NTN, the following applies in addition to Network entity related Identities as described in clause 8.2:

- A Tracking Area corresponds to a fixed geographical area. Any respective mapping is configured in the RAN;

- A Mapped Cell ID as specified in clause 23.21.5.

Three types of service links are supported:

- Earth-fixed: provisioned by beam(s) continuously covering the same geographical areas all the time (e.g., the case of GSO satellites);

- Quasi-Earth-fixed: provisioned by beam(s) covering one geographic area for a limited period of time and a different geographic area during another period of time (e.g., the case of NGSO satellites generating steerable beams);

- Earth-moving: provisioned by beam(s) whose coverage area slides over the Earth surface (e.g., the case of NGSO satellites generating fixed or non-steerable beams).

With NGSO satellites, the eNB can provide either quasi-Earth-fixed cell coverage or Earth-moving cell coverage, while eNB operating with GSO satellites can provide Earth fixed cell coverage or quasi-Earth-fixed cell coverage.

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| START OF CHANGE |

## 23.21 Support for BL UEs, UEs in enhanced coverage and NB-IoT UEs over Non-Terrestrial Networks

### 23.21.1 General

Support for BL UEs, UEs in enhanced coverage and NB-IoT UEs over Non-Terrestrial Networks (see clause 4.12) is only applicable to E-UTRA connected to EPC. UEs not supporting NTN are barred from accessing an NTN cell.

In NTN, only BL UEs, UEs in enhanced coverage and NB-IoT UEs with GNSS capability are supported in this release of the specification.

To accommodate long propagation delays in NTN, increased timer values and window sizes, or delayed starting times are supported for the physical layer and for higher layers.

UL segmented transmission is supported for UL transmission with repetitions. The UE shall apply UE pre-compensation per segment of UL transmission of PUSCH/PUCCH/PRACH for BL UEs or UEs in enhanced coverage and NPUSCH/NPRACH for NB-IoT UEs from one segment to the next segment.

In this release of the specification, NTN is only applicable to FDD system.

The network may configure the HARQ operation as follows:

- For downlink, HARQ feedback can be enabled or disabled per HARQ process (as specified in clause 5.3.2.2 and clause 5.7 of TS 36.321 [13]). Disabling HARQ feedback allows scheduling a HARQ process before one HARQ RTT has elapsed since last scheduled.

- For uplink, HARQ mode (i.e. HARQ mode A or HARQ mode B) can be configured per HARQ process (as specified in clause 5.4.3.1 and clause 5.7 of TS 36.321 [13]). HARQ mode B allows scheduling a HARQ process before one HARQ RTT has elapsed since last scheduled.

NOTE: For the HARQ processes configured with HARQ feedback enabled/disabled, it is up to network implementation to ensure a proper configuration of HARQ feedback (e.g., either all enabled or all disabled) for HARQ processes used by a downlink SPS configuration. For the HARQ processes configured with HARQ mode, it is up to network implementation to ensure a proper configuration of HARQ mode (e.g., either all HARQ mode A or all HARQ mode B) for HARQ processes used by an uplink SPS configuration.

Editor’s Note: A reference to RAN1 spec for DCI based control of enable/disable HARQ feedback is needed above.

### 23.21.2 Timing and synchronization

#### 23.21.2.1 Scheduling timing

DL and UL are frame aligned at the uplink time synchronization reference point (RP) with an offset given by $N\_{TA,offset} $(see clause 8 of TS 36.211 [4]).

To accommodate the long propagation delays in NTN, several timing relationships are enhanced by a Common Timing Advance (Common TA) and two scheduling offsets: $K\_{offset}$ and $K\_{mac}$ illustrated in Figure 23.21.2.1-1:

- $Common TA$ is a configured offset corresponding to the RTT between the RP and the NTN payload.

- $K\_{offset}$ is a configured scheduling offset that needs to be larger or equal to the sum of the service link RTT and the common TA.

- $K\_{mac}$ is a configured offset approximately corresponding to the RTT between the RP and the eNB.



Figure 23.21.2.1-1 Timing relationship parameters

The scheduling offset $K\_{offset}$ is used to allow the UE sufficient processing time between a downlink reception and an uplink transmission, see TS 36.213 [6].

The offset $K\_{mac}$ is used to delay the application of a downlink configuration indicated by a MAC CE received on NPDSCH/PDSCH, see TS 36.213 [6], and to determine the UE-eNB RTT, see TS 36.321 [13].

#### 23.21.2.2 Timing Advance and Frequency Pre-compensation

For the serving cell, the network broadcast ephemeris information and common Timing Advance (common TA) parameters.

The UE shall have valid GNSS position as well as the ephemeris and common TA before connecting to an NTN cell. To achieve synchronisation, before and during connection to a cell, the UE shall pre-compensate the Timing Advance (TTA, see TS 36.211 [4] clause 8.1), see Figure 23.21.2.2-1, by considering the common TA, UE position and the NTN payload position through the ephemeris.

The UE computes the frequency Doppler shift of the service link, and pre-compensates for it in the uplink transmissions, by considering UE position and the ephemeris. If the UE does not have a valid GNSS position and/or valid ephemeris and Common TA, it shall not transmit until they are regained.

In connected mode, the UE shall continuously update the Timing Advance and frequency pre-compensation, and the UE can be configured to perform GNSS acquisition. While the UE is performing GNSS acquisition, RLM is suspended. In connected mode, upon outdated ephemeris and common Timing Advance, the UE shall acquire the broadcasted parameters and upon outdated GNSS position the UE shall move to idle mode. Upon completing the GNSS acquisition, the UE shall trigger the remaining validity duration reporting.

Editor’s Note: Besides RLM, AS operations shall be suspended and that can be captured in stage 2 unless that is sufficiently captured in stage 3 (MAC and/or RRC).

Editor’s Note: A change may be neede in “upon outdated GNSS position the UE shall move to idle mode” depending on RAN1 conclusion on UE behaviour, if moving to IDLE shall be preceeded by an attempt to acquire the GNSS position or not.

The UEs may be configured to report Timing Advance at initial access or in connected mode. In connected mode triggered reporting of the Timing Advance is supported.



Figure 23.21.2.2-1 Illustration of Uplink/Downlink Radio Frame Timing at the UE

While the pre-compensation of the instantaneous Doppler shift experienced on the service link is to be performed by the UE, the management of Doppler shift experienced over the feeder link and transponder frequency error, whether introduced in Downlink or Uplink, is left to network implementation.

### 23.21.3 Support of discontinuous coverage

As an NTN payload moves on a specified orbit, for example in case of a NGSO satellite, the NTN payload beam(s) coverage area may move and cover different portions of a geographical area due to the orbital movement of the NTN payload. As a consequence, a UE located in the concerned geographical area may experience a situation of discontinuous coverage, due to e.g. a sparse satellite constellation deployment.

To enable the UE, in RRC\_IDLE, to save power during periods of no coverage, the network provides NTN payload assistance information (e.g. ephemeris parameters, the start-time of upcoming NTN payload coverage) to enable the UE to predict when coverage will be provided by upcoming NTN payloads. Predicting out of coverage and in coverage is up to UE implementation.

### 23.21.4 Mobility Management

#### 23.21.4.1 Mobility Management in ECM-IDLE

The principles described in clause 10.1.1 apply in NTN unless specified otherwise hereafter.

The network may broadcast more than one TAC per PLMN in an NTN cell. The AS layer indicates all received TACs for the selected PLMN to the NAS layer. The network may update the UEs upon TAC removal. UEs may by UE implementation also check whether a TAC has been removed.

For quasi-Earth-fixed cells, timing information on when the cell is going to stop serving the area may be broadcast by the network. This may be used by the UE to start measurements on neighbour cells before the broadcast stop time of the serving cell, while the exact start of the measurements is up to UE implementation.

Location and time-based measurements can be used for cell reselection.

#### 23.21.4.2 Mobility Management in ECM-CONNECTED

Radio link failure and RRC connection re-establishment are supported in NTN. The principles described in clause 10.1.6 apply unless specified otherwise.

To enable mobility in NTN, the network provides target cell NTN payload assistance information needed to access the NTN cell in the handover command.

Conditional handover is supported for BL UEs and UEs in enhanced coverage.

NTN supports the following additional trigger conditions upon which UE may execute CHO to a candidate cell, as defined in TS 36.331 [16]:

- The RRM measurement-based event A4;

- A time-based trigger condition;

- A location-based trigger condition.

A time-based or a location-based trigger condition is always configured together with one of the measurement-based trigger conditions (CHO events A3/A4/A5) as defined in TS 36.331 [16].

It is up to UE implementation how the UE evaluates the time- or location-based trigger condition together with the RRM measurement-based event.

#### 23.21.4.X Measurements

The principles described in clause 10.1.3.0 apply in NTN unless specified otherwise.

Measurements in RRC\_CONNECTED are optionally supported to reduce the time taken for RRC reestablishment. The following triggers can be used as specified in TS 36.331 [16]:

- A time-based trigger condition;

- A location-based trigger condition.

Editor’s Note: The agreement “New SIBxx is introduced to broadcast the neighbor cell/satellite information.” Is expected to be captured here.

### 23.21.5 Switchover

#### 23.21.5.1 Definitions

A feeder link switchover is the procedure where the feeder link is changed from a source NTN Gateway to a target NTN Gateway for a specific NTN payload. The feeder link switchover is a Transport Network Layer procedure.

Both hard and soft feeder link switchover are applicable to NTN.

#### 23.21.5.2 Assumptions

A feeder link switchover may result in transferring the established connection for the affected UEs between two eNBs.

For soft feeder link switchover, an NTN payload is able to connect to more than one NTN Gateway during a given period i.e. a temporary overlap can be ensured during the transition between the feeder links.

For hard feeder link switchover, an NTN payload only connects to one NTN Gateway at any given time i.e. a radio link interruption may occur during the transition between the feeder links.

#### 23.21.5.3 Procedures

The NTN control function determines the point in time when the feeder link switchover between two eNBs is performed. For BL UEs and UEs in enhanced coverage, the transfer of the affected UEs' context between the two eNBs at feeder link switchover is performed by means of either S1 based or X2 based handover, and it depends on the eNBs' implementation and configuration information provided to the eNBs by the NTN Control function.

### 23.21.6 Signalling

The Cell Identity, as defined in TS 36.413 [25] and TS 36.423 [42], corresponds to a Mapped Cell ID, irrespective of the orbit of the NTN payload or the types of service links supported in the following cases:

- The Cell Identity indicated by the eNB to the Core Network as part of the User Location Information, or as E-UTRAN CGI in the related S1AP messages;

- The Cell Identity used for Paging Optimization in S1 interface;

- The Cell Identity used for PWS.

For a BL UE or a UE in enhanced coverage, the Cell Identity included within the target identification of the handover messages allows identifying the correct target cell.

The mapping between Mapped Cell ID(s) and geographical area(s) is configured in the RAN and Core Network.

NOTE 1: A specific geographical location may be mapped to multiple Mapped Cell ID(s), and such Mapped Cell IDs may be configured to indicate different geographical areas (e.g. overlapping and/or with different dimensions).

The eNB is responsible for constructing the Mapped Cell ID based on the UE location information received from the UE, if available. The mapping may be pre-configured (e.g., depending on operator's policy) or up to implementation.

NOTE 2: As described in TS 23.401 [17], the User Location Information may enable the MME to determine whether the UE is allowed to operate at its present location. Special Mapped Cell IDs or TACs may be used to indicate areas outside the serving PLMN's country.

The eNB reports the broadcasted TAC(s) of the selected PLMN to the MME. In case the eNB knows the UE's location information, the eNB may determine the TAI the UE is currently located in and provide that TAI to the MME.

### 23.21.7 MME(Re-)Selection by eNB

The eNB implements the NAS Node Selection Function specified in TS 36.410 [95].

For a RRC\_CONNECTED UE, the eNB ensures that the BL UE or the UE in enhanced coverage connects to an MME that serves the country in which the UE is located. If the eNB detects that a BL UE or a UE in enhanced coverage is in a different country to that served by the serving MME, it should perform an S1 handover to change to an appropriate MME or initiate anUE Context Release Request procedure towards the serving MME (in which case the MME may decide to detach the UE).

For an RRC\_CONNECTED NB-IoT UE, the eNB ensures that the NB-IoT UE connects to an MME that serves the country in which the UE is located. If the eNB detects that the UE is in a different country to that served by the serving MME, it should initiate a UE Context Release Request procedure towards the serving MME (in which case the MME may decide to detach the UE).

### 23.21.8 O&M Requirements

The NTN related parameters shall be provided by O&M to the eNB providing non-terrestrial access, as specified in TS 38.300 [79].

### 23.21.9 Coarse UE location reporting

Upon network request, after AS security is established in connected mode, BL UEs and UEs in enhanced coverage can report its coarse UE location information (most significant bits of the GNSS coordinates, ensuring an accuracy in the order of 2km) to the eNB if available.

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Annex P (informative):
Example implementation of Non-Terrestrial Networks

The following figure illustrates an example implementation of a Non-Terrestrial Network for transparent NTN payload:



Figure P-1: NTN based E-UTRAN

The eNB depicted in Figure P-1 may be subdivided into non-NTN infrastructure eNB functions and the NTN Service Link provisioning System. The NTN infrastructure may be thought of being subdivided into the NTN Service Link provisioning System and the NTN Control function. The NTN Service Link provisioning System may consist of one or more NTN payloads and NTN Gateways.

The NTN payload is embarked on a spaceborne (or airborne) vehicle, providing a structure, power, commanding, telemetry, attitude control for the satellite (resp. high altitude platform station) and possibly an appropriate thermal environment and radiation shielding.

The NTN Service Link provisioning System maps the Uu radio protocol over radio resources of the NTN infrastructure (e.g. beams, channels, Tx power).

The NTN control function controls the spaceborne vehicles as well as the radio resources of the NTN infrastructure (NTN payload(s) & NTN Gateway(s)). It provides control data, e.g. Ephemeris, to the non-NTN infrastructure eNB functions of the eNB.

Provision of NTN control data to the eNB is out of 3GPP scope.

NOTE: The transport of Uu protocol between the NTN Service Link provisioning system and the non-NTN infrastructure eNB functions is out of 3GPP scope.

At least the following NTN related parameters are expected to be provided by O&M to the eNB for its operation.

a) Earth fixed beams: for each beam provided by a given NTN-payload:

- The Cell identifier (S1 and Uu) mapped to the beam;

- The Cell's reference location (e.g. cell's center and range).

b) Quasi Earth fixed beams: for each beam provided by a given NTN-payload:

- The Cell identifier (S1 and Uu) and time window mapped to a beam;

- The Cell's/beam's reference location (e.g. cell's center and range);

- The time window of the successive switchovers (feeder link, service link);

- The identifier and time window of all serving NTN payloads and NTN-Gateways.

c) Earth moving beams: for each beam provided by a given NTN-payload:

- The Uu Cell identifier mapped to a beam and mapping information to fixed geographical areas reported on NG, including information about the beams direction and motion of the beam's foot print on Earth;

- Its elevation with regard to NTN-payload;

- Schedule of successive serving NTN-Gateways/eNBs;

- Schedule of successive switchovers (feeder link, service link).

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| END OF CHANGE |

# Appendix Agreements (this section to be removed)

## RAN2#119

Agreements:

1. Disabling DL HARQ feedback is supported for NB-IoT and eMTC NTN. FFS on UE capability
2. For UL HARQ operation, introduce two HARQ modes, i.e., HARQ mode A and HARQ mode B in IoT NTN (both NB-IoT and eMTC NTN), similarly to NR NTN
3. From RAN2 perspective, at least for eMTC, enabling/disabling HARQ feedback can be configured per DL HARQ process at least via UE specific RRC signalling. FFS for NB-IoT (and especially for CP solution for NB-IOT).

Agreements:

1. IoT NTN can use the mechanism for neighbour cell measurements in connected mode (specified in Rel-17 for NB-IoT). FFS if any enhancements are needed (e.g. triggers) for both NB-IoT and eMTC.
2. RAN2 to continue working on a new time-based trigger for triggering intra and inter frequency measurements in connected mode, e.g. the serving cell is going to stop covering the current area, for both earth-moving and earth-fixed cell (FFS on distance-based trigger)
3. CHO enhancements for eMTC NTN (i.e. time/timer based solution) are introduced based on the R17 NR NTN solution. FFS on location-based solution
4. Measurement results reporting is not supported in Rel-18 NB-IoT NTN.

## RAN2#119bis

Agreements:

1. For NB-IoT, enabling/disabling HARQ feedback can be configured per DL HARQ process at least via UE specific RRC signaling (e.g. RRCConnectionSetup). This does not preclude other options (e.g. DCI-based). We can also revert this decision if requested by RAN1.
2. Disabling HARQ feedback is supported for NB-IoT with single HARQ process, and it is up to eNB implementation whether to disable the HARQ feedback

Working Assumption:

1. Blind retransmission can be used in IoT NTN when HARQ feedback is disabled and when HARQ mode B is used (RAN2 assumes there is no spec change for this)

Agreements:

1. HARQ mode A/B for uplink transmission may be configured per UL HARQ process at least via UE specific RRC signalling for eMTC and NB-IOT NTN. We can also revert this decision if requested by RAN1

Agreements:

1. RAN2 agree to take R17 NR NTN DRX solution as baseline for IoT NTN, e.g. for HARQ process with DL HARQ feedback disabled, the UE will not start the corresponding DL HARQ RTT timer.
2. For NB-IoT NTN with single HARQ process when the HARQ feedback is disabled, the UE will start/restart drx-inactivity timer in the subframe containing the last repetition of the corresponding PDSCH reception (can still check whether the alternative to set the HARQ RTT timer to 0 also works)
3. RAN2 agree to take R17 NR NTN DRX solution as baseline for IoT NTN, e.g. for HARQ process in HARQ mode B, the UE will not start the corresponding UL HARQ RTT timer.
4. For NB-IoT NTN with single HARQ process in HARQ mode B, the UE will start/restart drx-inactivity timer in the subframe containing the last repetition of the corresponding PUSCH transmission (can still check whether other alternatives also work)
5. The solutions of LCP restriction on allowed HARQ mode in NR NTN can be reused for eMTC NTN.

Agreements:

1. For eMTC over NTN, for both earth-moving and earth-fixed cell scenarios, we introduce location based CHO triggering events

## RAN2#120

Agreements:

1. For NB-IoT NTN with single HARQ process when the HARQ feedback is disabled, the UE will start/restart drx-inactivity timer in the subframe containing the last repetition of the corresponding PDSCH reception plus 12 subframes.
2. RAN2 understands that something needs to be added to consider the processing time also for inactivity timer of HARQ mode B. Continue the discussion on the details in the next meeting

Agreements:

1. For eMTC, the following LCH to HARQ process mapping rules are supported:

 1) LCH is mapped only to a HARQ process configured with HARQ mode A;

 2) LCH is mapped only to a HARQ process configured with HARQ mode B;

 3) If an LCH is not configured with a mapping rule, it may be mapped to any HARQ process (HARQ mode A or B).

 4) If UL HARQ mode is not configured, LCH mapping rules are not supported (legacy behaviour)

2. For eMTC, introduce allowedHARQ-mode for each logical channel, e.g. included in LogicalChannelConfig IE.

Agreements:

1. An optional UE capability is introduced to indicate whether the UE supports disabling HARQ feedback for downlink transmission.
2. An optional UE capability is introduced to indicate whether the UE supports HARQ Mode B and, for eMTC, the corresponding LCP restrictions for uplink transmission

Agreements:

1. For NB-IoT we support a trigger for neighbour cell measurements based on T-service (in the quasi-Earth fixed case) (this does not preclude anything for eMTC discussion)

Agreements:

1. At least for NB-IoT NTN, for quasi-earth fixed cells, UE shall start intra/inter frequency measurement in connected mode before the t-Service if present. The exact time to start measurements in connected mode before t-Service can be left to UE implementation” (can revisit if we agree other proposal based on neighbour cell coverage)
2. RAN2 will not specify the condition of stopping UE measurement before t-Service
3. For earth-moving cell, the UE derives when loss of coverage of current cell happens (how to derive this information is FFS)
4. For earth-moving cell, UE shall start intra/inter frequency measurements in RRC connected mode before losing coverage. The exact time to start measurements can be left to UE implementation

Agreements:

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.: UE is allowed to perform HO only during T1 to T2.
2. For eMTC NTN, introduce a location-based conditional reconfiguration trigger based on condEventD1 in NR, where the event will be satisfied if the distance between the UE and a first reference location (e.g. within the serving cell) is above a threshold, and the distance between the UE and a second reference location (e.g. within a neighbour cell) is below a threshold. (similar to condEventD1 in NR)
3. For eMTC NTN, introduce event A4 based conditional trigger (similar to condEventA4 in NR).
4. FFS whether time and location-based trigger conditions may be configured independently (i.e., without a jointly configured event A4 measurement condition) for eMTC NTN.

## RAN2#121

Agreements:

1. For UE to report GNSS position fix time duration for measurement during the initial access, at least the following Msg5 message can be used:

 RRCConnectionSetupComplete, RRCConnectionSetupComplete-NB,

 RRCConnectionResumeComplete, RRCConnectionResumeComplete-NB,

 FFS for RRCreestablishmentComplete and RRCConnectionReconfigurationComplete.

 FS for Msg3

1. FFS whether the UE can stay in RRC\_CONNECTED state when current GNSS position becoming out-of-date if the UE has initiated a new measurement
2. The value range {10s, 20s, 30s, 40s, 50s, 60s, 5 min, 10 min, 15 min, 20 min, 25 min, 30 min, 60 min, 90 min, 120 min, infinity} introduced in R17 is reused for connected UE GNSS validation duration report, unless modified by RAN1.
3. UE reports GNSS validity duration after GNSS measurement. FFS whether the UE reports every time or only if the validity duration changes. FFS if the duration is the remaining validity duration or the whole duration

Agreements:

1. Location-based connected mode measurement initiation is supported in quasi-Earth-fixed cell (UE is not required to update the GNSS location for this). A serving cell reference location and a distance threshold/radius for detecting when to trigger connected mode measurements will be broadcast for quasi-Earth-fixed cell. FFS on whether the R17 IEs are reused or not. FFS if the same mechanism can also be used in idle (like in NR-NTN)
2. Location-based connected mode measurement initiation is supported in earth-moving cell (UE is not required to update the GNSS location for this). A serving cell reference location and a distance threshold/radius for detecting when to trigger connected mode measurements will be broadcast for earth-moving cell. FFS on whether the R17 IEs are reused or not. FFS on whether additional information needs to be broadcast to inform the UE how the reference location moves over time or if this can be derived from other information (e.g. Epoch time and ephemeris). FFS if the same mechanism can also be used in idle (like in NR-NTN)

Agreements:

1. We don’t introduce any new low mobility criterion for enhanced mobility in Rel-18

Agreements:

1. RAN2 can continue to check whether dedicated RRC signalling can be used for providing satellite information corresponding to discontinuous coverage.

2. RAN2 will support enhancements in paging and eDRX, in alignment with the work in SA2 and CT1. FFS on the details

3. RAN2 may consider enhancements for connected UE upon detecting discontinuous coverage (e.g., suspend RLM, RLF detection, and RRC re-establishment process)

4. Companies supporting the store and forward approach can bring a proposal to the plenary for TEI18 or for updating the WID

## RAN2#121bis

#### 7.6.2.1 HARQ enhancements

Agreements:

1. RAN2#121’s agreement is revised to “For NB-IoT NTN with single HARQ process when the HARQ feedback is disabled, the UE will start/restart drx-inactivity timer in the subframe containing the last repetition of the corresponding PDSCH reception plus 12 subframes plus deltaPDCCH” (Can further check in the NB-IoT session if anything needs to be done for legacy NB-IoT as well, as some timers don’t take deltaPDCCH into account)
2. Wait for RAN1’s decision on the RRC signalling of enabling DCI-based solution to indicate HARQ feedback enabled/disabled, and the signalling granularity, e.g. per UE or per HARQ process
3. On DCI indication overriding RRC configuration for the HARQ feedback enabled/disabled, wait for RAN1’s progress on DCI-based solution before discussing related DRX impact in RAN2.
4. On DL multiple TB scheduling, wait for RAN1’s progress before discussing related DRX impact in RAN2.
5. P4 in [R2-2302557](file:///C%3A/Data/3GPP/Extracts/R2-2302557.DOCX) is not agreed, i.e. no special handling for single HARQ process for eMTC.
6. For eMTC NTN, a parameter harq-FeedbackEnablingforSPSactive could be configured for a UE. If harq-FeedbackEnablingforSPSactive is configured to enable HARQ feedback, UE reports ACK/NACK for the first SPS PDSCH after activation, regardless of if HARQ feedback is enabled or disabled corresponding to the first SPS PDSCH after activation.
7. For a NB-IoT UE configured with a single HARQ process in HARQ mode B, send LS to RAN1 and ask for the “processing time for starting drx-InactivityTimer (i.e. start to monitor NPDCCH)”. (can further check the detailed wording of the question)
8. Network implementation resolves the issue of ambiguity on start of DRX inactivity timer after the PUSCH transmission by not scheduling the NPDCCH back-to-back during the ambiguity period (i.e., Koffset – UE’s TA)
9. Send LS to RAN1 to check for UL multiple TB scheduling, which UL HARQ mode combination(s) are to be supported.
10. In the LS to RAN1, we don’t include a question on whether RAN1 intends to introduce the DCI-based solution for the UL HARQ mode
11. UL transmission using SPS can be configured with HARQ mode B
12. P1 in [R2-2303713](file:///C%3A/Data/3GPP/Extracts/R2-2303713%20%28R18%20IoT-NTN%20WI%20AI%207.6.2.1%29%20-%20disabling%20HARQ%20feedback.docx) is not agreed, i.e. do not enhance the LCP restriction based on uplinkHARQ-Mode for different RLC PDU types
13. Send LS to RAN1 informing RAN2’s agreements and also including potential questions to be checked with RAN1

Agreements via email – from offline 103 – second round:

1. Add one more question in the LS to check with RAN1 which of the below understandings is correct for the RAN1 agreement.

 Understanding 1: For a DL HARQ process with disabled HARQ feedback in NB-IoT, UE is not required to monitor NPDCCH for the same HARQ process in a period of Y=12(ms) from the end of reception of the NPDSCH.

 Understanding 2: For a DL HARQ process with disabled HARQ feedback in NB-IoT, UE is not required to monitor NPDCCH for all the HARQ processes in a period of Y=12(ms) from the end of reception of the NPDSCH.

1. RAN2 further discuss whether UL transmission using PUR can be configured with HARQ mode B.

#### 7.6.2.2 GNSS operation enhancements

Agreements:

1. There is no need for UE to provide GNSS position fix time duration in Msg3.
2. RLM is suspended during the GNSS measurement gap while the UE is measuring GNSS

Agreements via email – from offline 104 – second round:

1. UE can stay in RRC\_CONNECTED state when current GNSS position becomes out-of-date if the UE enters a GNSS measurement gap. FFS whether the new GNSS measurement shall be started before, upon or after the current GNSS validity duration expiry
2. For a UEs that cannot acquire system information and GNSS position at the same time, acquisition of SIB31 may be postponed until GNSS measurement is completed if the UE cannot complete acquisition of SIB31 before the start of GNSS measurement gap

Agreements online:

1. For the NB-IoT CP solution, UE will report the GNSS validity duration by using a MAC CE
2. RAN2 can discuss UE autonomously reacquire GNSS during inactive state of C-DRX based on RAN1’s input in the next RAN2 meeting

Working Assumption:

1. GNSS validity duration UE reported after GNSS measurement is the remaining validity duration

#### 7.6.3.1 Enhancements for neighbour cell measurements

Agreements:

1. New SIBxx is introduced to broadcast the neighbor cell/satellite information.

Agreements via email – from offline 114:

1. Common TA parameters are broadcast as assistance information for neighbor cell measurements.
2. Kmac is broadcast as neighbor cell assistance information.
3. For moving cell, the UE can derive the trajectory of serving cell with rough accuracy based on serving satellite ephemeris and epochTime, with the assumption that the serving cell reference location broadcast by the network is the one at Epoch time (like in NR-NTN)

Agreements online:

1. Introduce satellite ID for the satellite in a list in new SIB-xx. FFS on the details of the new IE
2. For eMTC NTN, for fixed cell, location-based measurement initiation can also be used in RRC\_IDLE for cell re-selection purposes (like in NR-NTN)
3. For eMTC NTN, for moving cell, location-based measurement initiation can also be used in RRC\_IDLE for cell re-selection purposes (like in NR-NTN). FFS whether to consider solution that does not require UE to update the GNSS for this same as in connected mode
4. SIB3 is extended to include the reference location and distanceThresh

### 7.6.4 Enhancements to discontinuous coverage

Agreements via email – from offline 115:

1. RAN2 will not introduce any enhancement to allow a UE in RRC Connected to stay in RRC\_CONNECTED during/after a coverage gap (e.g. suspend RLM/RLF, activation time in RRC Reconfiguration, CHO enhancement)

Agreements online:

1. RAN2 to introduce enhancement to RRC Release using one of the following options (FFS which one):

 - Explicit RRC Release using a new RRC Release cause

 - UE Autonomous release (e.g. timer based or upon detection of coverage gap)

## RAN2#122

Agreements:

1. Confirm the working assumption that GNSS validity duration UE reports is the remaining validity duration.
2. The UE triggers GNSS measurement reporting every time upon completing the GNSS fix operation.
3. When network triggers GNSS measurement initiation is up to network implementation.
4. Add a note to state some AS operations are suspended when UE is performing GNSS measurement during GNSS measurement gap.
5. GNSS fix time duration should be reported in 1) and 2):

 1) RRCConnectionReestablishmentComplete and RRCConnectionReestablishmentComplete-NB

 2) RRCConnectionReconfigurationComplete for HO case

 (FFS whether there are some scenarios where this is not needed or whether there has to be some explicit NW indication to do so)

Working Assumptions:

1. An UL MAC CE for GNSS validity duration reporting is used for NB-IoT user plane solution and eMTC UE as well, in addition to previously agreed NB-IoT control plane solution

2. A new DL MAC CE is introduced to trigger connected UE to perform GNSS measurement.

Agreements:

1. Extend the neighbour cell information in existing SIBs (not SIB31) to include satellite ID
2. The system Information modification procedure is not triggered for an update of new SIB on neighbor-cell assistance information.
3. For NB-IoT, SIBxx is not an essential SIB. UE does not need to consider the cell barred if it is unable to acquire the SIB when scheduled. FFS for eMTC
4. In RRC IDLE, how to (re-)acquire neighbour cell assistance information is up to UE’s implementation.
5. The satellite ID in the new SIB is an integer of X bits wherein X depends on the maximum number of satellites to be considered for mobility.
6. The satellite ID is defined as Radio resource control information element to be used in other configurations.
7. If a parameter in the common TA parameters is absent, then the value of the parameter is assumed zero.
8. If Kmac is absent, then the value of Kmac for the neighbor satellite in the list is assumed zero. FFS on further optimization on signaling, e.g., signalling explicit value 0 of Kmac.

Agreements:

1. Reference location and distanceThresh in SIB31. A change of reference location does not trigger SI modification. A UE does not need to get a new reference location as long as ephemeris and Epoch time are valid (in Connected mode the UE relies on T317)

Agreements:

1. For earth-fixed cells, introduce t-ServiceStart for neighbor cells. If UE is aware of the t-ServiceStart of the neighbour cell then may be used (up to UE implementation) to determine when to start measurements of that neighbor cell
2. If the serving cell t-service expires, stop T310 (if running) and start T311 (i.e. perform cell search and re-establishment without attempting to recover on the current cell for the duration of T310). FFS on discontinuous coverage
3. The distance between the UE and a second reference location (e.g. within a neighbour cell) is not taken into account.
4. R18 location and time based trigger for measurements (for connected mode and for idle) apply to both NB-IoT and eMTC.