**3GPP TSG RAN meeting #101 RP-23xxxx**

**Bangalore, India, September 11-15, 2023**

## Status Report to TSG

**Agenda item:** 10.2.1 IoT (Internet of Things) NTN (non-terrestrial network) enhancements

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **WI / SI Name** | IoT (Internet of Things) NTN (non-terrestrial network) enhancements | | | | |
| included in this status report | Study Item:  No | Core part:  Yes | Performance part:  Yes | | Testing part:  - |
| **Acronym** | IoT\_NTN\_enh | | | | |
| **Unique ID** | 941004 | | | | |
| **TSG Tdoc of latest approved WI/SI description (if any)** | RP-231407 | | | | |
| **Target Completion Date**  **(indicate if changed)** | Study Item: | Core part:  12/2023 | Performance part:  06/2024 | Testing part: - | |
| **Overall Completion level** | Study Item: | Core part:  Overall: 82%  For information  RAN1: 95%  RAN2: 80%  RAN3: 90%  RAN4: 65% | Performance Part: 0% | Testing part: - | |

Note: Overall completion level percentage numbers should use one of the colors below:

* xx%: Normal progress, no RAN plenary action needed
* xx%: Progress behind schedule, may need RAN plenary intervention. If so, SR should clearly define requested action
* xx%: Progress critically behind, RAN plenary shall intervene. SR should define requested action

**Source:**

|  |  |  |
| --- | --- | --- |
| **Leading WG** | | RAN2 |
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| **Secondary WG** | | RAN2 |

## 1 Work plan related evaluation

|  |  |
| --- | --- |
| **Do you want to modify the time budget for this WI/SI compared to what was endorsed at the last RAN meeting?** | No |

*If you answered No: Then please remove the Excel file from the zip file of this status report.*

*If you answered Yes: Then please fill out the attached Excel template to request a modification of the time budgets for your WI /SI. The Excel table has to be filled out for all affected RAN WGs and up to the target date of the WI/SI. The basis are the endorsed time budgets of the last RAN meeting. Please highlight all changes of the values.  
 One time unit (TU) corresponds to ~ 2 hours in the meeting.  
 If this status report covers a WI with Core and Performance part, then please have one line for each in the attached Excel table.  
 Note: If no Excel table is attached, then this means no time budget change.*

**Additional explanations/motivations for the time budget changes in the attached Excel table:**

## 2. Detailed progress in RAN WGs since last TSG meeting (for all involved WGs)

NOTE: Agreements and Open issues impacted cross-TSG aspects shall be explicitly highlighted

## 2.1 RAN1

#### 2.1.1 Agreements

**RAN1#114, August 21st – August 25th, 2023, Toulouse, France**

**Agreements on “9.9.3 Disabling of HARQ feedback for IoT NTN”**

Agreement

Confirm the following working assumption:

Working assumption

For DCI-based direct indication in single TB scheduled by DCI,

* Indication by reusing/reinterpreting HARQ-ACK related field in DCI
  + - For eMTC CE mode B, one state of “HARQ-ACK resource offset” field in DCI format 6-1B is used for indication of HARQ feedback disabled, other states are used for indication of HARQ feedback enabled and corresponding HARQ-ACK resource.
      * FFS: detailed state, and whether this state is different across different UEs
    - For NBIoT, one state of “HARQ-ACK resource” field in DCI format N1 is used for indication of HARQ feedback disabled, other states are used for indication of HARQ feedback enabled and corresponding HARQ-ACK resource.
      * FFS: detailed state, and whether this state is different across different UEs
* If reusing/reinterpreting HARQ-ACK related field in DCI is also used for DCI overriding scheme, the interpretation of the state can be different than for DCI-based direct indication.

For single TB scheduled by DCI,

* Working assumption 1 DCI based overridden indication is applied to both semi-statically HARQ disabled and enabled processes
  + For DCI based overridden indication, adopt indication by reusing/reinterpreting HARQ-ACK related field in DCI
    - For eMTC CE mode B, “HARQ-ACK resource offset” field in DCI format 6-1B is used for indication of maintaining/reversing the HARQ feedback enable/disable for the corresponding transmission from per-HARQ process RRC configuration and corresponding HARQ-ACK resource in case of indication of HARQ feedback enabled.
      * HARQ feedback disabled is reversed to enabled in case of any states other than state A in “HARQ-ACK resource offset”, otherwise is maintained as disabled.
      * HARQ feedback enabled is maintained in case of any states other than state A in “HARQ-ACK resource offset”, otherwise is reversed to disabled.
        + FFS: detailed state A, and whether this state A is different across different UEs
    - For NBIoT, “HARQ-ACK resource” field in DCI format N1 is used for indication of maintaining/reversing the HARQ feedback enable/disable for the corresponding transmission from per-HARQ process RRC configuration and corresponding HARQ-ACK resource in case of indication of HARQ feedback enabled.
      * The same DCI indication functionality as eMTC is adopted.

Agreement

For DCI-based direct indication in multiple TBs scheduled by single DCI, reuse/reinterpret the HARQ-ACK related field in corresponding DCI for indication of HARQ feedback enabled/disabled.

* The same DCI direct indication functionality as single TB scheduled by DCI scenarios. (i.e., same state of HARQ related field is used)

Agreement

For the DCI based overridden indication for multiple TBs scheduled by single DCI,

* reuse/reinterpret the HARQ-ACK related field in corresponding DCI for overridden indication of HARQ feedback enabled/disabled.
  + The same DCI overridden indication functionality as single TB scheduled by DCI scenarios.
    - This implies that all scheduled TBs by single DCI are HARQ feedback enabled or HARQ feedback disabled by the DCI overridden indication.

Agreement

For both RRC bitmap-based solution and DCI-based solutions (i.e., DCI-based direct indication and DCI-based overridden indication),

* For LTE-MTC/NB-IoT multiple TBs scheduled by single DCI without HARQ-ACK bundling,
  + HARQ feedback is reported for each TB at least in case that all TBs scheduled by single DCI are configured/indicated as HARQ feedback enabled.
  + HARQ feedback is not reported at least in case all TBs scheduled by single DCI are configured/indicated as HARQ feedback disabled.
* For LTE-MTC/NB-IoT multiple TBs scheduled by single DCI with HARQ-ACK bundling,
  + bundled HARQ feedback is reported at least in case that all TBs scheduled by single DCI are configured/indicated as HARQ feedback enabled.
  + HARQ feedback is not reported at least in case all TBs scheduled by single DCI are configured/indicated as HARQ feedback disabled.

Agreement

For LTE-MTC/NB-IoT, for the multiple TBs scheduled by single DCI with only RRC bitmap-based solution configuration, down select one of the options at RAN1#114.

* Option 2: Support mixed HARQ feedback enabled/disabled configuration, and in case of mixed HARQ feedback enabled/disabled configuration,
  + Option 2a: HARQ feedback is always reported based on the decoding results of corresponding transmission for all scheduled TBs for both HARQ-ACK bundling and non-HARQ-ACK bundling cases.
  + Option 2c: HARQ feedback is reported or not for all scheduled TBs depending on the HARQ feedback enabled/disabled configuration of the TB with the lowest HARQ process number among scheduled TBs for both HARQ-ACK bundling and non-HARQ-ACK bundling cases.
  + Option 2d: HARQ feedback is reported for TB with HARQ feedback enabled configuration and ACK is reported for TB with HARQ feedback disabled configuration for both HARQ-ACK bundling and non-HARQ-ACK bundling cases.
  + Option 2e: HARQ feedback is reported for TB with HARQ feedback enabled configuration.
    - Without HARQ-ACK bundling
      * HARQ feedback is not reported for TB with HARQ feedback disabled configuration.
      * HARQ timing for TBs with HARQ feedback enabled configuration does not count the legacy HARQ-ACK resource/HARQ timing adopted for TBs with HARQ feedback disabled configuration.
    - With HARQ-ACK bundling
      * HARQ feedback is not reported for TB with HARQ feedback disabled configuration.
        + Mapping of TBs to bundles is done as per legacy (i.e., TS36.213 Table 7.3-1 for LTE-MTC) based on all scheduled TBs.
        + The TB with HARQ feedback disabled configuration does not count in the HARQ bundling (i.e., it is not part of the logical AND operation). If all TBs in a bundle have HARQ feedback disabled, the UE does not send HARQ-ACK corresponding to this TB bundle.
        + HARQ timing for bundles for which HARQ-ACK feedback is sent do not count the legacy HARQ-ACK resource/HARQ timing adopted for bundles for which HARQ-ACK feedback is not sent.
* Note: mixed HARQ feedback enabled/disabled configuration means among TBs scheduled by single DCI, some TBs are RRC configured as HARQ feedback enabled, and the other TBs are RRC configured as HARQ feedback disabled.

Agreement

For LTE-MTC/NB-IoT, for the multiple TBs scheduled by single DCI with only RRC bitmap-based solution configuration and with mixed HARQ feedback enabled/disabled scheduling

* Without HARQ-ACK bundling
  + HARQ feedback is not reported for TB with HARQ feedback disabled configuration.
  + HARQ timing for TBs with HARQ feedback enabled configuration does not count the legacy HARQ-ACK resource/HARQ timing adopted for TBs with HARQ feedback disabled configuration. (Option 2e)
* With HARQ-ACK bundling
  + Option 2f-b: ACK is reported for TB with HARQ feedback disabled configuration for HARQ-ACK bundling. No change to HARQ feedback timeline. (Option 2d)

Agreement

For DCI-based direct/overridden indication, for the state of HARQ-related field (i.e., “HARQ-ACK resource offset” field for eMTC, “HARQ-ACK resource” field for NBIoT) in DCI to indicate the HARQ feedback enabled/disabled.

* Option 1: one common state is used for all UEs
  + Option 1-1: the state of indication of HARQ feedback disabled and state A are state of “11” for eMTC and state of “1111” for NB-IoT (i.e., for both 3.75kHz and 15kHz subcarrier spacing) respectively.

**Agreements on “9.11.4 Improved GNSS operations for IoT NTN”**

Agreement

From RAN1 perspective, during connected mode, reporting of GNSS position fix time duration is not needed except via RRCConnectionReestablishmentComplete, RRCConnectionReestablishmentComplete-NB and RRCConnectionReconfigurationComplete for HO case.

Agreement

For the aperiodic GNSS measurement gap triggered by eNB with MAC CE, the start time of the gap should be at

* n+ X1, where n is the end of MAC CE receiving subframe/slot when HARQ feedback for the MAC CE is disabled and X1>= 12ms for NB-IoT, X1>= 3ms for eMTC,
* or should be at p+ X2, where p is the end of HARQ feedback transmission subframe/slot when HARQ feedback for the MAC CE is enabled
  + X1 is predefined values, where X1=12ms for NB-IoT, and FFS X1 for eMTC
  + FFS: X2 is predefined value or configured value.

Agreement

Network can configure the length for GNSS measurement gap via a 4-bit field with component values [1,2,3,4,5,6,7,13,19,25,31] second.

* FFS: other component values
* Note: RAN2 can further discuss whether separate configurations are needed for GNSS measurement gap and GNSS measurement timer, and whether the configuration is by RRC or MAC CE

Agreement

For autonomous GNSS timer, the start time of the autonomous GNSS measurement timer is where the original GNSS validity duration expires, and the duration X (if any) expires.

Note (as already agreed): The duration X is where UL transmission can be allowed after original GNSS validity duration expires without GNSS re-acquisition.

Agreement

Network can configure the length for GNSS measurement timer via a 4-bit field with component values [1,2,3,4,5,6,7,13,19,25,31] second.

* FFS: other component values
* Note: RAN2 can further discuss whether separate configurations are needed for GNSS measurement gap and GNSS measurement timer

Agreement

For the aperiodic GNSS measurement gap triggered by eNB with MAC CE, the start time of the gap should be at n+ X1, where n is the end of MAC CE receiving subframe/slot when HARQ feedback for the MAC CE is disabled

* X1=12ms for NB-IoT
* X1=6ms for eMTC

Agreement

From RAN1 perspective, after autonomous GNSS measurement timer expires if UE failed to re-acquire GNSS position fix within the autonomous GNSS measurement timer UE goes to IDLE mode

Agreement

In RRC connected, every time after successful GNSS measurement, UE reports the new remaining GNSS validity duration.

FFS: Whether UE should report the new remaining GNSS validity duration within a duration D.

Agreement

The UE is not required to monitor N/MPDCCH within the aperiodic GNSS measurement gap, except after a CBRA (PRACH) is sent.

* CBRA (PRACH) can be sent at least to request UL resource to report the remaining GNSS validity duration.

Note1: The CBRA (PRACH) can only be sent within the duration after UE reacquires GNSS successfully to the end of the gap.

Note2: Whether CBRA (PRACH) is sent is up to UE implementation.

Note3: no change to existing CBRA procedures

FFS: whether other RA procedure is needed.

Agreement

From RAN1 perspective, *for the aperiodic GNSS measurement gap triggered by eNB with MAC CE, down select one of the alternatives for the failure of GNSS measurement:*

* Alt-1: UE goes to IDLE modeafter the end of GNSS measurement gap if UE failed to re-acquire GNSS position fix within GNSS measurement gap.

Agreement

From RAN1 perspective, down select one for the duration X:

* Alt-3: when timeAlignmentTimer is not infinity, X is equal to remaining timeAlignmentTimer;

when timeAlignmentTimer is infinity, X is equal to Y;

* + FFS: whether X can be used to extend the original GNSS validity duration
  + Y is a configured value.

Note 1: The feature can be enabled/disabled by network

Note 2 (as already agreed): The duration X is where UL transmission can be allowed after original GNSS validity duration expires without GNSS re-acquisition.

#### Remaining Open issues

Objective 1 (IoT-NTN Performance Enhancements in Rel-18 to address remaining issues from Rel-17):

- Remaining details on disabling of HARQ feedback to mitigate impact of HARQ stalling on UE data rates.

- Remaining details on improved GNSS operations for a new position fix for UE pre-compensation during long connection times and for reduced power consumption.

## 2.2 RAN2

#### 2.2.1 Agreements

**RAN2#123, August 21st – August 25th, 2023, Toulouse, France**

**Agreements on “7.6.2.1 HARQ Enhancements”**

Agreements:

* For eMTC NTN, it can be left to eNB’s implementation to configure either HARQ mode A or HARQ mode B for all HARQ process (or no HARQ mode) if mpdcch-UL-HARQ-ACK-FeedbackConfig is configured.
* For NB-IoT NTN and eMTC NTN for CE Mode B, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission:
  + Introduce an RRC bitmap with a value per HARQ process to indicate the HARQ feedback enabling/disabling for each HARQ process. (Similar to NR)
  + Introduce a single flag in RRC signaling to indicate whether DCI-based solution is enabled or not
* HARQ feedback shall always be sent for DL SPS deactivation (i.e. regardless of HARQ feedback enabled/disabled).
* For NB-IoT, UL HARQ mode configuration is based on RRC signalling (similar like NR NTN).
* For a NB-IoT UE configured with a single HARQ process, if the HARQ process is configured with HARQ mode B, UE (re)starts drx-InactivityTimer in the subframe containing the last repetition of the corresponding PUSCH transmission plus 1 subframe plus deltaPDCCH.
* HARQ mode B is not applicable for UL transmission using PUR. FFS whether HARQ mode can be configured for PUR.
* In the case mpdcch-UL-HARQ-ACK-FeedbackConfig is configured, for a HARQ process configure with HARQ mode B, the corresponding drx-ULRetransmissionTimer is not started after the last repetition of the corresponding PUSCH transmission if an UL HARQ-ACK feedback has not been received on MPDCCH until the last repetition of the corresponding PUSCH transmission
* For eMTC, UL HARQ mode configuration is based on RRC signalling (similar like NR NTN).
* RAN2 confirms working assumption 2 in LS R2-2307016 (R1-2306245) is feasible.

**Agreements on “7.6.2.2 GNSS Operation Enhancements”**

Agreements:

* An UL MAC CE for GNSS validity duration reporting is used for NB-IoT user plane solution and eMTC UE as well and A new DL MAC CE is introduced to trigger connected UE to perform GNSS measurement.
* RAN2 will wait for more input foRAN1 for the detailed format of UL MAC CE for GNSS validity duration reporting and DL MAC CE for GNSS measurement wait for more input from RAN1.
* T318 is restarted after GNSS position fix
* Capture the following NOTE in Stage 2 (can further fix the wording):

NOTE: The AS operations (e.g., RLM related timers, dataInactivityTimer, CHO execution, neighbour cell measurement, RACH, SR, and BSR) are suspended when UE is performing GNSS measurement during GNSS measurement gap.

FFS whether we need to state something about AS resumption

* UE assumes the GNSS location is valid upon successful GNSS measurement
* Network enables the reporting of GNSS position fix duration, in SIB2 and in dedicated signalling for the HO case
* UE autonomously trigger GNSS measurement can be configured via RRC dedicated signalling
* UE can autonomously start GNSS measurement during the inactive state of C-DRX.
* The exact time of starting GNSS measurement during the inactive state of C-DRX can be left for UE implementation.
* The priority of GNSS validity duration MAC CE is higher than BSR. The exact priority can be further checked during MAC running CR review.
* RRC layer needs to send indication to trigger MAC to report the remaining GNSS measurement validity duration.
* RRC layer sends such indication to MAC layer upon RRC layer receives indication that GNSS becomes valid.
* MAC layer should guarantee the reported remaining GNSS measurement validity duration is the latest value.
* If UE failed to autonomously re-acquire the GNSS position fix and the GNSS position is still valid during the inactive state of C-DRX, UE does not move to RRC\_IDLE. There is no specification impact. FFS if we still allow the UE not to move to Idle in case GNSS position is outdated
* If there is neither network aperiodically trigger nor network configuration of UE autonomously GNSS measurement, UE moves to RRC\_IDLE after GNSS becomes invalid. It’s FFS how to decide GNSS valid or invalid considering duration X and Y.

**Agreements on “7.6.3 Mobility Enhancements”**

Agreements:

* For eMTC, the new SIB (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.
* RAN2 will not consider to include cell stop time of neighbor cell in the new SIB (SIBxx) in this release.
* for NB-IoT NTN, location-based measurement initiation can also be optionally used in RRC\_IDLE for cell re-selection purposes (like in NR-NTN), with the assumption that it is up to the UE to update GNSS location.
* validity duration is optional, and if this field is absent, the UE uses validity duration from the serving cell
* For re-acquisition of SIBXX the UE may rely on T317/T318 in connected mode
* For CHO in NTN (both NR NTN and eMTC NTN, time and location-based trigger conditions may be configured independently (i.e., without a jointly configured measurement condition). We add a description/note saying in which scenarios this is reasonable, e.g., at least hard-switch case where gap is assumed to be zero/negligible.

**Agreements on “7.6.4 Enhancements to discontinuous coverage”**

* RAN2 understands that UE may directly go to RRC\_IDLE after RLF is triggered, if there is not enough time for the UE to finish the procedure of RRC re-establishment due to the discontinuous coverage (FFS whether this needs to be captured in the specs, e.g., a NOTE).

#### 2.2.2 Remaining Open issues

Objective 1 (IoT-NTN Performance Enhancements in Rel-18 to address remaining issues from Rel-17):

* Remaining details on disabling HARQ feedback in DL for both NB-IoT and eMTC based NTN.
* Remaining details on HARQ mode A and HARQ mode B for UL HARQ operation in IoT NTN.
* Remaining details on RAN2 aspects on GNSS enhancements.

Objective 2 (Mobility enhancements):

* Any remaining details on neighbor cell measurements.
* Any remaining details on CHO enhancements for eMTC-based NTN.

Objective 3 (Further enhancement to discontinuous coverage):

* RAN2 aspects on further enhancements in discontinuous coverage.

## 2.3 RAN3

#### 2.3.1 Agreements

**RAN3#121, August 21st – August 25th, 2023, Toulouse, France**

**Agreements on “18.2 Support discontinuous coverage”**

* Add the handover window start and duration IEs to S1AP Source eNB to Target eNB Transparent Container IE.
* Enhance the early data forwarding with data discarding for S1 HO, i,e. Introduce the DL Discarding IE in eNB Early Status Transfer Transparent Container IE.
* When time-based trigger condition is used, the source eNB should consider the time indicated to the UE to decide when start the early data forwarding to the target eNB.
* Other stage 2 and stage 3 alignment with NR NTN.

#### 2.3.2 Remaining Open issues

* Align with the progress of NR NTN, if any.

## 2.4 RAN4

#### 2.4.1 Agreements:

**RAN4#108, Toulouse, France, 21st - 25th August 2023**

* Agreements
  + FFS how to take into account *t-serviceStart* in inter-frequency and intra-frequency measurement requirements for NB-IoT and eMTC
  + For eMTC in CONNECTED mode, RAN4 to discuss the impact on measurement gaps configured for neighbour cell measurements and its relation to *t-ServiceStart*.
    - Option 1: Measurement gaps configured for neighbour cell measurements are suspended until *t-ServiceStart*.

Issue 1-0: Clarification on K\_satellite

FFS how clarify the value of K\_satellite.

* Option 1: For each inter-frequency carrier
  + if exists 2 satellites (including UE serving satellite) which need to be monitored by UE, the scaling factor = 2 is needed
  + if only exists 1 satellite which need to be monitored by UE, scaling factor is 1.
* Other options are not precluded.

Issue 1-2: Location-based triggering cell reselection measurements for eMTC moving cell and NB-IoT

Wait for further progress from RAN2.

Issue 1-3: Location-based triggering cell reselection measurements – configuration updates

Further discuss the following proposals:

* Proposal 1: Ask RAN2 to provide a signaling mechanism such that the UE is aware of updates in distanceThresh and/or reference location (this second at least for earth fixed cells).

Issue 1-4 (new): NGSO, neighbor cell measurement upon t-Service-r17

Further discuss whether the following proposal is agreeable:

* + If the UE is configured with ‘t-Service-r17’ [2] and eDRX\_IDLE, then the UE shall meet the requirements defined for DRX cycle length of [2.56] s in Table 4.7A.2.1.1-1 starting from at least [2] DRX cycles before ‘t-Service-r17’.

Issue 2-1: For NB-IoT inter-frequency measurements in connected mode, scaling factor for multiple NGSO satellites

* Agreements
  + For NB-IoT inter-frequency measurements in connected mode, introduce a scaling factor *Ksatellite* as the number of NGSO satellites to be measured on one carrier.

Issue 2-2A: Time-based triggering Neighbour cell measurements in connected mode for NB-IoT

* Agreements
  + For NB-IoT in quasi-earth fixed cell introduce time-based triggering in core spec according to RAN2’s design.
    - UE shall perform intra/inter-frequency measurements before *t-Service*, the exact time to start measurements is FFS
      * Option 1: left up to UE implementation
    - if t-*ServiceStartNeigh* is present the behavior is FFS
      * Option 1: UE implementation can decide to start measurements upon or after t-*ServiceStartNeigh*;
  + FFS whether to apply the same requirements to earth-moving cell.
  + FFS on requirements for the case of intra-frequency measurement for LEO case and when neighbor cell belongs to different satellite

Issue 2-2B: Time-based triggering Neighbour cell measurements in connected mode for eMTC

* For eMTC in quasi-earth fixed cell introduce time-based triggering in core spec according to RAN2’s design.
  + UE shall perform intra/inter-frequency measurements before *t-Service*, the exact time to start measurements is FFS
    - Option 1: left up to UE implementation
  + if t-*ServiceStartNeigh* is present the behavior is FFS
    - Option 1: UE implementation can decide to start measurements upon or after t-*ServiceStartNeigh*;
* FFS whether to apply the same requirements to earth-moving cell.
* FFS Ttrigger definition from IDLE mode in current spec are reused for CONNECTED mode

Issue 2-3: Location-based triggering Neighbour cell measurements in connected mode

* For NB-IOT NTN and eMTC NTN, quasi-earth fixed cell and earth-moving cell, RAN4 to define location-based connected mode measurement initiation condition in core spec.
* UE should perform intra/inter-frequency measurements when the criteria for location is met.

Issue 2-4: Location-based triggering Neighbour cell measurements – distance margin

Further discuss the following proposals:

* Proposal 1: For location-based triggering neighbour cell measurements in connected mode, the requirements apply provided that the distance exceeds the distanceThresh by a margin of 50 + X m. FFS the value of X as the UE is not required to update the GNSS location for Location-based connected mode measurement initiation.

Issue 2-5: For eMTC, CHO requirements

Wait for further progress from RAN2.

Issue 3-1: GNSS re-acquisition, impact on RLM

* Agreements
  + When the UE is performing GNSS measurements using gaps, RLM out-of-sync and in-sync evaluation periods can be longer than those defined in sections 7.19A and 7.23A in TS 36.133.
  + FFS whether to define deterministic RLM out-of-sync and in-sync evaluation periods

Issue 3-2: GNSS re-acquisition, impact on other RRM requirements

* Further discuss the impact on RRM requirements, including CONNECTED mode mobility.
* RAN4 to discuss the impact of GNSS re-acquisition on the measurement gaps configured for mobility measurements for eMTC in CONNECTED mode
  + Option 1: Measurement gaps configured for mobility measurements are suspended.
  + Option 2: GNSS measurement gaps are suspended.
* Further discuss the following proposals on how to capture in RRM specification:
  + Option 1: add generic description that the measurement delay could be longer if GNSS fix happens during measurement period.
  + Option 2: Wait for further progress from other WGs.

Issue 4-1: Measurements with satellite aspects

Further discuss the following proposals:

* Proposal 1: When more than one NGSO satellite is associated to neighbor cell information configured in a given frequency, and *t-serviceStart* is provided, if only one neighbor satellite is available at a given point in time, the neighbor cell measurement requirements will apply to the group of cells belonging to this neighbor satellite.
* Proposal 2: Ask RAN2 to provide signalling support to indicate satellite prioritization for neighbor cell measurements.
* Proposal 3: When more than one NGSO satellite is configured and available for neighbor cell measurements in multiple frequencies, and the set of frequencies available in each satellite is different, the following rules apply, until the UE has selected a satellite for measurement in every frequency layer:
  + If the frequency layer with the highest priority is available only in one satellite, the UE shall choose this satellite for measurements for every frequency layer available in this satellite.
  + If there are no higher priority frequencies available for measurements, the UE shall choose first the satellite which is associated to the highest number of frequency layers

Issue 4-2: Requirements applicability with SIB updates

Further discuss the following proposals:

* Proposal 1: Ask RAN2 to trigger SI modification indication if the list of cells or list of satellites is modified in SIBxx, otherwise mobility requirements cannot be applicable when the list of satellites is updated. (Nokia)

#### 2.4.2 Remaining Open issues:

Core Part

Define UE RRM requirements for the introduced mobility enhancement features, including location-based cell reselection, neighbour cell measurements in connected modelocation-based cell reselection, and eMTC CHO.

Performance Part

The work on Performance part has not started yet.

## 4. References

NOTE: This can be e.g. a list of all related Tdocs in the affected WGs since last TSG, references to LSs, produced TRs/TSs, the work/study item description or status reports of previous TSGs.

## 4.1 RAN1

**RAN1#114, August 21st – August 25th, 2023, Toulouse, France**

Submitted TDocs to AI 9.9.3

* R1-2306490 Discussion on disabling of HARQ feedback for IoT NTN Huawei, HiSilicon
* R1-2306565 Discussion on disabling of HARQ feedback for IoT-NTN ZTE
* R1-2306661 Discussion on disabling of HARQ feedback for IoT NTN Spreadtrum Communications
* R1-2306879 Disabling of HARQ feedback for NB-IoT/eMTC over NTN Nokia, Nokia Shanghai Bell
* R1-2306920 Discussion on disabling of HARQ feedback for IoT-NTN Sony
* R1-2307104 Discussion on remaining issues of disabling of HARQ feedback for IoT NTN CATT
* R1-2307117 Disabling of HARQ feedback for IoT NTN NEC
* R1-2307211 Discussion on disabling of HARQ feedback for IoT NTN CMCC
* R1-2307295 On HARQ Feedback Disabling for IoT NTN Apple
* R1-2307401 Discussion on the HARQ operation for IoT NTN xiaomi
* R1-2307433 Disabling of HARQ feedback for IoT NTN Sharp
* R1-2307545 Discussion on disabling of HARQ feedback for IoT NTN OPPO
* R1-2307615 Disabling of HARQ feedback for IoT NTN Lenovo
* R1-2307695 Disabling of HARQ feedback for IoT NTN Samsung
* R1-2307799 On disabling HARQ feedback for IoT NTN Ericsson
* R1-2307944 Disabling HARQ Feedback for IoT-NTN Qualcomm Incorporated
* R1-2308010 Disabling of HARQ feedback for IoT NTN Nordic Semiconductor ASA
* R1-2308058 HARQ MediaTek Inc.
* R1-2308231 FLS#1 on disabling of HARQ feedback for IoT NTN Moderator (Lenovo)
* R1-2308232 FLS#2 on disabling of HARQ feedback for IoT NTN Moderator (Lenovo)

Submitted TDocs to AI 9.9.4

* R1-2306491 Discussion on improved GNSS operations for IoT NTN Huawei, HiSilicon
* R1-2306566 Discussion on improved GNSS operation for IoT-NTN ZTE
* R1-2306662 Discussion on improved GNSS operations for IoT NTN Spreadtrum Communications
* R1-2306880 Enhancements for long connections in NB-IoT/eMTC over NTN Nokia, Nokia Shanghai Bell
* R1-2306944 On Improved GNSS Operations for IoT NTN NEC
* R1-2306950 On improved GNSS operation in IoT NTN Ericsson
* R1-2307105 Discussion on remaining issues of improved GNSS operations for IoT NTN CATT
* R1-2307212 Discussion on improved GNSS operations for IoT NTN CMCC
* R1-2307296 On improved GNSS operations for IoT NTN Apple
* R1-2307402 Discussion on the improved GNSS operation for IoT NTN xiaomi
* R1-2307546 Discussion on improved GNSS operations for IoT NTN OPPO
* R1-2307616 Improved GNSS operations for IoT NTN Lenovo
* R1-2307696 Improved GNSS operations for IoT NTN Samsung
* R1-2307945 Improved GNSS Operations for IoT-NTN Qualcomm Incorporated
* R1-2308011 Improved GNSS operations for IoT NTN Nordic Semiconductor ASA
* R1-2308059 Improved GNSS operations MediaTek Inc.
* R1-2308235 Feature lead summary#1 of AI 9.9.4 on improved GNSS operations Moderator (MediaTek)
* R1-2308236 Feature lead summary#2 of AI 9.9.4 on improved GNSS operations Moderator (MediaTek)
* R1-2308237 Feature lead summary#3 of AI 9.9.4 on improved GNSS operations Moderator (MediaTek)

## 4.2 RAN2

**RAN2#123, August 21st – August 25th, 2023, Toulouse, France**

Submitted TDocs to AI 7.6.1

* R2-2304612 LS on GNSS position fix during inactive state of Connected DRX for improved GNSS operations (R1-2304126; contact: MediaTek) RAN1
* R2-2304737 36.321 (MAC) Running CR for IoT-NTN Mediatek Inc.
* R2-2305199 Running CR for TS 36.306 for Rel-18 IoT NTN Qualcomm Incorporated
* R2-2306065 36331 running CR for IOT NTN Huawei, HiSilicon
* R2-2306265 Running CR for R18 IoT NTN Ericsson

Submitted TDocs to AI 7.6.2

* R2-2308890 On improved GNSS operation and HARQ for IoT NTN Samsung Electronics Czech

Submitted TDocs to AI 7.6.2.1

* R2-2307105 Discussion on HARQ Enhancement for IoT NTN vivo
* R2-2307189 On Disabling HARQ Feedback in IoT-NTN MediaTek Inc.
* R2-2307250 Discussion on HARQ enhancement for IoT NTN OPPO
* R2-2307251 Draft reply LS on NPDCCH monitoring restriction for NB-IoT NTN OPPO
* R2-2307413 Discussion on HARQ enhancements in IoT NTN CATT
* R2-2307488 Discussion on HARQ mode for PUR Huawei, Turkcell, HiSilicon
* R2-2307506 Discussion on HARQ enhancement Xiaomi
* R2-2307587 Further discussion on HARQ enhancements ZTE Corporation, Sanechips
* R2-2307626 HARQ process enhancement Qualcomm Incorporated
* R2-2308228 On HARQ enhancements for IoT NTN Nokia, Nokia Shanghai Bell
* R2-2308288 Discussion on the HARQ enhancement for IoT-NTN CMCC
* R2-2308541 R18 IoT NTN HARQ enhancements Ericsson
* R2-2308576 Remaining Issues on Disabling HARQ feedback for IoT-NTN Interdigital, Inc.
* R2-2308981 [AT123][101][IoT NTN] HARQ Enhancements (Nokia) Nokia, Nokia Shanghai Bell (Rapporteur)

Submitted TDocs to AI 7.6.2.2

* R2-2307106 Discussion on GNSS Operation for IoT NTN vivo
* R2-2307190 Enhancements on GNSS operation MediaTek Inc.
* R2-2307259 Discussion on GNSS operation for IoT NTN OPPO
* R2-2307414 Discussion on GNSS operation in connected mode CATT
* R2-2307477 Discussion on the GNSS Validity Reporting Google Inc.
* R2-2307489 Discussion on the impact of GNSS measurement Huawei, Turkcell, HiSilicon
* R2-2307505 Discussion on GNSS operation enhancement Xiaomi
* R2-2307588 Remaining issues of GNSS enhancements ZTE Corporation, Sanechips
* R2-2307629 GNSS fix in RRC\_CONNECTED Qualcomm Incorporated
* R2-2307865 Improved GNSS Operation Apple
* R2-2308008 Some remaining issues of GNSS operations for IoT NTN Lenovo
* R2-2308229 GNSS operation enhancement in Rel-18 IoT NTN Nokia, Nokia Shanghai Bell
* R2-2308289 Discussion on GNSS enhancement for IoT-NTN CMCC
* R2-2308540 R18 IoT NTN GNSS operation enhancements Ericsson
* R2-2308577 GNSS acquisition and reporting for IoT NTN Interdigital, Inc.
* R2-2308617 Discussion of GNSS operation enhancements SHARP Corporation
* R2-2308881 GNSS Validity duration Reporting Nordic Semiconductor ASA

Submitted TDocs to AI 7.6.3

* R2-2307192 Report of [Post122][112][IoT NTN Enh] Mobility MediaTek Inc.
* R2-2307589 Remaining issues of mobility enhancements ZTE Corporation, Sanechips

Submitted TDocs to AI 7.6.3.1

* R2-2307191 Remaining Enhancements on Neighbor Cell Measurements in IoT-NTN MediaTek Inc.
* R2-2307252 Discussion on mobility enhancement for IoT NTN OPPO
* R2-2307511 Discussion on UE behavior when serving cell t-service expires Xiaomi
* R2-2307628 Measurement and Mobility enhancements Qualcomm Incorporated
* R2-2307772 On remaining issues of IoT-NTN mobility enhancements Nokia, Nokia Shanghai Bell
* R2-2307866 Neighbour cell measurements before RLF for NB-IoT Apple
* R2-2308034 Enhancements for neighbour cell measurements Huawei, Turkcell, HiSilicon
* R2-2308578 Open issues on mobility enhancements (not covered by [Post122][112]) Interdigital, Inc.
* R2-2308811 Discussion on gaps for neighbour cell measurements in IoT NTN Ericsson
* R2-2308891 On enhancements for neighbour cell measurements Samsung Electronics Czech

Submitted TDocs to AI 7.6.3.2

* R2-2307107 Discussion on Mobility Enhancement for R18 IoT NTN vivo
* R2-2307867 Mobility enhancement in IoT NTN Apple
* R2-2308035 Discussion on CHO enhancements Huawei, Turkcell, HiSilicon
* R2-2308290 Discussion on CHO enhancements for eMTC NTN CMCC
* R2-2308892 On CHO and other mobility enhancements for IoT NTN Samsung Electronics Czech

Submitted TDocs to AI 7.6.4

* R2-2307108 Discussion on Discontinuous Coverage for R18 IoT NTN vivo
* R2-2307319 Discontinuous coverage handling enhancement for IoT NTN THALES, Telit
* R2-2307415 Discussion on enhancements to discontinuous coverage CATT
* R2-2307444 Considerations on Supporting Discontinuous Coverage NEC
* R2-2307497 Report of [Post122][113][IoT NTN Enh] Discontinuous coverage (Huawei) Huawei, HiSilicon
* R2-2307590 Remaining issues of discontinuous coverage ZTE Corporation, Sanechips
* R2-2307627 RRC release procedure in discontinuous coverage Qualcomm Incorporated
* R2-2307773 Further discussion on discontinuous coverage enhancements Nokia, Nokia Shanghai Bell
* R2-2307868 Support on discontinuous coverage in IoT NTN Apple
* R2-2308009 Some remaining issues for discontinuous coverage Lenovo
* R2-2308217 Discussion on enhancement to discontinuous coverage for IoT NTN Transsion Holdings
* R2-2308285 Enhancements to discontinuous coverage Samsung R&D Institute UK
* R2-2308579 Paging in discontinuous coverage Interdigital, Inc.
* R2-2308580 <draft> LS on PTW modification due to UE unreachability Interdigital, Inc.
* R2-2308717 Discussion on TN coverage for discontinuous coverage ASUSTeK

## 4.3 RAN3

**RAN3#121, Toulouse, France, 21st - 25th August 2023**

* R3-234059, Further discussion on discontinuous coverage issue for IoT NTN, ZTE
* R3-234200, (TP for BL CR IoT NTN TS36.423) Correction for Time based CHO, CATT, Ericsson, Nokia, Nokia Shanghai Bell, ZTE, Huawei
* R3-234219, (TP to BL CRs, 36.300, 36.423) Alignment with NR NTN, Huawei, Ericsson
* R3-234017, (TP for BL CR 36.300 and 36.413) on support X2-CHO and S1-HO with time-based trigger condition, Nokia, Nokia Shanghai Bell
* R3-234105, Time-Based HO and IoT NTN - Stage 2 Impacts, Ericsson, CATT, ESA, Huawei
* R3-234106, Time-Based HO for IoT NTN - S1AP Impacts, Ericsson, Huawei, CATT, ESA
* R3-234107, Time Margin for CHO in IoT NTN - X2AP Impact, Ericsson, Inmarsat, ESA

## 4.4 RAN4

**RAN4#108, Toulouse, France, 21st - 25th August 2023**

* R4-2314371, WF on R18 IoT NTN RRM requirements, MediaTek.
* R4-2312411, Discussion on RRM requirements for IoT NTN enhancement, Huawei, HiSilicon
* R4-2313430, Discussion on mobility requirements for IoT NTN enhancements, Nokia, Nokia Shanghai Bell
* R4-2311689, Discussion on RRM requirements for IoT NTN enhancement, MediaTek inc.
* R4-2312049, Discussion on RRM core requirements for IOT NTN enhancement, CMCC
* R4-2312623, Discussions on RRM requirements for IoT NTN enhancements, Ericsson

# 5 Others

***END***