**3GPP TSG-RAN WG4 Meeting # 111 R4-240xxxx**

**Fukuoka, Japan, 20th – 24th May 2024**

**Agenda item:** 7.5.5

**Source:** Intel Corporation

**Title:** WF on NR\_MG\_enh2\_part2

**Document for:** Approval

# Topic #1 and #2: Core part maintenance

## Summary of discussions

### Sub-topic 1-1 DRX

**Issue 1-1-3: Aligned DRX-on duration and SMTC for NFG measurements and: DRX ON duration is LONG and DRX cycle is SMALL**

* Proposals
  + Option 1: Interruption is always allowed, and it is according to Tcycle,i.
  + Option 2: interruption is always allowed but except for the last DL slot containing PDCCH in the ON duration.
* Agreement
  + Interruption ratio requirement not based on DRX-on duration
  + Not define the interruption location

**Issue 1-1-6a: Interruption requirements for Tcycle,i when DRX cycle is configured**

* Proposals
  + Option 1: For DRX, the interruption ratio is defined based on
    - Tcycle,i = max (80ms, DRX cycle) x CSSFoutside\_gap,i, for DRX cycle > 320ms
    - Tcycle,i = max (80ms, SMTC period, DRX cycle) x 1.5 x CSSFoutside\_gap,i, for DRX cycle ≤ 320ms
  + Option 2:
    - Tcycle,i = DRXcycle, DRXcycle >320ms.
    - Tcycle,i = max (80ms, SMTCi, DRXcycle) , DRXcycle <=320ms

### Sub-topic 1-2 MRDC interruption requirements

**Issue 1-2-1: Interruption requirements in 8.2.2.2.19 apply also for NR-DC, EN-DC, and NE-DC**

* Background:
  + the NFG signalling is used in NR SA only, as shown below:

|  |
| --- |
| **From 38.331**:  – *NeedForGapsInfoNR*  The IE *NeedForGapsInfoNR* indicates whether measurement gap is required for the UE to perform SSB based measurements on an NR target band while NR-DC or NE-DC is not configured. |

* Proposals
  + Option 1: Yes. Interruption requirements in 8.2.2.2.19 shall also apply for NR-DC, EN-DC, and NE-DC considering that operations in one cell group do not impact operations on another cell group.
    - Option 1a: Same interruption requirement defined at 7.8.2.22 in 36.133 and 8.2.2.2.19 in 38.133 are applied for each cell group for UE perform NR measurement without gap with interruption.
      * 7.8.2.22 in 36.133 and 8.2.2.2.19 in 38.133 is applied for MCG and SCG, respectively in EN-DC,
      * 7.8.2.22 in 36.133 and 8.2.2.2.19 in 38.133 is applied for SCG and MCG, respectively in NE-DC,
      * 8.2.2.2.19 in 38.133 is applied for both MCG and SCG in NR-DC.
  + Option 2: NFG requirements are applicable for NR SA only.
    - Option 2a: deprioritize MR\_DC for NFG in objective 2 of the WI.

### Sub-topic 1-3 Others in NFG

**Issue 1-3-1: further clarification on the measurement and interruption spec about gap/BWP configurations**

* Proposals
  + Option 1a: Clarify in the spec that [no gap with interruption] requirements only apply when gap is not configured, or gap is fully non-overlapped with SMTC on any carriers which are measured with interruption.
  + Option 1b: Capture in the specification the agreement from RAN4#106 that intra-frequency measurements without gaps don’t cause interruption when target SSB is completely contained withing the active BWP of the UE.
  + Option 2: Do not clarify.

**Issue 1-3-2: NFG and NCSG capabilities**

* Previous Agreements
  + No need to establish the mapping between UE’s indication for NeedForGaps and NCSG.
* Proposals
  + Option 1: NeedForGaps and NCSG are not expected to be enabled for the same UE at the same time.
  + Option 2: Allow to enable both R17 and R18 reporting.

**Issue 1-3-3: Cross feature support**

* Proposals
  + Proposal 1: Rel 18 measurements without gaps with interruptions do not apply for HST.
  + Proposal 2: Rel 18 measurements without gaps with interruptions do not apply for operation above 52.6 GHz.

### Sub-topic 1-4 UE capabilities

**Issue 1-4-1: Relations between nr-NeedForGap-Reporting-r16 and nr-NeedForInterruptionReport-r18 and UE behaviours**

* Previous agreements

|  |
| --- |
| **Issue 1-1-2: Scenario 2, NR measurements without gaps**  **Tentative agreements**   1. “no-gap” as part of NeedForGapsInfoNR-r16=FALSE means that the UE support measurement without gaps    1. The UE may or may not cause interruption. 2. if UE causes interruptions when performing measurements without gaps:    1. Support early implementation of Rel-18 NeedForInterruption:       1. Optional since R17    2. FFS the UE behavior if the Rel-18 UE does not support NeedForInterruptionNR-r18 |

* Proposals
  + Option 1: A Rel-18 UE indicating support of nr-NeedForGap-Reporting-r16 shall also indicate support of nr-NeedForInterruptionReport-r18.
  + Option 2: When a Rel-18 UE only supports Rel-16 NFG capability but not supports Rel-18 NFI capability, the UE’s behaviour is the same as Rel-16 UE.
    - Option 2a: When a Rel-18 UE supports both Rel-16 NFG and Rel-18 NFI capabilities, but NW doesn’t configure Rel-18 needForInterruptionConfigNR, the UE’s behaviour is the same as Rel-16 UE.
  + Option 3: A Rel-18 UE indicating support of interRAT-NeedForGapsNR-r16 shall also indicate if interruptions are needed.
    - No new RRM test cases are defined for a Rel-18 UE supporting signalling above.

### Sub-topic 2-1 Scheduling restriction

**Issue 2-1-1: Scheduling restriction for case b-1**

* Proposals
  + Option 1 : No scheduling restriction is applied for UE indicate nogap-noncsg for inter-RAT EUTRAN measurement without gap.

**Issue 2-1-2: Scheduling restrictions and UE capability reporting**

* Proposals
  + Proposal 1a: For Cases b-1 and/or b-2: When the UE require NO scheduling restriction for a specific carrier:
    - the UE shall report to the NW that the UE can measure a given/specific carrier frequency of inter-RAT EUTRAN without gap and without interruption;
    - the UE shall not report EMW (i.e. the UE can measure with at any reference signal occasion).
  + Proposal 1b: For Cases b-1 and/or b-2: When the UE require scheduling restriction for a specific carrier:
    - the UE reports to the NW that the UE can measure a given/specific carrier frequency of inter-RAT EUTRAN without gap and without interruption,
    - also, the UE shall report the support of effective measurement window (EMW) for inter-RAT EUTRAN capability (i.e. the UE can measure and cause scheduling restrictions only within the EMW occasions).
  + Proposal 1c: For Cases b-1 and/or b-2: When the UE reports for inter-RAT EUTRAN measurements without gap and without interruption and the UE doesn’t support EMW capability, the UE shall report NCSG, or gaps.

A diagram of a system

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Figure 1: Illustration of Option 1, UE behaviour for measuring inter-RAT EUTRAN without gaps and without interruption.

### Sub-topic 2-2 Measurement reporting period requirements

**Issue 2-2-1: Overlap between Effective measurement window and SMTC/SSB**

* ***Background***
  + Previous Agreements
    - For case b-2, when EMW is configured overlapped with SMTC/SSB/CSI-RS measurement with scheduling restrictions, inter-RAT LTE measurement will be dropped.
    - For case b-1 and b-2, when EMW is partially overlapped with MG (EMW periodicity < MGRP), the EMW occasion colliding physically with MG will be dropped.

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* Proposals to: For case b-1 and b-2 inter-RAT LTE measurement causing scheduling restriction, when EMW periodicity is smaller than MGRP,
  + Option 1: RAN4 to update the legacy agreements as: after considering EMW dropping rule if EMW is colliding with SMTC/SSB/CSI-RS, when the remaining EMW is fully overlapping with MG, the inter-RAT meas will be performed within MG.
  + Option 2: RAN4 to update the legacy agreements as: after considering EMW dropping rule if EMW is colliding with SMTC/SSB/CSI-RS, when the remaining EMW is fully overlapping with MG, the inter-RAT measurements will be left to UE implementation (i.e. no requirements defined for this corner case).

**Issue 2-2-1a: Overlap between Effective measurement window and MG**

* ***Background***
  + Agreements
    - For case b-1 and b-2, when EMW is partially overlapped with MG (EMW periodicity < MGRP), the EMW occasion colliding physically with MG will be dropped.
    - Note: The proximity rule in Rel-17 does not apply in this case.
* Proposals to: For case b-1 and b-2 inter-RAT LTE measurement causing scheduling restriction, when EMW periodicity is larger than MGRP and all EMW are covered by measurement gaps,
  + ~~Option 1: inter-RAT LTE measurement will be dropped.~~
  + ~~Option 2: No UE behaviour is specified.~~
  + Option 3: apply legacy gap-based measurement requirements, i.e. RAN4 requirements should NOT be defined based on EMW.
  + Option 4: UE measurement requirements are based on EMW-RP.

**Issue 2-2-2: Tinter1 for EMW configuratios:**

Table 2

|  |  |  |  |
| --- | --- | --- | --- |
| **EMW Pattern Id** | **EMW Length (EMWL, ms)** | **EMW Repetition Period**  **(EMWRP, ms)** | **Minimum available time for inter-RAT measurements during 480 ms period**  **(Tinter1, ms)** |
| 2 | 2 | 40 | [24] |
| 3 | 2 | 80 | [12] |

* Proposals
  + Option 1: Update the Tinter1 for EMW pattern 2/3 to 60/30ms.

|  |  |  |  |
| --- | --- | --- | --- |
| **EMW Pattern Id** | **EMW Length (EMWL, ms)** | **EMW Repetition Period**  **(EMWRP, ms)** | **Minimum available time for inter-RAT measurements during 480 ms period**  **(Tinter1, ms)** |
| 2 | 2 | 40 | [60] |
| 3 | 2 | 80 | [30] |

* + Option 2: When determining UE requirements using Tinter1 for EMW pattern IDs 2, 3, 4, 5, Tinter1 = 60 for gap pattern IDs 2, 4, and Tinter1 = 30 for gap pattern IDs 3 and 5 shall be used.
  + Option 3: When determining UE requirements using Tinter1 for EMW IDs 2 and 3, Tinter1 = 60 for EMW ID 2 and Tinter1 = 30 for EMW ID 3 shall be used if EMW dropping rule is not applied specified in clause X. Otherwise, Tinter1 specified in table 2 is applied.

**Issue 2-2-4: Tinter1 without EMW configuration**

* Proposals
  + Option 1: Define Tinter1 without EMW configuration as 60ms (based on EMW pattern 0).
  + Option 2: For UE can perform inter-RAT LTE measurement without gap and does not require a scheduling restrictions, Tinter1 = 60ms is applied for the inter-RAT LTE measurement without gap.

**Issue 2-2-3: Scaling factor for case a-1: Nfreq definition**

* ***Background***
  + The principles are different between NR MO outside gap and LTE inter-frequency without MG, where all inter-frequency MOs, regardless if they are measured with or without MG, are counted in the same Nfreq.
* Proposals
  + Option 1: number of NR MOs that are measured outside MG (same principle as NR SA).
  + Option 2: total number of LTE and NR MOs (same principle as LTE SA).
    - Option 2a: total number of inter-frequency LTE and NR MOs (same principle as LTE SA).

### Sub-topic 2-3 UE capabilities

**Issue 2-3-1: case a-1: The issue with UE capability interRAT-NeedForIntrNR-r18**

* Proposals
  + ~~Option 1: Interruptions due to interRAT NR measurements without gaps must be explicitly allowed by the network (via SIB or other means). Send LS to RAN2.~~
  + Option 2: Do not change current interRAT-NeedforIntrNR-r18 capability design. Not to make reporting of interRAT-NeedForIntrNR-r18 based on NW control. Do not further discuss how to report UE capability interRAT-NeedForIntrNR-r18.
  + Option 3: interRAT-NeedForIntrNR-r18 capability is based on network request. Send LS to RAN2.

**Issue 2-3-1a: Relations between interRAT-NeedForGaps-r16 and interRAT-NeedForIntrNR-r18 and UE behaviours**

* Previous agreements

|  |
| --- |
| **Issue 1-1-1: Scenario 1, LTE – NR inter-RAT measurement**  **Tentative agreements**   1. interRAT-NeedForGaps-r16=FALSE means that the UE support measurement without gaps    1. The UE may or may not cause interruption. 2. if UE causes interruptions when performing measurements without gaps:    1. Support early implementation of Rel-18 NeedForInterruption:       1. Optional since R17    2. FFS mandatory report of the UE capability R18 interRAT-NeedForIntrNR-r18 from Rel-18 UE if the UE reports interRAT-NeedForGaps-r16=FALSE    3. FFS the UE behavior if the Rel-18 UE does not support interRAT-NeedForIntrNR-r18 |

* Proposals
  + Option 1: A Rel-18 UE indicating support of interRAT-NeedForGapsNR-r16 shall also indicate support of interRAT-NeedForInterruptionNR-r18.
  + Option 2: When a Rel-18 UE only supports Rel-16 NFG capability but not supports Rel-18 NFI capability, the UE’s behaviour is the same as Rel-16 UE.
    - Option 2a: When a Rel-18 UE supports both Rel-16 NFG and Rel-18 NFI capabilities, but NW doesn’t configure Rel-18 needForInterruptionConfigNR, the UE’s behaviour is the same as Rel-16 UE.
  + Option 3: A Rel-18 UE indicating support of interRAT-NeedForGapsNR-r16 shall also indicate if interruptions are needed.
    - No new RRM test cases are defined for a Rel-18 UE supporting signalling above.
* Recommended WF

**Issue 2-3-2: Additional UE capability for scheduling restriction of case a-1**

* Agreement:
  + Introduce an E-UTRA FG x-z for scheduling restriction due to mixed numerology.

**Issue 2-3-3: Remove FG32-4 from prerequisite feature groups for FG 32-7.**

* Agreement:
  + Not Remove FG32-4 from prerequisite feature groups for FG 32-7

**Issue 2-3-4: Update FG 32-5 description.**

* Agreement:
  + Support of inter-RAT EUTRAN measurements without gap when CRS is completely contained within UE’s active DL BWP.

**Issue 2-3-5: Update FG 32-4 description.**

* Agreement:
  + this issue is closed.

**Issue 2-3-8: Feature list tables for inter-RAT measurements without gap**

* Agreements
  + For UE support 32-4, no scheduling restriction is needed due to mix-numerology for CRS fully non-overlapping with UE’s active BWP
  + FFS whether to add a FG for scheduling restriction for FG x-y
* Agreed feature list:

Table 1: Rel-18 NR UE features for NR\_MG\_enh2 WI.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** | **Applicable to the capability signalling exchange between UEs (V2X WI only)”.** | **Consequence if the feature is not supported by the UE** | **Type** | **Need of FDD/TDD diff** | **Need of FR1/FR2 diff** | **Capability interpretation for mixture of FDD/TDD and/or FR1/FR2** | **Note** | **Mandatory/Optional** |
| 32-1 | Concurrent gaps with Pre-MG in a FR | Support of multiple per-UE (or per-FR) measurement gap patterns with at least one per-UE (or per-FR) Pre-MG. Details in Clause [9.1.x.2] of TS 38.133. | 19-3-x and 19-2  x = 1 or 2 | Yes | No | UE behaviour is undefined if the network configures concurrent MGs where at least one of the gaps is a Pre-MG | Per UE | No | No | N.A |  | Optional with capability signalling |
| 32-2 | Support for dynamic collisions | Support RRM requirements for handling dynamic collisions between a Pre-MG and another measurement gap or Pre-MG. | 32-1 | Yes | No | UE is not expected to meet RRM requirements for dynamic collisions | Per UE | No | No | N.A |  | Optional with capability signalling |
| 32-3 | Concurrent gaps with NCSG in a FR | Support of multiple per-UE (or per-FR) measurement gap patterns with at least one per-UE (or per-FR) NCSG. Details in clause [9.1.y.2] of TS 38.133. | 19-1 and 19-2 | Yes | No | UE behaviour is undefined if the network configures concurrent MGs where at least one of the gaps is a NCSG | Per UE | No | No | N.A |  | Optional with capability signalling |
| 32-4 | Inter-RAT EUTRAN measurements without gap and outside active DL BWP | Support inter-RAT EUTRAN measurements outside active DL BWP for nogap-noncsg | 19-1b | Yes | NA | UE does not meet the requirements of inter-RAT EUTRAN measurements without gap in TS 38.133 and the UE behavior is unknown to network | Per UE | No | No | N.A |  | Optional with capability signalling |
| 32-5 | Inter-RAT EUTRAN measurement without gap and within active DL BWP | Support of inter-RAT EUTRAN measurements without gap when CRS is completely contained within UE’s active DL BWP |  | Yes | No | Measurement gap will be needed for inter-RAT EUTRAN measurements | Per UE | No | FR1 only | N.A |  | Optional with capability signalling |
| 32-6 | Effective measurement window for inter-RAT EUTRAN measurements | Support configuration of effective measurement window for inter-RAT EUTRAN measurements, including offset, duration and periodicity. | 32-4 or 32-5 | Yes | No | UE is not allowed to cause scheduling restriction defined in TS 38.133 for 32-4 or 32-5 | Per UE | No | No | N.A | * A bitmap for 6 effective measurement window (EMW) patterns defined in TS 38.133. * #0 and #1 are mandatory, if UE supports EMW feature.   Other patterns are optional  Note: If UE supports 32-4 or 32-5 and UE requires scheduling restriction, UE should support this FG | Optional with capability signalling |
| 32-7 | Simultaneous reception of NR data and EUTRAN CRS with different numerology | Support concurrent inter-RAT measurement on EUTRAN cell in non-DSS ~~with CRS~~ and PDCCH or PDSCH reception from the serving cell with a different numerology | 32-4 or 32-5 | Yes | No | scheduling restriction is applicable | Per UE | No | FR1 only | N.A |  | Optional with capability signalling |

Table 2: Rel-18 LTE UE features for NR\_MG\_enh2 WI.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** | **Applicable to the capability signalling exchange between UEs (V2X WI only)”.** | **Consequence if the feature is not supported by the UE** | **Type** | **Need of FDD/TDD diff** | **Need of FR1/FR2 diff** | **Capability interpretation for mixture of FDD/TDD and/or FR1/FR2** | **Note** | **Mandatory/Optional** |
| x-y | interRAT-NeedForInterruptionNR-r18 | Support of inter-RAT NR measurements without gap with or without interruption when the interRAT-NeedForGapsNR-r16 is false.  Note: This feature already has a defined UE capability: ‘interRAT-NeedForInterruptionNR-r18’. The intention of adding this FG is only keep consistency between 38.822 and 36.306. | interRAT-NeedForGapsNR-r16 | Yes | NA | The UE does not support inter-RAT NR measurements without gap with or without interruption for performing inter-RAT NR measurement without gap | [Per target band per BC]  Note: the same granularity as interRAT-NeedForGapsNR-r16 | No | No | NA | Candidate value: “{no-gap-with-interruption, no-gap-no-interruption}” | Optional with capability signalling |
| x-z | Simultaneous reception of EUTRAN data and NR SSB with different numerology | Support concurrent SSB-based inter-RAT measurement on NR cell and PDCCH or PDSCH reception from the serving cell with a different numerology | x-y | Yes | NA | scheduling restriction is applicable | Per UE | No | FR1 only | NA |  | Optional with capability signalling |

# Topic #3: Performance part requirements for measurements without gap

## Summary of discussions

Up to this meeting, all agreed using scenarios for inter-RAT NR/LTE measurements without gap can summarized as:

1. the inter-RAT NR measurements without gap in Rel18 includes the two scenarios below.
   * **Case a-1**: UE performing the measurements without gap in NR carriers as there is vacant RF chains for UE measurements
2. the inter-RAT LTE measurements without gap in Rel18 includes the two scenarios below.
   * **Case b-1**: UE performing the measurements without gap in LTE carriers as there is vacant RF chains for UE measurements
   * **Case b-2**: LTE CRS are fully contained within UE’s active BWP

## Configurations for test cases

**Issue 2-1-1: Configuration for Intra-frequency measurements test cases:**

* Agreement
  + Define the test case where the serving cell SSB is outside of UE’s active BWP by
  + Configuring CSI-RS for RLM
  + Note: In RAN4’s understanding, RAN5 can follow the legacy applicability of the Rel-15 intra-frequency with gap TC

**Issue 2-1-2: Test cases with DRX**

* Agreement
  + Do not introduce test cases with DRX configured for NFG and inter-RAT measurements.

## Test cases list and responsibilities

### NFG

**Test list agreed**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No. #** | **Item of core requirements** | **Type of test cases** | **FR of serving cell** | **SMTC** | **MG** | **DRX** | **Subclause** | **Responsibility** |
| NFG1 | Event triggered reporting and interruptions | **Intra**-frequency measurements without gap config but **with DRX**  Note: The testability needs to be checked before introducing the test case | FR1 | 20ms | No | No | A.6.6.1.X | Nokia |
| NFG2 |  | **Intra**-frequency measurements **with gap** configuration and non-DRX configuration  The test purpose: UE is not allowed to cause interruption outside MG when SMTC partially overlaps with gap | FR2 | 20ms | gap is configured  Note: UE can skip corresponding Rel-15 TC | No | A.7.6.1.X | Intel |
| NFG3 |  | **Inter**-frequency measurements without gap and without DRX | All in FR1 | 20ms | No | No | A.6.6.1.X | QC |
| NFG4 |  | **Inter**-frequency measurements without gap config but without DRX  Note: The testability needs to be checked before introducing the test case | All in FR1 | **160ms** | No | No | A.7.6.1.X | HW |
| NFG5 | Event triggered reporting [without interruption] | **Inter**-frequency measurements without gap with non-DRX | All in FR1 | 20ms | No | No | A.6.6.1.X | Ericsson |
| NFG6 |  | **Inter**-frequency measurements without gap with non-DRX | All in FR2 | 20ms | No | No | A.7.6.1.X | CATT |
| NFG7 |  | **Intra**-frequency measurements without gap with non-DRX | FR1 | 20ms | No | No | A.6.6.1.X | CMCC |
| NFG8 |  | **Intra**-frequency measurements without gap with non-DRX | FR2 | 20ms | No | No | A.7.6.1.X | MTK |

* Agreements
  + No TC among NFG5 to NFG8 will be merged.

### Inter-RAT

**Test list agreed**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Item of core requirements** | **Type of test cases** | **FR of serving cell** | **EMW** | **MG** | **DRX** | **Subclause** | **Responsibility** |
| IR1 | Event triggered reporting and nogp-noncsg | Inter-RAT **EUTRAN** measurements case **b-1** without MG without interruption and no DRX configuration  Note: UE follows EMW | NR FR1 | [Yes] | No | No | A.6.6.3.X | CATT |
| [IR2] | Event triggered reporting and nogp-noncsg | Inter-RAT **EUTRAN** measurements case **b-1** with MG but no DRX configuration  Note: UE is configured with MG and has no scheduling restrictions outside MG | NR FR1 | TBD | [Pattern TBD] | No | A.6.6.3.X | xiaomi |
| IR3 | Event triggered reporting [without interruption] | Inter-RAT **EUTRAN** measurements case **b-2** without MG or DRX configuration | NR FR1 | [Yes] | No | No | A.6.6.3.X | CMCC |
| IR4 | Event triggered reporting | Inter-RAT **NR** measurements case **a-1** with MG | NR FR1 | No EMW config | [Pattern TBD] | No | A.8.4.2.X | HW |
| IR5 | Event triggered reporting and interruptions | Inter-RAT **NR** measurements case **a-1** with MG | NR FR1 | No EMW config | [Pattern TBD] | No | A.8.4.2.X | Nokia |