3GPP TSG-RAN WG4 Meeting #111 R4-24xxxxx

Fukuoka, Japan, May 20th – 24th, 2024

**Agenda item:** 7.12.3

**Source:** Ad-hoc chair (Intel Corporation)

**Title:** Ad-hoc minutes for NR positioning – Part 3 (Core part maintenance)

**Document for:** Approval

# Introduction

This document is the ad-hoc minutes for Rel-18 NR Positioning with the following threads covered with the focus on RRM Core part maintenance.

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| --- | --- | --- | --- | --- |
| # | Email title | Topic areas | AI covered in the topic thread | Summary document |
| 212 | [111][212] NR\_pos\_enh2\_part1 | RRM core maintenance and performance requirements - General- RedCap positioning- PRS/SRS BW aggregation | 7.12.1.1 (relevant tdocs)  7.12.1.4  7.12.2.1 (relevant tdocs)  7.12.2.4  7.12.2.5 | R4-2408009 |
| 213 | [111][213] NR\_pos\_enh2\_part2 | RRM core maintenance and performance requirements - SL Positioning - Carrier Phase Positioning | 7.12.1.1 (relevant tdocs) 7.12.1.2 7.12.2.1 (relevant tdocs) 7.12.2.2 7.12.2.6 | R4-2408010 |
| 214 | [111][214] NR\_pos\_enh2\_part3 | RRM core maintenance and performance requirements - LPHAP use case | 7.12.1.1 (relevant tdocs) 7.12.1.3 7.12.2.1 (relevant tdocs) 7.12.2.3 | R4-2408011 |

# [111][212] NR\_pos\_enh2\_part1

Recommendations for the online discussion:

* Core maintenance: RedCap positioning
  + Issue 2-1-1-4: Update to RAN4 UE feature list.
  + Issue 2-1-1-2: Time window for RX FH in RRC\_INACTIVE/IDLE state.
  + Issue 2-1-1-3: Mapping between PRS configuration and number of hops per slot in core requirements
  + Issue 2-1-1-1: Clarification of parameters for number of RX FH within MG in RRC\_CONNECTED state
* Core maintenance: PRS/SRS bandwidth aggregation
  + Issue 2-1-2-2: Interruption delay requirement for SRS aggregation.
  + Issue 2-1-2-3: Core requirement for PRS-RSRP/RSRPP measurement based on bandwidth aggregation
  + Issue 2-1-2-1: Clarification regarding nominal channel spacing in core requirements for PRS aggregation

## Topic #2: RRM core requirement maintenance for RedCap positioning and PRS/SRS bandwidth aggregation (AI 7.12.1.4)

### Sub-Topic 2-1-1: RRM core requirement maintenance for RedCap positioning

**Issue 2-1-1-4: Update to RAN4 UE feature list.**

* Proposals
  + Option 1: E///
    - Pre-requisite groups for RAN4 FGs 37-1 is updated to “RAN1 feature 28-1 **or 48-1**, 27-3-1, 41-5-1”.
    - Pre-requisite groups for RAN4 FG 37-1A is updated to “ RAN1 feature 28-1 **or 48-1**, 27-3-1, 41-5-1”.
* Tentative agreement:
  + *RAN4 UE feature list for RedCap positioning is updated to align with the RAN1 UE feature list for RedCap positioning.*
    - *Pre-requisite groups for RAN4 FGs 37-1 is updated to “RAN1 feature 28-1* ***or 48-1****, 27-3-1, 41-5-1”.*
    - *Pre-requisite groups for RAN4 FG 37-1A is updated to “ RAN1 feature 28-1* ***or 48-1****, 27-3-1, 41-5-1”.*
* Recommended WF
  + *Agree on tentative agreement*.

**Issue 2-1-1-2: Time window for RX FH in RRC\_INACTIVE/IDLE state.**

* Proposals
  + Option 1: OPPO
    - 2 separate time windows defined in Rel-17 could be reused for redcap positioning with FH.
    - The formula should apply for each individual time window if PRS resources are separated into 2 windows.
  + Option 2: E///
    - No update to time window for PRS measurement is needed for RedCap positioning, including Rx FH, in RRC\_INACTIVE/IDLE state.
  + Option 3: Nokia
    - RAN4 to discuss whether the time window length up to 10 ms is appropriate for RedCap positioning.
* Recommended WF
  + Discuss the option(s).

**Issue 2-1-1-3: Mapping between PRS configuration and number of hops per slot in core requirements.**

* Proposals:
  + Option 1: Huawei, HiSilicon
    - Confirm Table 1 for mapping between PRS configuration and number of hops per slot

Table 1: mapping between PRS configuration and number of hops per slot, version 1

|  |  |  |  |
| --- | --- | --- | --- |
|  | **(comb size, Number of PRS symbols)** | **Applicable number of hops per slot** | **Applicable length per hop () in number of symbols** |
|  | [(≤ 2, 12) with SCS 15kHz, 30kHz, 60kHz in FR2, 120kHz] | 2 | 7 |
| All others | 1 | 14 |
|  | (≤ 6, any) | 1 | 14 |
| (12, 12) | ½ | 28 |
|  | Any combination | ½ | 28 |

* Recommended WF
  + Discuss the option(s).

**Issue 2-1-1-1: Clarification of parameters for number of RX FH within MG in RRC\_CONNECTED state.**

* Proposals
  + Option 1: OPPO
    - Clarify that is the number of unmuted PRS repetitions (i.e. bit 1 signalled by *dl-PRS-MutingOption2*) within the MG occasion excluding the gap retuning times.
    - If = 1/2 and = 1, the effective number of Rx hops within a MG instance is defined as the number of PRS repetitions within MG occasion after applying the logic AND operation between *bitmap-MutingOption2* and *bitmap-default*, where:
      * *bitmap-MutingOption2* is the bitmap given by higher-layer parameter *dl-PRS-MutingOption2*.
      * bitmap-default is “101010…” with the same length as *bitmap-MutingOption2.*
* Recommended WF
  + Discuss the option(s).

**Issue 2-1-1-5: Number of RX FH in RRC\_INACTIVE/IDLE state.**

* Proposals
  + Option 1: ZTE
    - The number of Rx hops measured by the RedCap UE in Inactive/Idle mode is given by

where

* + - * is the maximum number of Rx hops signaled in the UE capability (FG 41-5-1a for INACTIVE state and FG 41-5-1b for IDLE state).
      * is the effective number of Rx hops within a time window.
* Recommended WF
  + It is moderator’s understanding that this issue has already been resolved in the Draft Big CR endorsed in RAN4#110bis.
  + No further discussion on this issue.

### Sub-Topic 2-1-2: RRM core requirement maintenance for PRS/SRS bandwidth aggregation

**Issue 2-1-2-2: Interruption delay requirement for SRS aggregation.**

* Proposals
  + Option 1: CATT
    - RAN4 do not need to define interruption requirements for SRS transmission for BW aggregation on CC without PUSCH/PUCCH.
  + Option 2: HW
    - RAN4 to define interruption requirements for SRS CA based on existing requirements for SRS carrier switching and SRS antenna switching.
  + Option 3: E///
    - For UEs supporting guard period values {30µs, 100µs, 140µs, 200µs} interruption lengths are defined by reusing the values in 8.2.2.2.9 of TS 38.133 for SRS aggregation.
* Tentative agreement:
  + *RAN4 to define interruption requirements for SRS CA. The values for SRS carrier switching is used.*
    - *FFS: whether to consider interruption due to SRS antenna switching for SRS aggregation.*
* Recommended WF
  + *Agree on tentative agreement*.

**Issue 2-1-2-3: Core requirement for PRS-RSRP/RSRPP measurement based on bandwidth aggregation.**

* Proposals
  + Option 1: OPPO, HW
    - Core requirement for timing measurements (RSTD or UE Rx-Tx) based on aggregated carriers/PFLs apply to PRS-RSRP/RSRPP, when UE reports PRS-RSRP/RSRPP together with the timing measurements (RSTD or UE Rx-Tx) based on the aggregated carriers/PFLs.
* Tentative agreement:
  + *Core requirement for timing measurements (RSTD or UE Rx-Tx) based on aggregated carriers/PFLs apply to PRS-RSRP/RSRPP, when UE reports PRS-RSRP/RSRPP together with the timing measurements (RSTD or UE Rx-Tx) based on the aggregated carriers/PFLs*.
* Recommended WF
  + *Agree on tentative agreement*.

**Issue 2-1-2-1: Clarification regarding nominal channel spacing in core requirements for PRS aggregation.**

* Proposals
  + Option 1: CATT
    - The clarification regarding the nominal channel spacing can be captured in performance part to make this feature clearer in specification.
* Tentative agreement:
  + *The clarification regarding the nominal channel spacing is captured in the performance requirement part of the specification*.
* Recommended WF
  + *Agree on tentative agreement*.

**Issue 2-1-2-4: Applicability of core requirements for positioning measurements based on bandwidth aggregation.**

* Proposals
  + Option 1: OPPO
    - Requirements for aggregate measurement are applicable to PRS resources in the resource sets that are indicated to be linked, provided that the alignment conditions defined by RAN1 are met.
* Recommended WF
  + The following text in the Draft Big CR endorsed in RAN4#110bis already clarifies the applicability of the core requirements for positioning measurements based on the bandwidth aggregation.
  + “*The requirements in this clause for aggregated measurements apply provided that the linked PRS resource sets on multiple PFLs for aggregated measurements are transmitted by the TRP using single Tx chain as defined in clause 5.1.6.5.3 in TS 38.214 [26].*”
  + No further discussion on this issue.

# [111][213] NR\_pos\_enh2\_part2

Recommendation of prioritized topics:

* For SL positioning:
  + Sub topic 1-1: Issue 1-1-1/2/4
* For CPP positioning:
  + Sub topic 2-1: Issue 2-1-1/2/3/4

## Topic #1: Sidelink Positioning Core requirements

**Issue 1-1-1: Applicability of SL PRS measurement period requirements**

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| *Proposals in RAN4#110bis:*  **Issue 1-1-2: Applicability of SL PRS measurement period requirements**  Proposals   * Option 1: (Qualcomm)   + Limits on the number of active SL PRS resources per slot and number of active slots across all configured resource pools and across all bands defined by RAN1 in FG 41-1-1a should be included as applicability conditions for measurement period requirements for SL positioning measurements.   + Measurement requirements for SL RSTD apply provided the time separation between the target and reference SL PRS resources is no larger than [160 ms]. |

* Proposals

For FG 41-1-1a,

* + Option 1: (vivo)
    - The FG 41-1-1a should not be included as applicability conditions for measurement period requirements for SL positioning measurements.
  + Option 2: (Huawei)
    - Include FG 41-1-1a for the applicability condition of SL PRS measurement requirements when UE supports SL PRS measurement on multiple CCs or RPs.

For time separation between PRS resources from reference UE and target UE,

* + Option 1: (OPPO)
    - The condition regarding time separation between the target and reference SL PRS resource should be considered in accuracy requirements.
  + Option 2a: (vivo, Qualcomm)
    - Performance requirements for SL RSTD apply provided the time separation between the SL PRS resources from the target and reference is no larger than 160 ms.
  + Option 2b: (Huawei)
    - Measurement requirements for SL RSTD apply provided the time separation between the [last] SL-PRS from the reference UE and [last] SL-PRS from the target UE is no larger than [160 ms].
* Recommended WF
  + Discuss the options.

**Issue 1-1-2: UE behaviour and the impact on SL-PRS measurement requirements when synchronization reference source change occurs at Tx side**

* Proposals
  + Option 1: (CATT, OPPO)
    - When UE is indicated of the synchronization source change at anchor UE via SL-RTD-Info during the positioning measurements, the UE shall restart the measurements after the synchronization source change.
  + Option 2: (Qualcomm)
    - RAN4 not to define any special UE behavior for a UE performing SL Rx-Tx measurements in the event of a synchronization reference source change at a Tx UE during the SL Rx-Tx measurement period.
    - SL Rx-Tx measurement accuracy requirements do not apply in the event of a synchronization reference source change at a Tx UE during the SL Rx-Tx measurement period.
    - If a UE receives sl-RTD-Info while performing SL RSTD or SL RTOA measurements, the UE is allowed to restart the measurements and the measurement period can be longer.
  + Option 3: (vivo)
    - For SL RSTD and SL RTOA measurements, UE shall restart the measurement after the synchronization reference source change at Tx side.
    - For SL-PRS Rx-Tx measurements:
      * If the UE reports the transmission timestamp of a SL PRS, it shall continue the measurement after the synchronization reference source change at Tx/Rx side.
      * Else, UE shall restart the SL Rx-Tx time difference measurement.
  + Option 4: (Huawei)
    - For synchronization reference source change occurs at Tx side, measurement accuracy requirements do not apply and no specific UE behaviour is defined.
  + Option 5: (Ericsson)
    - For SL RTOA, UE behaviour upon the synchronization source change at the transmitting UE is the same as when upon the synchronization change at the measuring UE.
    - For SL RTOA, the same UE behaviour shall apply as for SL RSTD (as defined in TS 38.133) in case of the synchronization source change at the transmitting UE, e.g., indicated by SL-RTD-Info [TS 38.355].
* Recommended WF
  + Discuss the options

**Issue 1-1-3: End point of SL-PRS based RSTD measurement period requirements**

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| *Agreements in RAN4#110bis:*   * The SL RSTD measurement period ends after the UE has measured SL PRS resources from at least two different Tx UEs including target and reference UEs. * FFS whether any updates to the TS 38.133 are needed. |

* Proposals
  + Option 1: (Huawei)
    - Update the SL RSTD requirements to reflect that measurement period ends after the UE has measured SL PRS resources from at least two different Tx UEs.
* Recommended WF
  + Discuss Option 1.

**Issue 1-1-4: Impact of Uu link connect**

* Proposals
  + Option 1: (Huawei)
    - RAN4 not to define any impact of Uu link connection on the measurement period.
  + Option 2: (Ericsson)
    - It is clarified in TS 38.133 for the SL-PRS based measurements in the introduction section 12A.1:
      * NOTE 3: When a UE in RRC\_CONNECTED state is performing transmissions and/or reception for SL positioning operation, the UE shall meet all the requirements specified in Clause 6, assuming that UE has a dedicated RX/TX chain for the sidelink operation. Otherwise, the UE may interrupt the SL positioning measurements or SL-PRS transmissions in order to meet the measurement requirements specified in Clause 6.
* Recommended WF
  + Discuss the option(s).

## Topic #2: CPP Positioning Core requirements

**Issue 2-1-1: Clarification on the PRS measurement period requirements for DL RSCP/DL RSCPD**

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| *Agreements in RAN4#110bis:* Issue 2-1-2: Clarification on the PRS measurement period requirements for DL RSCP/DL RSCPD FFS:   * For UE configured for CPP measurement with legacy measurement with multiple PFLs, When LMF does not configure measurement time window(s) for a PFL or UE does not support FG 41-2-3,   + Carrier phase positioning measurement is only performed on single PFL.     - FFS which PFL is measured.   + Existing requirements for RSTD/UE Rx-Tx without time window apply. * For UE configured for CPP measurement with legacy measurement with multiple PFLs, when UE is configured with time window and does not support FG 41-2-8/41-2-9,   + Option 1:     - Existing requirements for RSTD/UE Rx-Tx without time window apply.   + Option 2:     - Existing requirements without time window apply for legacy measurements, but UE is not required to report CP if the resource set(s) associated to the window have occasions outside the time window.   + Option 3:     - Not to define requirements for this case. |

* Proposals
  + Option 1a: (CATT)
    - When multiple PFLs are configured and UE is requested to perform CPP with time window(s) not indicated or FG 41-2-3 not supported, on which PFL the CPP is performed depends on UE implementation.
    - When multiple PFLs and time window(s) are configured and UE is requested to perform CPP with FG 41-2-8/9 not supported, existing requirements without time window apply for legacy measurements, but UE is not required to report the carrier phase measurements on the PRS resources outside the time window.
  + Option 1b: (Huawei)
    - When LMF does not configure measurement time window(s) for a PFL or UE does not support FG 41-2-3, for the case of multiple PFLs,
      * Existing requirements without time window apply for both legacy and CP measurement,
      * UE is only required to report CP for one PFL,
      * The selection of PFL for CP measurement is based on LMF indication if provided, otherwise up to UE implementation.
    - When LMF does not request the UE to perform legacy measurements in the measurement time window or UE does not support FG 41-2-8/9,
      * existing requirements without time window apply for legacy measurements,
      * existing requirements without time window apply for CP measurement provided that the resource associated to the time window have occasions only within the time window.
  + Option 2: (OPPO)
    - When time window is not configured, the existing requirements for RSTD/Rx-Tx without time window should apply.
  + Option 3: (Qualcomm)
    - No DL RSCPD measurement requirements are defined for UEs that do not support FG 41-2-8.
    - No DL RSCP measurement requirements are defined for UEs that do not support FG 41-2-9.
    - When multiple PFLs are configured in the DL PRS assistance data, if the LMF does not configure time window(s) or the UE does not support FG 41-2-3 (Measurement on indicated DL PRS resource sets within the indicated time window(s) for UE based and UE assisted)
      * Carrier phase measurements are performed on a single PFL
      * If the LMF does not indicate a PFL for CPP measurements, the selection of the PFL for CPP measurements is up to UE implementation.
      * Measurement requirements are independent of the time windows (if configured). i.e. for the indicated PFL j is calculated counting PRS resources outside the time windows.
  + Option 4: (Ericsson)
    - For UE configured for CPP measurement with legacy measurement with multiple PFLs, when LMF does not configure measurement time window(s) for a PFL or UE does not support FG 41-2-3,
      * Carrier phase positioning measurement is performed on per PFL basis.
        + UE reports the carrier phase measurement as *nr-RSCPD-r18* defined in 37.355.
      * Existing requirements for RSTD/UE Rx-Tx without time window apply.
    - For UE configured for CPP measurement with legacy measurement with multiple PFLs, when UE is configured with time window but does not support FG 41-2-8/41-2-9, existing requirements without time window apply for legacy measurements. The UE is not required to report carrier phase measurement if the resource set(s) associated to the configured time window have occasions outside of the time window.
* Recommended WF
  + For UE configured for CPP measurement with legacy measurement with multiple PFLs, when LMF does not configure measurement time window(s) for a PFL or UE does not support FG 41-2-3,
    - Carrier phase measurements are performed on a single PFL
    - If the LMF does not indicate a PFL for CPP measurements, the selection of the PFL for CPP measurements is up to UE implementation.
    - Existing requirements for RSTD/UE Rx-Tx without time window apply.
    - FFS:
      * Measurement requirements are independent of the time windows (if configured). i.e. for the indicated PFL j is calculated counting PRS resources outside the time windows.
  + For UE configured for CPP measurement with legacy measurement with multiple PFLs, when UE is configured with time window and does not support FG 41-2-8/41-2-9, discuss the following options:
    - Option 1:
      * Existing requirements without time window apply for legacy measurements.
      * Existing requirements without time window apply for CP measurement provided that the resources associated to the time window have occasions only within the time window.
      * UE is not required to report the carrier phase measurements on the PRS resources outside the time window.
    - Option 2:
      * No DL RSCPD measurement requirements are defined for UEs that do not support FG 41-2-8.
      * No DL RSCP measurement requirements are defined for UEs that do not support FG 41-2-9.

**Issue 2-1-2: Measurement period requirements for DL RSCP/DL RSCPD with multiple PFLs configured**

* Proposals
  + Option 1: (Qualcomm)
    - When multiple PFLs are configured in the assistance data and DL RSCPD is requested with RSTD, the measurement period is given by
      * where j is the index of the indicated PFL, if provided by the LFM, otherwise the PFL j is selected by UE implementation.
      * If an aperiodic time window is configured, the start of the measurement period coincides with the start of the time window.
    - When multiple PFLs are configured in the assistance data and DL RSCP is requested with UE Rx-Tx, the measurement period is given by
      * where j is the index of the indicated PFL, if provided by the LFM, otherwise the PFL j is selected by UE implementation.
      * If an aperiodic time window is configured, the start of the measurement period coincides with the start of the time window.
  + Option 2: (OPPO)
    - When multiple PFLs are configured where RSCPD is supposed to be measured in PFL j, support option 1 with the following updates (taking RSCPD measurement as the example)
      * For UE supporting both FG 41-2-3 and FG 42-2-8， is the measurement period for both RSCPD and RSTD in PFL j by taking time window into account.
      * For UE supporting FG 41-2-3 only, , where is the measurement period for RSCPD in PFL j by taking time window into account, and is the legacy measurement period for RSTD in PFL j without time window.
      * For UE not supporting FG 41-2-2 or FG 41-2-8, .
* Recommended WF
  + Discuss the option(s).

**Issue 2-1-3: The impact of carrier frequency offset**

* Proposals
  + Option 1: (Huawei)
    - The accuracy requirements for CP measurement apply provided that the two PRS resources for calculating RSCPD or relative RSCP are located in the same set of symbols after accounting for expected RSTD.
  + Option 2: (Lenovo)
    - The carrier phase definition should be clarified to indicate the carrier phase is defined at a specific location within the slot.
    - Define a common reference time and refer the DL-PRS carrier phase measurements to this reference time by subtracting the phase rotation due to the carrier frequency offset in the time interval between the DL-PRS and the reference time for the carrier phase measurement.
    - Define the referred carrier phase difference as the difference between the referred carrier phase measurements.
    - Define the same common reference time for the UE and the PRU.
    - The UE and the PRU report either the referred carrier phase measurements or the carrier phase difference measurements computed using the referred carrier phase measurements.
  + Option 3: (Qualcomm)
    - RAN4 not to define enhancements to mitigate impact of carrier frequency offset on CPP measurements in Rel-18.
    - RAN4 to define an applicability condition for DL RSCPD accuracy requirements based on the time proximity between the target and reference PRS resources used to calculate the DL RSCPD measurement.
    - DL RSCPD accuracy requirements are defined and apply when the target and reference PRS resources are measured in the same time slot. FFS the maximum time separation between the resources within a slot.
    - RSCPD accuracy derived from RAN4 simulations applies assuming zero carrier frequency error at the UE and TRPs.
* Recommended WF
  + Discuss the option(s).

**Issue 2-1-4: Update measurement period requirements for RSTD, UE Rx-Tx and PRE-RSRP(P) with time window configured**

*Background: Companies mention that the time window can be configured for legacy measurements with RSCPD/RSCP measurements not requested. Hence the measurement period requirements for legacy measurements need to be updated.*

* Proposals
  + Option 1: (OPPO)
    - Update the measurement period for legacy RSTD, UE Rx-Tx and RSRP(P) with time window if configured and supported by UE capability.
* Recommended WF
  + Discuss the option(s).

**Issue 2-1-5: UE behaviour due to AGC adjustment**

* Proposals
  + Option 1: (Huawei)
    - RAN4 not to define UE behaviour related to AGC adjustment.
* Recommended WF
  + RAN4 not to define UE behaviour related to AGC adjustment.

# [111][214] NR\_pos\_enh2\_part3

No discussion paper submitted and no open issue to be discussed.

# Tdoc recommendations

## [111][212] NR\_pos\_enh2\_part1

**New tdocs**

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| **Title** | **Source** |
|  |  |
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## [111][213] NR\_pos\_enh2\_part2

**New tdocs**

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| **Title** | **Source** |
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