**3GPP TSG-RAN WG4 Meeting #111 R4-2410193**

**Fukuoka, May 20 ‒ 24, 2024**

**Title:** WF on SL positioning and carrier phase positioning

**Agenda Item:** 7.12.3

**Source: CATT**

**Document for:** Approval

# Introduction

This WF includes the agreements and open issues discussed in topic summary for [111][213] NR\_pos\_enh2\_part2.

# Topic #1: Sidelink Positioning Requirements

## Sub-topic 1-1 SL Positioning Core Requirements Maintenance (agenda 7.12.1.2)

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

*Agreements:*

* + - The measurement requirements for SL positioning are applicable to a single SL carrier case. The FG 41-1-1a is not included as an applicability condition.
    - Measurement accuracy 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

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

*Agreements:*

* + - It is a RAN4 understanding that UE performing measurements may not be aware on the synchronization source change at the Tx UE.
    - For synchronization reference source change occurring at Tx side, measurement accuracy requirements do not apply and no specific UE behaviour is defined.
      * Note: the agreement can be revisited if a RAN1/2 solution is introduced to inform the UE performing measurements on the synchronization source change at the Tx UE.
    - Send LS to RAN1/2 to check on whether UE is aware on the synchronization reference source change occurs at Tx side and introduce a respective solution if it is not available. Details of the LS can refer to R4-241XXXX.

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

Proposals:

* + Option 1:
    - 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.

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

Proposals:

* + Option 1:
    - RAN4 not to define any impact of Uu link connection on the measurement period.
  + Option 2:
    - 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.

## Sub-topic 1-2 SL Positioning Performance Requirements (agenda 7.12.2.2)

### Issue 1-2-1: SINR side conditions

*Agreements:*

* + SL RSTD: (0, -3) dB
  + SL Rx-Tx/RSRP/RSRPP: -3 dB

### Issue 1-2-2: Margin for RF calibration

*Agreements:*

* + Define the RF calibration margin for SL RSTD measurements in FR1 using the following structure:

|  |  |  |  |
| --- | --- | --- | --- |
| *PRS BW (RB number)* | | | *Margin (Tc)* |
| *SCS=15kHz* | *SCS=30kHz* | *SCS=60kHz* |
| ***≥ 48*** | ***≥ 24*** | ***N/A*** | ***Z1*** |
| ***≥ 96*** | ***≥ 48*** | ***≥ 24*** | ***Z2*** |

* + Define the RF calibration margin for SL Rx-Tx measurements in FR1 using the following structure:

|  |  |  |  |
| --- | --- | --- | --- |
| *[Min(SL PRS Rx BW, SL PRS Tx BW) (RB)]* | | | *Margin (Tc)* |
| *SCS = 15 kHz* | *SCS = 30 kHz* | *SCS = 60 kHz* |
| ***≥ 48*** | ***≥ 24*** | ***N/A*** | ***δ1*** |
| ***≥ 96*** | ***≥ 48*** | ***≥ 24*** | ***δ2*** |

* + FFS the detailed values in the above tables.

Margins due to frequency drift (Y):

* + For SL RSTD, the existing margins due to frequency drift for DL PRS can be reused for SL PRS.
  + Consider time margins due to frequency drift to Rx-Tx time difference accuracy requirement if the UE reports the transmission timestamp of a SL PRS measurement
    - FFS the exact time margin values, e.g., the ones for RSTD could be reused.

### Issue 1-2-3: Time margin for Rx-Tx time difference measurements when UE reports the transmission timestamp of a SL PRS

Resolved under issue 1-2-5.

### Issue 1-2-4: Value of Nsample for 48 PRB SL-PRS BW

Resolved under issue 1-2-5.

### Issue 1-2-5: Measurement accuracy requirements

*Agreements:*

* + Requirements are to be defined for 1 and 4 samples, depending on BW.
  + The accuracy requirements for 4 samples allow for non-coherent combining.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Accuracy | Conditions | | | | | | |
| SL-PRS Ês/Iot | SL-PRS SCS | SL-PRS bandwidth  Note 1 | Number of samples, S | Io Note 2 range | | |
| NR operating band groups Note 3 | Minimum Io | Maximum Io |
| Tc Note 4 | dB | kHz | RB |  |  | dBm/SCS | dBm/BWChannel |
| TBD | (SL-PRS Ês/Iot)ref ≥  0 dB  (SL-PRS Ês/Iot)*i* ≥  -3 dB | 15 | 48 | ≥ 4 | NR\_TDD\_FR1\_B |  |  |
| NR\_TDD\_FR1\_J |
| >48 | ≥ 1 | Note 5 |  |  |
| TBD | ≥ 96 | ≥ 1 | Note 5 |  |  |
| TBD  TBD | 30 | ≥ 24 | ≥ 4 | NR\_TDD\_FR1\_B |  |  |
| NR\_TDD\_FR1\_J |  |  |
| TBD | >48 | ≥ 1 | Note 5 |  |  |
| TBD | 60 | ≥ 24 | ≥ 4 | NR\_TDD\_FR1\_B |  |  |
| NR\_TDD\_FR1\_J |  |  |
| NOTE 1: Minimum SL-PRS bandwidth, which is the minimum of the SL-PRS bandwidths of the reference resource and the measured neighbour resource i.  NOTE 2: Io is assumed to have constant EPRE across the bandwidth.  NOTE 3: NR operating band groups in FR1 are as defined in clause 3.5.2.  NOTE 4: Tc is the basic timing unit defined in TS 38.211 [6].  NOTE 5: The same bands and the same Io conditions for each band apply for this requirement as for the corresponding requirement with the SL-PRS bandwidth of the smallest PRB number for the corresponding SCS. | | | | | | | |

* + Further discuss the Io in the table.

### Issue 1-2-6: Test case configurations

*Agreements:*

* + RAN4 will not specify SL positioning test cases with additional path reporting
  + RAN4 will not specify SL positioning test cases with LoS/NLoS reporting (no corresponding RAN4 requirements to test)
  + RAN4 will not specify SL positioning test cases with Tx/Rx ARP-ID reporting (no corresponding RAN4 requirements to test)
  + NR Uu configurations

|  |  |
| --- | --- |
| NR Uu configuration | Description |
| 1 | NR Uu: 15 kHz SSB SCS, 20 MHz bandwidth, FDD duplex mode |
| 2 | NR Uu: 15 kHz SSB SCS, 20 MHz bandwidth, TDD duplex mode |
| 3 | NR Uu: 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode |

* + SL PRS configurations

|  |  |
| --- | --- |
| NR SL configuration | Description |
| 1 | SL: 15 kHz, 10 MHz bandwidth, HD duplex mode |
| 2 | SL: 30 kHz, 10 MHz bandwidth, HD duplex mode |
| 3 | SL: 30 kHz, 20 MHz bandwidth, HD duplex mode |

* + The number of SL UEs in test cases
    - The number of SL UEs in the SL measurement delay test cases for SL positioning:
      * SL RSTD: **4** (1 target rx UE, 3 anchor tx UEs [1 reference anchor UE and 2 other anchor tx UEs)])
      * SL Rx-Tx, SL PRS-RSRP/RSRPP, SL AoA: **3** (1 target rx UE, 2 anchor tx UEs),
      * SL RTOA: **[2]** (1 target tx UE, 1 anchor rx UE).
    - The number of SL UEs in the SL measurement accuracy test cases for SL positioning:
      * SL RSTD: **3** (1 target rx UE, 2 anchor tx UEs [1 reference anchor UE and 1 other anchor tx UEs)])
      * SL Rx-Tx, SL PRS-RSRP/RSRPP: **3** (1 target rx UE, 2 anchor tx UEs).
  + All TX and RX UEs are in coverage and using gNB as sync reference.

### Issue 1-2-7: Whether to verify accuracy of legacy measurements in SL PRS-RSRP(P) TCs

Proposals:

* + Option 1:
    - Consider the following rules:
      * If RAN1/2 confirms that the SL PRS-RSRP(P) is possible to be requested and/or reported standalone, the SL PRS-RSRP(P) accuracy is verified alone in separate section.
      * If RAN1/2 confirms that the SL PRS-RSRP(P) cannot be requested and/or reported standalone, the SL PRS-RSRP(P) accuracy should be verified with RSTD/RX-TX accuracy together in one section.
  + Option 2:
    - Verify accuracy requirements for SL PRS-RSRP together with SL Rx-Tx in the same section, but different test cases with and without SL PRS-RSRP.
    - Define test case to verify accuracy requirements for SL PRS-RSRPP in a separate section.
  + Option 3:
    - Support option 1a to define separate sections for testing SL PRS-RSRP/PRS-RSRPP, without verifying the accuracy of the other (SL RSTD/Rx-Tx) measurement, respectively.

### Issue 1-2-8: Test case for additional path measurements

Proposals:

* + Option 1:
    - RAN4 to discuss whether to define test cases for additional path measurements.

# Topic #2: Carrier Phase Positioning Requirements

## Sub-topic 2-1 Carrier Phase Positioning Core Requirements Maintenance (agenda 7.12.1.2)

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

*Way forward:*

For UE configured for CPP measurement with legacy measurement with multiple PFLs, when LMF does not configure measurement time window(s) for a PFL

* + Existing requirements for RSTD/UE Rx-Tx without time window apply.
  + Option 1
    - Carrier phase positioning 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.
  + Option 2:
    - Carrier phase positioning measurement is performed on a per PFL basis.
    - UE reports the carrier phase measurement as *nr-RSCPD-r18* defined in 37.355.

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 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:
    - 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:
    - 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, .

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

Proposals:

* + Option 1:
    - 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:
    - 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:
    - 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.

### 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:
    - Update the measurement period for legacy RSTD, UE Rx-Tx and RSRP(P) with time window if configured and supported by UE capability.

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

*Agreements:*

RAN4 not to define UE behaviour related to AGC adjustment.

## Sub-topic 2-2 Carrier Phase Positioning Performance Requirements (agenda 7.12.2.6)

### Issue 2-2-1: Whether to verify the accuracy of legacy measurements in RSCPD/RSCP TCs

Proposals:

* + Option 1:
    - Verify both the accuracies of legacy measurements and CPP measurements in one TC with a 90% success rate to reflect UE’s real positioning performance in the deployment.
  + Option 2:
    - Not verify the accuracy requirements for legacy RSTD/Rx-Tx measurement in the RSCPD/RSCP TC.

### Issue 2-2-2: Additional margins for frequency drift and RF calibration

Proposals:

* + Option 1: Define extra margin in requirements
    - FFS: need for extra simulations.
  + Option 2: Do not define extra margin in requirements
    - Do not update simulation assumptions for carrier phase measurement.

Further discuss in the next meeting, proponents are requested to bring results justifying the additional margin for Option 1.

### Issue 2-2-3: Test configurations

*Agreements:*

Time window configuration in CPP TCs:

* + Offset: same as PRS resource offset
  + Duration: covering all PRS resources from all TRPs
  + For RRC\_CONNECTED: Periodicity: 2 times of PRS resource periodicity
  + For RRC\_INACTIVE: The periodicity of time window should be 2 times of LCM(DRX cycle, PRS periodicity)
    - Note: In the legacy configuration PRS periodicity is always smaller than DRX periodicity

# Reference

1. R4-2408010, Topic summary for [111][213] NR\_pos\_enh2\_part2, CATT, RAN4#111.