**3GPP TSG-RAN WG1 Meeting #107-e R1-2112457**

**e-Meeting, November 11th – 19th, 2021**

**Agenda Item: 8.5.4**

**Source: Moderator (Huawei)**

**Title: Summary #1 of [107-e-NR-ePos-04] latency improvements**

**Document for: Discussion and decision**

# Introduction

In RAN1#107-e, the following papers provided input on latency improvements for DL and DL+UL methods.

1. R1-2110853 Enhancements to positioning latency improvements Huawei, HiSilicon
2. R1-2110959 Discussion on latency reduction for NR positioning ZTE
3. R1-2111016 Remaining issues on latency enhancement for NR positioning vivo
4. R1-2111259 Remaining issues on latency reduction for NR positioning CATT
5. R1-2111292 Enhancements on Latency Reduction in NR Positioning OPPO
6. R1-2111367 Views on PHY Latency Reductions Nokia, Nokia Shanghai Bell
7. R1-2111400 Remaining issues on latency improvements for NR positioning Sony
8. R1-2111435 Discussion on latency improvement for positioning China Telecom
9. R1-2111498 Remaining Open Aspects of NR Positioning Latency Reduction Intel Corporation
10. R1-2111575 Latency improvements for both DL and DL+UL positioning method Xiaomi
11. R1-2111611 Discussion on latency improvement for positioning CMCC
12. R1-2111741 Discussion on latency improvements for both DL and DL+UL positioning methods Samsung
13. R1-2111800 Latency improvements for both DL and DL+UL positioning methods InterDigital, Inc.
14. R1-2111877 Views on Rel-17 positioning latency reduction Apple
15. R1-2111976 Discussion on latency improvements for NR positioning LG Electronics
16. R1-2112073 Physical latency improvement aspects MediaTek Inc.
17. R1-2112111 Discussion on latency improvements for both DL and DL+UL positioning methods NTT DOCOMO, INC.
18. R1-2112220 Remaining issues on Latency Improvements for Positioning Qualcomm Incorporated
19. R1-2112325 Remaining issues on Positioning Latency Reduction Lenovo, Motorola Mobility
20. R1-2112342 Latency improvements for both DL and DL+UL positioning methods Ericsson
21. R1-2112411 Draft LS on lower Rx beam sweeping factor for latency improvement Moderator (Huawei)

This paper provides the moderator summary of solutions to improve positioning latency for DL and DL+UL methods, subject to the following email discussion.

[107-e-NR-ePos-04] Email discussion/approval on latency improvements for both DL and DL+UL positioning methods with checkpoints for agreements on November 15 and 19 – Su (Huawei)

# Measurement gap enhancements

## General information

The following agreements were made in RAN1#106bis-e on this issue.

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| --- |
| Agreement:  Support the following options (in the agreement made in RAN1#106-e) for a new mechanism of MG activation request for the purpose of positioning.   * Option 2: by UE (via UCI or UL MAC CE)   + Select only one of UCI and UL MAC CE in RAN1#106bis-e * Option 1: by LMF (via an NRPPa message)   + Note: This is transparent to the UE   Conclusion:  Potential enhancements to latency reduction with respect to MG sharing with other RRM procedures is up to RAN4 to decide.  Agreement:  Support using UL MAC CE for MG activation request by UE (Option 2) for the purpose of positioning.  Agreement:  Support the following option (from the agreement made in RAN1#106-e) for a new MG activation procedure to be performed by the gNB for the purpose of positioning.   * Option 2: DL MAC CE * FFS: Deactivation process   Agreement:  With regards to MG activation by DL MAC CE, further study   * DL MAC CE payload * The necessity of pre-configuration of MGs in higher layers. |

## Preconfiguration of MG

The following sources provided their views on preconfiguration of MG

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| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 3:** Support preconfiguration of up to 8 MGs in RRC and DL MAC CE to provide the bitmap of the activation/deactivation status of each MG.   * The preconfigured MGs are by default deactivated. * From RAN1 perspective, at most a single preconfigured MG among all preconfigured MGs can be activated for the purpose of PRS measurement at any given time. * Send an LS to RAN2 and RAN4. |
| vivo [3] | **Proposal 1**   * The pre-configured MG should be transmitted to UE by RRC signaling, and include the following information.   + The common configuration parameters (e.g. MGRP, MGL, etc.)   + Initial status of pre-configured MG: activated, deactivated   + The pre-configured ID can be supported for indicating one of multiple pre-configured MG, or indicating a positioning MG   **Proposal 6:**   * Before MG or pre-configured MG configuration, the time/frequency characteristics (i.e., periodicity/offset and/or frequency layer information) of PRS should be transmitted to gNB in advance. |
| OPPO [5] | Proposal 2: Support configuring a list of MG configurations in RRC and the UE can use MAC CE to request one of them. |
| Nokia, NSB [6] | **Proposal 2**: RAN1 to discuss if pre-configured MG is supported or not. |
| SONY [7] | **Proposal 1:** gNB provides the configuration of supported MG(s) for positioning latency improvements to UE / LMF. The configuration is provided in higher layers signalling. |
| CTC [8] | **Proposal 2-1:** Rel-17 should support the pre-configuration of MG via RRC signaling.  **Proposal 2-2:** The details of RRC signalling of pre-configuration should left up to RAN2, while the reuse of configuration can be a start point, e.g. MGL, MGRP, MG offset. |
| Intel [9] | **Proposal 1:**   * + To reduce latency of NR positioning with MGs for DL PRS processing define the following enhancements:     - Support pre-configuration of the multiple MG patterns for the DL PRS processing using RRC or LPP signaling       * Signaling details are left up to RAN2     - Support DL MAC CE signaling only to activate the pre-configured MGs for DL PRS processing by UE       * Signaling details are left up to RAN2     - Inform RAN2 on the RAN1 discussion and agreement |
| Xiaomi [10] | **Proposal 4:** Prefer pre-configuration of MG. |
| IDC [13] | **Proposal 2:** If pre-configured measurement gaps are available at the UE, the UE sends a MG request via MAC-CE. Otherwise the UE sends the MG request via RRC. |
| LGE [15] | **Proposal 4:**   * RAN1 should support the pre-configuration of MGs in terms of latency reduction   **Proposal 5:**   * RAN1 should support followings if the pre-configuration of multiple MGs is supported   + Introducing MG index(or ID) to distinguish configured Multiple MGs easily   + Providing UE with information regarding association between pre-configuration of MGs and MG indices (or MG IDs)   + MG index (or MG ID) needs to be included in the both MG activation request (UE-initiated) and MG activation (gNB-initiated). |
| DCM [17] | **Proposal 1:**   * MG activation procedure based on combination of RRC and MAC-CE should be considered   + A MG configuration list including multiple MG configurations is configured via RRC signaling   + MAC CE is used to activate/deactivate one MG configuration in the configuration list |
| Lenovo, Moto Mobility [19] | **Proposal 4:** Support multiple pre-configured measurement gaps for latency reduction together with applicable assistance information from the LMF. |

**FL comments**

The preconfiguration of MGs are supported by majority of companies (12), while one company suggested to carry everything from RRC into DL MAC CE.

There were questions how gNB could determine the proper MG patterns in the preconfiguration, and there was a proposal on the preconditions on the signaling between LMF and gNB to enable so.

There were also a few proposals mentioning that preconfiguration of MGs should be provided by LMF. However, based on the understanding from the FL, this may involve RAN2 to check the feasibility.

### Round 1

Based on the summary from the contributions, the FL has the following proposal, and questions.

### Proposal 2.1.1-1

* Preconfiguration of MG(s) in RRC is supported from RAN1 perspective.

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| **Company** | **Yes/No** | **Comments** |
| vivo | Yes |  |
| Nokia/NSB | Yes | We don’t see how this feature is useful without it |
| Qualcomm |  | To Nokia: Why you don’t see being useful without it? If a MAC-CE can include the RRC config of the DL-MAC-CE, what do we initially benefit from having multiple preconfigured?  Either way, for the sake of progress we can go with the majority on this, assuming that for UL-MAC-CE request, a UE will be able to request any MG needed, and not within the ones are preconfigured. |

### Question 2.1.1-2

* Do companies see the need to send an LS to RAN2 and RAN3 if Proposal 2.1.1-1 is agreed?

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| **Company** | **Yes/No** | **Comments** |
| Nokia/NSB |  | Okay with LS |
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### Question 2.1.1-3

* Do companies think RAN1 should discuss how gNB determines the preconfiguration of MG(s) or leave it to RAN2 and/or RAN3 if Proposal 2.1.1-1 is agreed?

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| **Company** | **Comments** |
| vivo | We are okay to determine the preconfiguration of MG(s) by gNB and discuss in RAN1 |
| Nokia/NSB | We are okay for RAN1 to assume there will be preconfigured MG with an assocaiated ID and then let RAN2/3 work on details. |
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### Question 2.1.1-4

* Do companies think preconfiguration of MG(s) could also be provided by LPP?

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| **Company** | **Yes/No** | **Comments** |
| vivo | No |  |
| Qualcomm | No |  |
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## MG activation request by UE

The following sources provided their views on UL MAC CE based MG activation request by the UE.

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| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 1:** Support inclusion of the following information in the NRPPa message and UL MAC CE for MG activation request.   * PRS point A * PRS measurement periodicity and offset * PRS measurement length   **Proposal 2:** Introduce a new parameter in RRC to enable/disable the MG activation request using UL MAC CE. |
| vivo [3] | **Proposal 2:**   * With pre-configured MG, MG request only includes the activation/deactivation indication |
| OPPO [5] | Proposal 2: Support configuring a list of MG configurations in RRC and the UE can use MAC CE to request one of them. |
| CTC [8] | **Proposal 1:** Rel-17 should support a new mechanism of MG request by UE via UCI or UL MAC CE at least for UE-based positioning methods. |
| IDC [13] | **Proposal 2:** If pre-configured measurement gaps are available at the UE, the UE sends a MG request via MAC-CE. Otherwise the UE sends the MG request via RRC.  **Proposal 3:** Support using UL MAC CE for MG deactivation request by UE for the purpose of positioning. |
| Apple [14] | **Proposal 2**: DL (UL) MAC-CE contains indication of which MG-ID is activated (demanded) |
| LGE [15] | **Proposal 5:**   * RAN1 should support followings if the pre-configuration of multiple MGs is supported   + Introducing MG index(or ID) to distinguish configured Multiple MGs easily   + Providing UE with information regarding association between pre-configuration of MGs and MG indices (or MG IDs)   + MG index (or MG ID) needs to be included in the both MG activation request (UE-initiated) and MG activation (gNB-initiated). |
| Qualcomm [18] | **Proposal 1:** Support request of MG(s) with an UL MAC-CE from the UE which copies NR-PRS-MeasurementInfoList-r16 elements, i.e., includes the following elements in the UL MAC-CE.   * dl-PRS-PointA-r16 * nr-MeasPRS-RepetitionAndOffset * nr-MeasPRS-length-r16 |

**FL comments**

It appears that there are two solutions.

* Solution 1: The UL MAC CE indicates the MG ID associated with the preconfiguration.
  + Supported by (6): vivo, OPPO, CTC, IDC, Apple, LGE
* Solution 2: The UL MAC CE provides the information carried in RRC LocationMeasurementIndication.
  + Supported by (2): Huawei/HiSilicon, Qualcomm

### Round 1

Based on the summary from the contributions, the FL has the following proposal and questions.

### Proposal 2.2.1-1

* Select between the following two alternatives on the information in the UL MAC CE for MG activation request by the UE.
  + Alt.1 MG ID associated with the preconfiguation of MGs
  + Alt.2 Information carried in the RRC LocationMeasurementIndication, i.e.
    - dl-PRS-PointA
    - nr-MeasPRS-RepetitionAndOffset
    - nr-MeasPRS-length

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| **Company** | **Alt** | **Comments** |
| vivo | Alt.1 | Firstly, if the preconfiguation of MGs is provided, why provides the information carried in RRC LocationMeasurementIndication in MAC CE?  In addition, we would like to note the agenda is about latency reduction, and if the preconfiguation of MGs is provided after MG request, we don’t know how to reduce latency |
| Nokia/NSB | Alt 1. | Payload size should be considered. |
| Qualcomm | Alt. 2 | A UE should be able to request any MG it requires. We could accept having an UL-MAC-CE which has 1 one bit flag to pick between the MG-IDs, if the UE has received pre-configuration, or ask for a new MG using UL-MACCE |

### Question 2.2.1-2

* Should UL MAC CE be used for MG deactivation request?

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| **Company** | **Yes/No** | **Comments** |
| vivo | Yes |  |
| Nokia/NSB |  | We should first discuss if there is a need for UL MG deactivation request. It is not clear from prior agreements we have agree to add this feature. |
| Qualcomm |  | Unclear. It’s a “request”. A UE would send a separate request if it wants a different MG. |

## MG activation request by LMF

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| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 1:** Support inclusion of the following information in the NRPPa message and UL MAC CE for MG activation request.   * PRS point A * PRS measurement periodicity and offset * PRS measurement length |
| ZTE [2] | **Proposal 1:** For a new mechanism of MG activation request by LMF (via an NRPPa message), support at least one of the following options,   * Option 1: The MG activation request message includes the same information as the RRC signaling LocationMeasurementInfo defined in Rel-16 for DL PRS measurement * Option 2: The MG activation request message indicates a specific MG pattern, where the MG pattern at least include, * MGL: the measurement gap length of the measurement gap * MGRP: measurement gap repetition period of the measurement gap * Gap offset: the gap offset of the measurement gap pattern indicated by MGL and MGRP * MGTA: the measurement gap timing advance |
| vivo [3] | **Proposal 3:**   * The MG request including the activated/deactivated indication by the LMF can be transmitted in the NRPPa Request location information (via a UE-associated NRPPa message).   **Proposal 16:**   * Support a new requesting NRPPa signaling from LMF to gNB for gNB to determine the use of MG or PRS processing window, and the detailed configuration of the corresponding MG or PRS processing window that includes   + The time/frequency characteristics (i.e., periodicity/offset information, and frequency layer information) of PRS”   + The location request information (i.e., positioning requirement, latency, Bandwidth that needed to meet accuracy requirement) |

**FL comments**

For MG activation request by the LMF, there is limited input. The views from proponents are quite diverse.

### Round 1

Based on the summary from the contributions, the FL has the following questions.

### Question 2.3.1-1

* Do companies think RAN1 should discuss the MG activation request by LMF or leave the detailed analysis to RAN3?

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| **Company** | **Comments** |
| vivo | At least, the parameter is used to determine MG activation or PRS Process window configuration by gNB is needed |
| Nokia/NSB | Can be left to RAN3. |
| Qualcomm | Up to RAN3 |

### Question 2.3.1-2

* For the companies thinking that RAN1 should discuss the MG activation request by LMF, which parameter do you think should be included in the NRPPa message?

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| **Company** | **Comments** |
| vivo | 1. PRS parameter: periodicity/offset information, and frequency layer information, length  2. The location request information (i.e., positioning requirement, latency, Bandwidth that needed to meet accuracy requirement) is used to determine to activate MG or configure PRS Process window |
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## DL MAC CE for MG activation and deactivation

The following sourced provided their views on DL MAC CE for MG activation and the corresponding deactivation process.

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| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 3:** Support preconfiguration of up to 8 MGs in RRC and DL MAC CE to provide the bitmap of the activation/deactivation status of each MG.   * The preconfigured MGs are by default deactivated. * From RAN1 perspective, at most a single preconfigured MG among all preconfigured MGs can be activated for the purpose of PRS measurement at any given time. * Send an LS to RAN2 and RAN4. |
| vivo [3] | **Proposal 5:**   * With preconfigured MG, the MG activation via MAC CE only includes activation and deactivation indications.   + FFS pre-configured MG indication for indicating one of multiple pre-configured MG and/or indicating a positioning MG |
| CATT [4] | **Proposal 4:** It is not necessary to introduce a deactivation process. |
| OPPO [5] | Proposal 3: In MG activation MAC CE, the gNB indicates:   * One MG configuration to be activated * Indicate a number of repetitions.   Proposal 4: The activated MG configuration is deactivated automatically when the indicated number of repetitions is finished. |
| SONY [7] | **Proposal 2:** DL MAC CE payload contains the triggering/activation of MG(s) for positioning measurement, including the index of the selected measurement gap configuration. |
| Intel [9] | **Proposal 1:**   * + To reduce latency of NR positioning with MGs for DL PRS processing define the following enhancements:     - Support pre-configuration of the multiple MG patterns for the DL PRS processing using RRC or LPP signaling       * Signaling details are left up to RAN2     - Support DL MAC CE signaling only to activate the pre-configured MGs for DL PRS processing by UE       * Signaling details are left up to RAN2     - Inform RAN2 on the RAN1 discussion and agreement |
| CMCC [11] | **Proposal 1:** Support one or both of the following options for the MG deactivation process;   * Option 1: DL MAC-CE * Option 2: A MG validation timer |
| IDC [13] | **Proposal 4:** Support using DL MAC CE for MG deactivation by gNB for the purpose of positioning. |
| Apple [14] | **Proposal 2**: DL (UL) MAC-CE contains indication of which MG-ID is activated (demanded)  **Proposal 4**: Associate each new MG configuration with a life cycle after which the MG will be deactivated automatically with no further signaling/indication from gNB is required. |
| LGE [15] | **Proposal 3:**   * For the deactivation of MG, RAN1 should select one option:   + Option #1: Introducing the additional signaling for activation and the signaling is transmitted after activation of MG. For the signalling, downselect among following two alternatives.     - Alt. 1: DCI     - Alt. 2: MAC-CE   + Option #2: MG is autonomously deactivated after specific time (e.g. inactivity timer) from reference time (e.g. activation time of MG) and the information regarding inactivity timer can be transmitted through one or more following alternatives     - Alt.1 :System information     - Alt.2: RRC signaling     - Alt.3: MAC-CE (for activation of MG)   **Proposal 5:**   * RAN1 should support followings if the pre-configuration of multiple MGs is supported   + Introducing MG index(or ID) to distinguish configured Multiple MGs easily   + Providing UE with information regarding association between pre-configuration of MGs and MG indices (or MG IDs)   + MG index (or MG ID) needs to be included in the both MG activation request (UE-initiated) and MG activation (gNB-initiated).   **Proposal 6:**   * RAN1 should consider that MAC-CE for MG activation includes the information about measurement report. |
| DCM [17] | **Proposal 1:**   * MG activation procedure based on combination of RRC and MAC-CE should be considered   + A MG configuration list including multiple MG configurations is configured via RRC signaling   + MAC CE is used to activate/deactivate one MG configuration in the configuration list |
| Qualcomm [18] | **Proposal 2:** Support a new DL MAC CE to activate a MG for Positioning which includes the following elements from the GapConfig message from 38.331:   * gapOffset, * measuremeng gap length (mgl) including the values from mgl-16, * measurement gap periodicity (mgrp), * measurement gap timing advance (mgta), * refServCellIndicator, refFR2ServCellAsyncCA * per-FR1/per-FR2/per-UE flag. |

**FL comments**

For MG activation DL MAC CE, there are two solutions.

* Solution 1: The DL MAC CE indicates the MG ID associated with the preconfiguration.
  + Supported by (10): vivo, CATT, OPPO, SONY, Intel, CMCC, IDC, Apple, LGE, DCM
* Solution 2: The DL MAC CE indicates the bitmap of MGs associated with the preconfiguration
  + Supported by: Huawei/HiSilicon
* Solution 3: The DL MAC CE provides the information carried in the RRC GapConfig IE.
  + Supported by: Qualcomm

For MG deactivation process, there were two alternatives

* Alt.1: Based on explicit DL MAC CE for deactivation
  + Supported by (7): Huawei/HiSilicon, vivo, [CATT], CMCC, IDC, [LGE], DCM
* Alt.2: Timer/counter based (e.g. the MG activation MAC CE indicates the timer/counter and the MG is deactivated when the timer/counter expires)
  + Supported by (4): OPPO, CMCC, Apple, [LGE]

### Round 1

Based on the summary from the contributions, the FL has the following proposal and questions.

### Proposal 2.4.1-1

* Select between the following alternatives on the information in the DL MAC CE for MG activation by the gNB.
  + Alt.1 MG ID associated with the preconfiguation of MGs
  + Alt.2 MG bitmap associated with the preconfiguration of MGs
  + Alt.3 Information carried in the RRC GapConfig IE, i.e.
    - gapOffset,
    - measuremeng gap length (mgl) including the values from mgl-16,
    - measurement gap periodicity (mgrp),
    - measurement gap timing advance (mgta),
    - refServCellIndicator, refFR2ServCellAsyncCA
    - per-FR1/per-FR2/per-UE flag.

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| --- | --- | --- |
| **Company** | **Alt** | **Comments** |
| vivo |  | Alt 2 or Alt 1 |
| Nokia/NSB | 1 | Alt 2 is our second preference but we prefer Alt 1 |
| Qualcomm | Alt. 3 | First preference is Alt. 3, otherwise we can go with Alt. 1 |

### Proposal 2.4.1-2

* Select between the following alternatives on how the activated MG is deactivated.
  + Alt.1 By an explicit DL MAC CE for deactivation
  + Alt.2 By a timer/counter included in the MG activation DL MAC CE

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| --- | --- | --- |
| **Company** | **Alt** | **Comments** |
| vivo |  | Alt 1, one bit to indicate deactivation MAC CE or activation MAC CE |
| Nokia/NSB |  | We think both options could be considered. |
| Qualcomm | Alt. 1 |  |

## Handling on duplicated MG activation request from UE and LMF

The following source provided their views on handling on duplicated MG activation request from UE and LMF.

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| **Company** | **Proposals** |
| vivo [3] | **Proposal 4:**   * To select one of the following options for avoiding duplicated MG request from both LMF and UE   + The LMF indicate whether the LMF request MG by NRPPa when LMF send the LPP RequestLocationInformation message to the UE.   + Guarantee the MG activation is not later than the time when the location request is received   **Proposal 7:**   * UE is not expected to perform the measurement outside MG if MG is requested or configured. |
| IDC [13] | **Proposal 1:** If LMF makes a request for a measurement gap, to avoid the duplicate request from the UE, the LMF indicates to UE that MG config is not needed. |

**FL comments**

There is limited input on this issue. To the understanding of the FL, this issue may not be so essential for this meeting, and it can even be better discussed by RAN2/RAN3/RAN4.

### Round 1

Based on the summary from the contributions, the FL has the following question.

### Question 2.5.1-1

* Do companies think RAN1 should discuss the solution to avoid “duplicated” request from LMF and UE on the MG activation request.

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| **Company** | **Yes/No** | **Comments** |
| vivo | Yes |  |
| Nokia/NSB | No | gNB has full control if it receives two requests. We don’t see the issue. |
| Qualcomm | No | There is nothing to do. gNB will handle it. |

## Others

The FL added comments to the following proposals, considering that they may not be so essential and proposed only by a single source.

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| --- | --- |
| **Company** | **Proposals** |
| ZTE [2] | **Proposal 2**: Support UE to report UE capability information related to MG (e.g. supportedGapPattern) to LMF.  FL: This could be discussed on the basis that LMF configures the MG to the UE. |
| Intel [9] | **Proposal 2:**   * + Optimize the Rel.16 MG patterns (e.g., period, length, type) for NR DL PRS processing by UE to facilitate the flexible MG pre-configuration and send LS to RAN4 with a recommendation to define new MG patterns for positioning   FL: Suggest to let RAN4 handle this. |
| Lenovo, Moto Mobility [19] | **Proposal 6:** Introduce additional T values for UE (N,T) processing capabilities (e.g. 1, 2 or 4ms) within a MG.  FL: As discussed in the previous meeting, this can be directly discussed in the UE feature. |

# PRS measurement outside MG

## General information

The following agreements were made in RAN1#106bis-e on this issue.

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| Agreement:  For PRS measurement outside MG, support the following Alt. 2 in the working assumption made in RAN1#106-e with the following update of the PRS cell condition.   * Alt. 2: Applicable to all PRS (serving and/or non-serving cell) under conditions to PRS of non-serving cell.   + The conditions at least include that the Rx timing difference between PRS from the non-serving cell and that from the serving cell is within a threshold     - The UE is not expected to determine whether the above condition is satisfied by performing measurements and instead can be determined using assistance data       * FFS: Rx timing difference between PRS from the non-serving cell and that from the serving cell is determined by the expected RSTD and expected RSTD uncertainty.   + Further discuss the necessity on the following additional conditions     - When the PRS is higher priority than other channels/signals, for capability 1A and 1B, the PRS from the non-serving cell have to be inside the PRS prioritization window.     - When the PRS is higher priority than other channels/signals, for capability 2, the PRS from the non-serving cell have to be in the same symbols as the PRS of the serving cell since the serving cell does not know the symbol position of neighbour cell PRS.   Agreement:   * With regards to UE determining the PRS priority with other DL signal/channels within the PRS processing window for PRS measurement outside MG, support the priority indicated by gNB.   + FFS: What are the other DL signals/channels * With regards to the PRS processing window for PRS measurement outside MG, at least support the window indicated by gNB. |

## Condition of the non-serving cell

The following sources provided their views on the condition to receive the non-serving cell, especially on the Rx time difference determination and the threshold to compare against.

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| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 4:** UE may assume that the PRS from the serving cell and non-serving cell are synchronized if the PRS processing window is indicated by the gNB.   * Note: The threshold of Rx timing difference between PRS from the non-serving cell and that from the serving cell is CP length of the active DL BWP of the serving cell on the PRS frequency. * Send an LS to RAN4 informing that   + RAN1 understands that UE performance requirement for PRS measurement outside MG may only target the synchronization condition. |
| ZTE [2] | **Proposal 5**: Support UE to receive DL PRS from both serving cell and non-serving cell, where Rx timing difference between DL PRS from the non-serving cell and that from the serving cell determined by expected RSTD and expected RSTD uncertainty should be smaller than a threshold (e.g the cyclic prefix length determined by the serving cell). |
| vivo [3] | **Proposal 13:**   * In the RAN1 perspective, the minimum threshold of Rx timing difference can be the length of CP for the synchronization case. * RAN4 should specify the minimum threshold of Rx timing difference.   **Proposal 14:**   * Subject to UE capability, if the UE implementation is to do sliding correlation in the time domain, and PRS prioritization over all other DL signals/channels in all symbols inside the window, all the PRS within the PRS processing window from the serving cell and/or the non-serving cell(s) can be measured in the PRS process window. * The maximum threshold of Rx timing difference can be the length of the PRS processing window. |
| CATT [4] | **Proposal 1:** Support Rx timing difference between PRS from the non-serving cell and that from the serving cell is determined by the expected RSTD and expected RSTD uncertainty. |
| OPPO [5] | **Proposal 5:** In PRS assistance data, the LMF explicitly indicate to the UE whether the PRS resource of one TRP can be measured outside MG. |
| Nokia, NSB [6] | **Proposal 7**: The PRS from non-serving cells must be within the PRS prioritization window for the UE to measure it outside a MG. |
| Ericsson [20] | **Proposal 2** When a UE with capabilities 1A or 1B is configured to measure PRS outside measurement gaps, a non-serving cell PRS is required to be inside the PRS prioritization window if the PRS is higher priority than other DL signals/channels.  **Proposal 3** When a UE with capabilities 2 is configured to measure PRS outside measurement gaps, a non-serving cell PRS is required to be in the same symbols as a serving cell PRS inside the PRS prioritization window if the PRS is higher priority than other DL signals/channels. |
| LGE [15] | **Proposal 1:**   * Support using the expected RSTD and expected RSTD uncertainty in PRS processing window to determine Rx timing difference between PRS from the non-serving cell and that from the serving cell. |
| MTK [16] | **Proposal 2-1**: The expectRSTD and expectRSTD-uncertainty are applicable to measurement outside the gaps |
| Qualcomm [18] | **Proposal 4:** For the purpose of determining the condition for MG-less PRS processing between PRS from the non-serving cell and that from the serving cell, the UE shall use the expected RSTD and expected RSTD uncertainty configured in the assistance data.  **Proposal 5:** Within an active BWP of a serving cell, for the MG-less PRS processing feature, the UE is not expected to process the DL PRS of a non-serving cell which has Rx timing difference from the DL PRS of the serving cell that is larger than 50% of the OFDM symbol duration of the active BWP. |

**FL comments**

On determination of the Rx timing difference between PRS from the serving cell and non-serving cell, majority of companies support to use expected RSTD and expected RSTD uncertainty. One company thinks that UE may simply assume they are synchronized and requests RAN4 to only consider the synchronization condition for the corresponding requirements, while another company thinks LMF could explicitly indicates the PRS resources of TRPs that can be received outside MG.

On the threshold to compare against, some companies mentioned CP length, and a company mentioned 50% of the OFDM symbol duration. The understanding from the FL is that this may be properly handled by RAN4.

### Round 1

Based on the summary from the contributions, the FL has the following proposals.

### Proposal 3.1.1-1

* The Rx timing difference between the PRS from the non-serving cell and that from the serving cell is determined by expected RSTD and expected RSTD uncertainty in the assistance data.
* Send an LS to RAN4 to consider the following thresholds which is used to be compared against with the Rx timing difference to determine whether the PRS from the non-serving cell satisfy the condition of PRS measurement outside MG.
  + Option 1: CP length
  + Option 2: 50% of the OFDM symbol
  + Other options can be considered by RAN4

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| vivo |  | We suggest adding option 3: the length of PRS processing window for the UE is to do sliding correlation in the time domain for positioning. |
| Nokia/NSB | Yes | This should be decided by RAN4 so listing options and sending an LS is reasonable. |
| Qualcomm | Yes | We don’t see how the suggestion option 3 from vivo would work. PRS processing window will be many many OFDM symbols. Saying that the Rx timing difference is as large as the PRS processing window, doesn’t put any constraint. |

## PRS processing window indication

The following source provided their views on PRS processing window indication/configuration.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 5:** Support LMF-based PRS processing window request, where the full PRS configuration is provided to the serving cell.   * This can be in the same NRPPa message used for MG activation request.   **Proposal 6:** Support LMF to recommend the expected PRS measurement latency to the gNB to facilitate gNB setting the priority of PRS against other signals and channels.  **Proposal 7:** Support preconfiguration of a PRS processing windows in RRC per BWP and DL MAC CE to provide the bitmap of the activation/deactivation status of each PRS processing window.   * The preconfigured PRS processing windows are by default deactivated. * From RAN1 perspective, multiple preconfigured PRS processing windows can be activated for the purpose of PRS measurement. * Send an LS to RAN2. |
| ZTE [2] | **Proposal 4**: Support the following general procedure to indicate the PRS processing window and PRS priority as shown below,   * Step 1: UE should provide its capabilities related to the PRS processing window and PRS priority to both LMF and serving gNB. * Step 2: LMF should send a request to serving gNB. The request may include the response time, recommended PRS processing window (e.g. offset, the length and repetition period of the PRS processing window), the types of to PRS processing window (Cap.1A, Cap.1B or Cap.2) and the DL PRS configuration that is expected to be measured in the PRS processing window. * Step 3: Serving gNB send a response to LMF. The response may include the PRS processing window (e.g. offset, the length and repetition period of the PRS processing window) and PRS priority determined by serving gNB. * Step 4: LMF provide the PRS processing window (e.g. offset, the length and repetition period of the PRS processing window) and PRS priority to UE (e.g. in a location information request message). |
| vivo [3] | **Proposal 9:**   * PRS processing window can be described by the following parameters   + Starting slot and symbol of PRS processing window   + Periodicity of PRS processing window   + Duration of PRS processing window   + PRS processing window type, e.g. Pre UE or Per Band, or Per CC window.   + Frequency related to PRS processing window, e.g. Point A of PRS within PRS processing window   **Proposal 16:**   * Support a new requesting NRPPa signaling from LMF to gNB for gNB to determine the use of MG or PRS processing window, and the detailed configuration of the corresponding MG or PRS processing window that includes   + The time/frequency characteristics (i.e., periodicity/offset information, and frequency layer information) of PRS”   + The location request information (i.e., positioning requirement, latency, Bandwidth that needed to meet accuracy requirement) |
| OPPO [5] | **Proposal 7:** When LMF requests positioning measurement results, the LMF indicates a configuration of PPW and the configuration of PPW includes the following parameters:   * The periodicity and slot offset of PPW * The length of time window * The number of occurrences of PPW. |
| SONY [7] | **Proposal 6:** UE can provide assistance information (UAI) indicating serving gNB that the UE is feasible to perform positioning outside the measurement gap. Subsequently, serving gNB can provide the response whether the UE is allowed to perform positioning measurement (e.g., when it is needed). Hence, there is no additional latency. |
| Samsung [12] | **Proposal 4:** LMF or NG-RAN configures the parameters of a UEPRS processing window. |
| IDC [13] | **Proposal 5:** The prioritization window is configured only when the priority level of PRS from the serving cell is high |
| Qualcomm [18] | **Proposal 6:** Support a new DL-MAC-CE to activate a PRS processing window with the following details:   * + PRS processing window starting time: SFN and slot offset   + Length: In slot level granularity at a chosen SCS with the following values supported:   + {1,2,4,5,8,10,16,20,32,40,60,64,80,100,128,160} slots   + Periodicity: Reuse the already supported PRS periodicities   + Type: {Type-1A, Type-1B, Type-2}   + PRS priority indication flag   **Proposal 7:** Support LMF suggesting to serving gNB a PRS processing window with the following signaling details:   * + PRS processing window starting time: SFN and slot offset   + Length: In slot level granularity at a chosen SCS with the following values supported:   + {1,2,4,5,8,10,16,20,32,40,60,64,80,100,128,160} slots   + Periodicity: Reuse the already supported PRS periodicities   + Type: {Type-1A, Type-1B, Type-2}   + For Type-1B and Type-2 type, set of Band IDs which may be affected by the PRS processing window   + PRS priority indication flag * Note: It is up to the serving gNB whether it will activate such a PRS processing window to the UE |
| Lenovo, Moto Mobility [19] | **Proposal 1:** Support the configuration of the PRS processing prioritization window via LPP with at least the start time and length of the window configuration parameters. |

**FL comments**

This area is quite diverged.

For PRS processing window request

* A few sources (Huawei/HiSilicon [1], ZTE [2], vivo [3], Qualcomm [18]) mentioned that it can be done by LMF, while one source (SONY [7]) mentioned that it can be done by UE.

For PRS processing window indication

* Some sources (ZTE [2], OPPO [5], Samsung [12], LenMM [19]) propose that it can indicated by LMF to the UE. However, to understanding of the FL, we already agreed that it should be indicated by the gNB.

For PRS processing window parameters, the following are mentioned by various sources

* Starting slot (vivo [3], OPPO [5], Qualcomm [18])
* Starting symbol (vivo [3])
* Periodicity (vivo [3], OPPO [5], Qualcomm [18])
* Duration/length (vivo [3], OPPO [5], Qualcomm [18])
* Processing type (vivo [3] , Qualcomm [18])
* Frequency information (vivo [3])
* Number of occurrence (OPPO [5])

On PRS processing window activation

* One source (Huawei/HiSilicon [1]) mentioned that it can be RRC preconfiguration and activated by a DL MAC CE
* One source (Qualcomm [18]) mentioned that it can be directed activated by a DL MAC CE.

### Round 1

Based on the summary from the contributions, the FL has the following question.

### Question 3.2.1-1

* Q1: Do companies support LMF-based PRS processing window request or UE-based PRS processing window request?
* Q2: What is your view on handling the discussion in RAN1?
  + (Note this may be similar to Question 2.3.1-1/2 on MG activation request by LMF)

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | We suggest using one signaling to request MG or PRS processing window. And okay with UE/LMF-based request. |
| Nokia/NSB | Q1: LMF based. If UE sends a request then it is unclear there is latency gains in MG-less.  Q2: Likely could be handled by RAN3 but some additional details may be discussed in RAN1 as PRS processing window is not known in RAN3 the way MG is. |
| Qualcomm | Q1: We have already agreed that it will be from the serving gNB. So, this really means that the flow LMF -> serving gNB -> UE has been agreed. I  We are supportive of having UE->serving gNB request, as we do for MG-based PRS processing.  Q2: We need to discuss it in RAN1 |

### Question 3.2.1-2

* Do companies think it necessary to support PRS processing window indicated by the LMF given that RAN1#106b already agreed gNB-based indication?

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | No  There are two alternative solutions as follows  Alt 1: LMF recommend PRS processing window to gNB  Alt 2: LMF provides PRS information (similar to Information carried in the RRC LocationMeasurementIndication ) to gNB to determine the PRS processing window |
| Nokia/NSB | No. |
| Qualcomm | No |

### Question 3.2.1-3

* What is your view on the following parameters to indicate the PRS processing window?
  1. Starting slot
  2. Starting symbol
  3. Periodicity
  4. Duration/length
  5. Processing type
  6. Frequency information
  7. Number of occurrence

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Vivo | First 6  In addition to First 6, we think reference serving cell indicator may be needed to indicate which serving cell the time parameters of PRS processing window refer to, which is similar to the mechanism for MG.  refServCellIndicator ENUMERATED {pCell, pSCell, mcg-FR2}  refServCellIndicator  Indicates the serving cell whose SFN and subframe are used for gap calculation for this gap pattern. Value pCell corresponds to the PCell, pSCell corresponds to the PSCell, and mcg-FR2 corresponds to a serving cell on FR2 frequency in MCG. |
| Nokia/NSB | We have a question for clarification: What information would be in processing type? In addition, the number of occurrences may not strictly be needed. |
| Qualcomm | This proposal may need a clarification. Is this the indication from LMF to the gNB, or from gNB to the UE?  To Nokia: The UE reports its MG-less capability & Type to the LMF. The LMF should send a request to the serving gNB, and that request should include what capability the UE has; so that the servig gNB can make scheduling decisions. If the Type-1 is per-UE then the processing window will affect all DL CCs (across LTE,NR), but if it is Type-2, then the window will affect a single band, etc.  If we are talking about the signaling from gNB -> UE, the “Processing type” is needed if the UE supports multiple Processing types. This way, the UE/gNB would agree on which symbols/bands are affected/prioritized/deprioritized.  It is a bit unclear what “frequency information” corresponds to. From our understanding:   * If it is Type-1A, then ALL DL CCs, in LTE/NR are affected, so frequency information is not really needed * For Type-1B/2, then we agree that frequency information isneeded, on which bands are affected.   So we suggest to change this bullet to:   * + Frequency information for Type-1B/2. For Type-1A, according to the WA, the PRS processing window applies to all all DL CCs in LTE/NR (“per UE”). |

### Question 3.2.1-4

* What is your view on the PRS processing window configuration/activation?
  + Alt.1: Configured in RRC-only
  + Alt.2: Activated by DL MAC CE directly without RRC (pre-)configuration
  + Alt.3: RRC (pre-)configuration and activated by DL MAC CE
  + Alt.4: Configured in LPP-only
  + Alt.5: Others (please indicate the solution in the table)

|  |  |  |
| --- | --- | --- |
| **Company** | **Alt** | **Comments** |
| Vivo | Alt.3 |  |
| Qualcomm | Alt. 2 | 2nd preference Alt. 3. |
|  |  |  |

## PRS measurement priority indication and determination

The following sources provided their views on priority indication and determination.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 8:** A single priority indicator for PRS is included in the DL MAC CE to activate the PRS processing window.   * Note: the priority applies to the PRS on frequencies that satisfies the condition of PRS measurement outside MG.   **Proposal 9:** For the specially handling of SSB, both CD-SSB and SSB in SMTC should be prioritized over PRS within the PRS processing window.  **Proposal 10:** Support binary indicator to select either from the following two priority states.   * PRS is higher priority than PDCCH, PDSCH, and CSI-RS. * PRS is lower priority than PDCCH, PDSCH, and CSI-RS.   **Proposal 11:** For UE supporting PRS prioritization processing capability 1 (1A/1B), if the PRS has lower priority than data, UE is not expected to receive PRS within an occasion of the PRS processing window, if the occasion overlaps with PDCCH monitoring, or PDSCH/CSI-RS reception on the same or different CC (capability 1A), or on the same CC (capability 1B).  **Proposal 12:** For UE supporting PRS prioritization processing capability 2, PRS is always assumed to be higher priority than data within the PRS processing window on the target CC. |
| vivo [3] | **Proposal 10:**   * The priority indication of PRS can be included in the configuration of PRS processing window since it used to indicate the PRS priority with other DL signal/channels within the PRS processing window   **Proposal 11:**   * For capability 1 UE, if PRS configured by high priority collides with other DL signals/channels, the other DL signals/channels are dropped within a PRS processing window. * For capability 1 UE, if PRS configured by low priority collides with other DL signals/channels, the PRS is dropped within a PRS processing window.   **Proposal 12:**   * For capability 2 UE, if PRS configured by low priority collides with low priority other DL signals/channels, the DL signals/channels are dropped in the collide symbols. * For capability 2 UE, if PRS configured by low priority collides with high priority other DL signals/channels, the PRS is dropped in the collide symbols. * For capability 2 UE, if PRS configured by high priority collides with low priority other DL signals/channels, the DL signals/channels are dropped in the collide symbols. * For capability 2 UE, if PRS configured by high priority collides with high priority other DL signals/channels, the PRS is dropped in the collide symbols. |
| CATT [4] | **Proposal 2:** Support the DL PRS has higher priority than other DL signal/channels (e.g. PDCCH, PDSCH, CSI-RS, PT-RS, and non cell-defined SSB, etc.) within the PRS processing window for PRS measurement outside MG indicated by gNB .  **Proposal 3:** All DL signals/channels (PDCCH, PDSCH, CSI-RS, PT-RS, and non cell-defined SSB) except for cell-defined SSB can have lower priority than DL-PRS, and cell-defined SSB has the highest priority. |
| OPPO [5] | **Proposal 6:** For processing PRS outside MG:   * The gNB can indicate the priority of PRS vs the PDSCH/PUSCH/PUCCH and UCI associated with high priority index. * The gNB can indicate the priority of PRS vs the PDCCH in Type-3 CSS set in SpCell and USS. * The gNB can indicate the priority of PRS vs serving cell SSB. * The gNB can indicate that PRS resource has higher priority than PDCCH/PDSCH/PUSCH/PUCCH not associated with high priority, CSI-RS and SRS. |
| Nokia, NSB [6] | **Proposal 6**: The gNB can indicate the PRS is either lowest priority or high priority. Namely the priority order in decreasing order is SSB, other system information, high priority PRS, all other DL signals/channels, low priority PRS. |
| Xiaomi [10] | **Proposal 1:** With regards to the priority states to be indicated between PRS (serving and/or non-serving cell) and other DL signals/channels from serving cell, at least support the case with two priority states   * PRS is higher priority than any other DL signals/channels excluding SSB * PRS is lower priority than any other DL signals/channels   **Proposal 2:** Prefer no special handling for priority related to PDSCH/PDCCH carrying URLLC data/control.  **Proposal 3:** Discuss whether to support MAC CE or DCI for priority state indication to consider PDSCH/PDCCH carrying URLLC data/control. |
| CMCC [11] | **Proposal 2:** Support special handling for priority related to PDSCH/PDCCH carrying URLLC data/control and high priority LPP signalling.  **Proposal 3:** Support introducing physical layer priority to identify high priority DL signals/channels. |
| Samsung [12] | **Proposal 5:** Priority between PRS and SSB is indicated by gNB and PRS has higher priority than other non-SSB DL signals  **Proposal 6:** Indication of priority between PRS and SSB includes   * PRS has higher priority than SSB; * PRS has lower priority than SSB; * PRS has equal priority as SSB. |
| IDC [13] | **Proposal 5:** The prioritization window is configured only when the priority level of PRS from the serving cell is high  **Proposal 6:** When the priority level of PRS is high, the UE should not expect to receive other channels/signals, except SSB, during the prioritization window for Capability 1 and over PRS symbols for Capability 2. |
| Apple [14] | **Proposal 1**: If PRS is indicated to be high priority,   * UE is not expected to receive other configured DL signals and channels, except SSB * UE does not expect to be dynamically scheduled a DL signal/channel within the PRS processing window |
| LGE [15] | **Proposal 2:**   * Regarding priority in the processing time window, except for SSB, RAN1 should support that gNB can informs/indicates priority rules between PRS and other DL signals/channels (CSI-RS, PDCCH, PDSCH). |
| DCM [17] | **Proposal 2:**   * Rel-17 should support the following two priority states for DL-PRS measurement without MG   + PRS is higher priority than any other DL signals/channels excluding SSB   + PRS is lower priority than any other DL signals/channels including SSB |
| Qualcomm [18] | **Proposal 7:** Support LMF suggesting to serving gNB a PRS processing window with the following signaling details:   * + PRS processing window starting time: SFN and slot offset   + Length: In slot level granularity at a chosen SCS with the following values supported:   + {1,2,4,5,8,10,16,20,32,40,60,64,80,100,128,160} slots   + Periodicity: Reuse the already supported PRS periodicities   + Type: {Type-1A, Type-1B, Type-2}   + For Type-1B and Type-2 type, set of Band IDs which may be affected by the PRS processing window   + PRS priority indication flag * Note: It is up to the serving gNB whether it will activate such a PRS processing window to the UE   **Proposal 8:** Support the following priority options in the processing window:   * PRS is higher priority than any other DL signal/channel * PRS is higher priority than any other DL signal/channel except URLLC channels.   1. In this contenxt, URLLC channel corresponds a dynamically scheduled PDSCH whose PUCCH resource for carrying ACK/NAK is marked as high-priority. * PRS is lower priority than all other DL signals/channels   **Proposal 14:** For a PRS processing window starting in symbol of carrier and a conflicting transmission in carrier starting in symbol, the UE shall apply the prioritization / dropping between the PRS and the conflict transmission taking into account:   * DCI(s) for which the time interval between the last symbol of PDCCH and is at leastsymbols, and the time interval between the last symbol of PDCCH and is at least symbols,   wherein the time interval unit of OFDM symbol is counted based on the smaller subcarrier spacing across and their corresponding scheduling cells  **Proposal 15:** For a PRS processing window starting in symbol of carrier and a conflicting transmission in carrier starting in symbol, the UE shall apply the prioritization / dropping between the PRS and the conflict transmission taking into account:   * DL channels & signals considered active at least before and at least symbols before ,   wherein the time interval unit of OFDM symbol is counted based on the smaller subcarrier spacing across and their corresponding scheduling cells. |
| Lenovo, Moto Mobility [19] | **Proposal 2:** Consider both high and low priority PRS processing behaviors with respect to other DL signals/channels. |
| Ericsson [20] | **Proposal 4** For the UE to determine whether DL PRS shall be prioritized or not, the priority of at least the following channels/signals relative to DL PRS can be indicated by the gNB to the UE:  (i) Dynamic scheduled traffic/reference signals (e.g., PDCCH, dynamically scheduled PDSCH, aperiodic CSI-RS including aperiodic TRS)  (ii) Periodic/semi persistent signals and channels (e.g., SPS PDSCH, semi-persistent CSI-RS, periodic CSI-RS including periodic TRS) |

**FL comments**

This area is quite diverged.

On special handling of SSB

* Huawei/HiSilicon [1] considered CD-SSB and SSB in SMTC always has higher priority than PRS
* CATT [4] considered CD-SSB always has higher priority than PRS, while non-CD SSB can have higher or lower priority than PRS subject to priority indication.
* OPPO [5] considered no specially handling of SSB, but proposed to have a dedicated priority indication for SSB.
* Nokia [6] considered SSB/OSI always has higher priority than PRS.
* Xiaomi [10], Apple [14], LGE [15], and DCM [17] considered SSB always has higher priority than PRS.
* Samsung [12] prefers to only design priority indication between PRS and SSB, and they also proposed to have “equal priority” between PRS and SSB.

On the priority states between PRS and another DL signals/channels

* Huawei/HiSilicon [1], vivo [3] (capability 1), [CATT [4]], Nokia [6], Xiaomi[10], LGE [15], and DCM [16] proposed to have 2 states
  + State 1: PRS > data
  + State 2: data > PRS
* CMCC [11], and Qualcomm [18] proposed to have 3 states
  + State 1: PRS > (URLLC, others)
  + State 2: URLLC > PRS > others
  + State 3: (URLLC, others) > PRS
  + The URLLC channel corresponds a dynamically scheduled PDSCH whose PUCCH resource for carrying ACK/NAK is marked as high-priority. (Qualcomm [18])
* vivo [3] explained the handling of dropping between PRS being high/low priority with data being high/low priority for capability 2, but to the understanding of the FL, there is no difference between high priority PRS and low priority PRS.

|  |  |  |
| --- | --- | --- |
|  | L PRS | H PRS |
| L data | Drop data | Drop data |
| H data | Drop PRS | Drop PRS |

* OPPO [5] proposed to have separate priority indication for PRS vs. high priority data, PRS vs. type-3 CSS and USS, PRS vs. other signaling/channel not associated with high priority, respectively. OPPO also included UL signals/channels in the discussion.
* Ericsson [20] proposed to have separate priority indication for PRS vs. dynamical scheduled traffic/signals, and PRS vs. periodic/semi-persistent signals/channels.

On the priority indication signaling

* Huawei/HiSilicon [1] proposed to use DL MAC CE
* vivo [3] proposed to be included the PRS processing window configuration
* Xiaomi [10] proposed to discuss the MAC CE or DCI based priority state indication.
* Qualcomm [18] proposed to use DL MAC CE

In addition,

* Huawei/HiSilicon [1] proposed to drop the entire PRS processing window for capability 1 if the window collides with DL signals/channels and do not define low priority for capability 2.
* IDC [13] proposed that PRS processing window should not be provided if the PRS is low priority.
* Qualcomm [18] proposed the timeline to determine the collision between PRS and other signals/channels.

### Round 1

Based on the summary from the contributions, the FL has the following proposal and questions.

### Proposal 3.3.1-1

* At least CD-SSB of the serving cell is always higher priority than PRS
  + Send an LS to RAN4 to consult on other SSBs, including non-CD SSBs, and SSB detected in SMTC.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Vivo |  | In general, the priority should be dependent on the PRS processing window periodicity and length, and /or measurement request.  Even in MG, the CSSF is also dependent on PRS periodicity(e.g PRS periodicity>160ms, CSSF is 1), so we prefer to add a priority indication for SSB too since gNB knows the PRS process window and SSB configuration |
| Nokia/NSB |  | Okay with the main bullet. We think RAN1 can define a more detailed/complete priority and then send an LS to RAN4. E.g., SSB>high priority PRS>other DL signals/channels>low priority PRS. |
| Qualcomm |  | Up to RAN4 to decide. |

### Proposal 3.3.1-2

* Select between the following alternatives on priority states to be indicated to the UE
  + Alt.1 Two priority states are defined
    - State 1: PRS is higher priority than PDCCH/PDSCH/CSI-RS
    - State 2: PRS is lower priority than PDCCH/PDSCH/CSI-RS
  + Alt. 2 Three priority states are defined
    - State 1: PRS is higher priority than PDCCH/PDSCH/CSI-RS
    - State 2: PRS is lower priority than URLLC PDSCH and higher priority than PDCCH/PDSCH/CSI-RS
      * Note: The URLLC channel corresponds a dynamically scheduled PDSCH whose PUCCH resource for carrying ACK/NAK is marked as high-priority.
    - State 3: PRS is lower priority than PDCCH/PDSCH/CSI-RS
  + Note: SSB is a separate issue.

|  |  |  |
| --- | --- | --- |
| **Company** | **Alt** | **Comments** |
| vivo |  | Whether state 3 is needed？ Is it any different from state 2 “PRS is lower priority than URLLC PDSCH and higher priority than PDCCH/PDSCH/CSI-RS”  Why does PDCCH/PDSCH/CSI-RS in state 2 has priority indication, while state 1 and state 3 haven't |
| Nokia/NSB |  | Okay with Alt 2 in principle. |
| Qualcomm | Alt. 2 |  |

### Question 3.3.1-3

* Do companies think it is necessary to have separate priority indication for different PDCCH/PDSCH as the following exemplary options?
  + Option 1
    - One priority indicator for PRS vs. PDSCH associated with high priority index
    - One priority indicator for PRS vs. PDCCH in type-3 CSS of SpCell and USS
    - One priority indicator for PRS vs. other DL signaling/channel not associated with high priority
  + Option 2
    - One priority indicator for PRS vs. dynamical scheduled traffic/signals
    - One priority indicator for PRS vs. periodic/semi-persistent signals/channels

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| vivo | No |  |
| Nokia/NSB |  | Not needed in our view. |
| Qualcomm | No |  |

### Question 3.3.1-4

* Do companies think it is necessary to discuss the priority between PRS and UL signals/channels?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia/NSB |  | If UE is schedule for UL signals/channels it should likely be higher priority as it would be neighbor cell PRS which will be interfered with by UL signals |
|  |  |  |
|  |  |  |

### Question 3.3.1-5

* What is your preference on the following alternatives on the message to carry the priority indication to the UE?
  + Alt.1 The priority is indicated in RRC
  + Alt.2 The priority is indicated in DL MAC CE
  + Alt.3 The priority is indicated in DCI.

|  |  |  |
| --- | --- | --- |
| **Company** | **Alt** | **Comments** |
| Vivo | Alt 2 |  |
| Qualcomm | Alt. 2 | Use the MAC-CE that activates a specific PRS processing window. |
|  |  |  |

### Question 3.3.1-6

* What is your view on the collision detection timeline as proposed by [18]?

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Support |
|  |  |
|  |  |

## Working assumption

The following sources provided their view on the working assumption for MG-less PRS measurements.

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| **Company** | **Proposals** |
| Nokia, NSB [6] | **Proposal 3**: Confirm the prior working assumption on MG-less PRS reception. |
| SONY [7] | **Proposal 3:** Confirm the working assumption: Subject to UE capability on support PRS measurement outside the MG within a PRS processing window, and UE measurement inside the active DL BWP with PRS having the same numerology as the active DL BWP. |
| Qualcomm [18] | **Proposal 3:** For Type-1B, and Type-2 MG-less PRS processing, a UE should be able to signal whether the MG-less PRS processing in one band, impacts the downlink receiving in another band. This can be a per band in a per band-pair combination reporting.  **Proposal 13:** A UE should be able to report multiple of the Type-1A, Type-1B, Type-2 MG-less PRS processing capabilities, each one associated with a different PRS processing capability, to the LMF. |
| Ericsson [20] | **Proposal 1** Confirm the working assumption made in RAN1#106-e to support DL measurements based on DL PRS without the UE having to request measurement gaps. |

**FL comments**

Three sources proposed to confirm the working assumption, and one source proposed to finalize capability 1B by settling the band/CC.

### Round 1

Based on the summary from the contributions, the FL has the following proposal and questions.

### Proposal 3.4.1-1

* Select between band and CC for capability 1B as per working assumption made in RAN1#106-e.
  + Alt.1 band
  + Alt.2 CC

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| Working assumption:  Subject to UE capability, support PRS measurement outside the MG, within a PRS processing window, and UE measurement inside the active DL BWP with PRS having the same numerology as the active DL BWP.   * Inside the PRS processing window, subject to the UE determining that DL PRS to be higher priority, support the following UE capabilities:   + Capability 1: PRS prioritization over all other DL signals/channels in all symbols inside the window.     - Cap. 1A: The DL signals/channels from all DL CCs (per UE) are affected.     - Cap. 1B: Only the DL signals/channels from a certain band/CC are affected.       * FFS: band or CC   + Capability 2: PRS prioritization over other DL signals/channels only in the PRS symbols inside the window   + A UE shall be able to declare a PRS processing capability outside MG.     - FFS: Details of capability signalling (e.g., per UE or per band, etc.) |

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| **Company** | **Alt** | **Comments** |
| vivo | Alt 1 |  |
| Qualcomm | Alt. 1 |  |
|  |  |  |

### Question 3.4.1-2

* Do companies support the extension on the impacted band/CC beyond the (single) certain band/CC for capability 1B and 2?
  + E.g. as proposed by [18], for Type-1B, and Type-2 MG-less PRS processing, a UE should be able to signal whether the MG-less PRS processing in one band, impacts the downlink receiving in another band.

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| **Company** | **Yes/No** | **Comments** |
| Qualcomm | Yes | The WA says “certain”, it doesn’t say which one. As we pointed out in our paper, PRS in one band could be affected by Positioning in another band. Especially in FR2. |
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## Conditions for MG-less measurement not satisfied

The following source provided their view on conditions for MG-less measurement not being satisfied.

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| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 13:** Support UE to request MG configuration or MG activation by the existing means if the MG-less PRS measurement condition is not satisfied.   * Note: It is already Rel-16 behaviour that UE may request MG configuration if the current MG is not sufficient for PRS measurement. |
| ZTE [2] | **Proposal 6:** UE performs PRS measurement following the measurement period defined in Rel-16 when the conditions for PRS processing window are not met. |
| vivo [3] | **Proposal 8:**   * When MG is not configured, subject to UE capability, whether to request MG or perform PRS outside MG is decided by UE itself   + if the overlapping bandwidth of active BWP and PRS can satisfy the performance requirement, UE measurement can be inside the active BWP. Otherwise, the UE can request MG(s) or BWP switching. |
| Nokia, NSB [6] | **Proposal 4**: Specify a fallback method for the UE to switch from MG-less to MG-based if the UE drops enough PRS.  **Proposal 5**: A UE should be able to measure the PRS both outside and inside of a MG where applicable. Note: Any changes to RAN4 requirements can be discussed directly by RAN4. |
| SONY [7] | **Proposal 4:** Define UE behaviour when positioning measurement (outside measurement gap) cannot be satisfied due to interruption event.  **Proposal 5:** Support a UE to provide positioning measurement report based on the partial reception of PRS resource(s) in case there is an interruption (e.g. BWP switching) during positioning measurement time window. |
| Lenovo, Moto Mobility [19] | **Proposal 3:** Support partial reporting for PRS within a prioritization window and measurement dropping for PRS deemed outside the prioritization window. |

**FL comments**

There is limited input on this issue. To the understanding of the FL, this issue may not be so essential for this meeting, and it can even be better discussed by RAN2 and RAN4.

### Round 1

Based on the summary from the contributions, the FL has the following question.

### Question 3.5.1-1

* Do companies think RAN1 should discuss the issues on conditions of MG-less measurement not satisfied?

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| **Company** | **Yes/No** | **Comments** |
| vivo | Yes |  |
| Nokia/NSB | Yes | In our view, if the conditions are not satisfied, the UE needs to switch over to MG-based mode. Otherwise latency may suffer due to dropped PRS. |
| Qualcomm | No |  |

## Others

The FL added comments to the following proposals, considering that they may not be so essential and proposed only by a single source.

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| Qualcomm [18] | **Proposal 9:** Leave it up to UE implementation whether to do simultaneous processing of PRS within an MG and outside an MG. Any measurement period requirements can be defined assuming one type of PRS processing or the other.  **Proposal 11:** Inside each single instance of a PRS processing window, a single PFL can be measured. This is applicable to all Types of MG-less PRS processing.  **Proposal 12:** Simultaneously processing of multiple PRS processing windows on different CCs/Bands is not supported for the MG-less PRS processing feature.  FL: My understanding is that proposal 11 and proposal 12 are already implied in the UE capability (N, T) signaling for the MG-less PRS measurement. |

# Other open issues

## PRS processing capability enhancements

The following sources provided their views on PRS processing capability enhancements.

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| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 14:** MG or PRS processing window should not be extended to cover the processing period, and no additional enhancement with respect to Rel-16 measurement period optimization is considered in RAN1. |
| ZTE [2] | **Proposal 8**: For the PRS processing capability in a PRS processing window, at least consider one of the following types,   * Type 1 PRS processing capability: UE has to report its capability with at least of the combination {R, P}, * A PRS processing window (with duration L) is divided into a PRS buffering window (with duration L-(T-N)) and a PRS computation window (with duration T-N). The PRS computation window starts right after the end of the PRS buffering window. * UE shall take (T-N) ms of time to process up to N ms of symbols containing PRS resources received by UE in the PRS buffering window * UE is not expected to be configured a PRS processing window with duration smaller than T-N. * Type 2 PRS processing capability: UE has to report its capability of PRS computation time (Tcompute) * A time span (Tspan) is calculated from an end of the latest DL PRS resource in the PRS processing window that is used for a location information report to the end of the PRS processing window * The value of Tspan is not expected to be smaller than the PRS computation time (Tcompute). |
| vivo [3] | **Proposal 15:**   * The processing optimization of the PRS processing window is not supported (e.g. no corresponding enhancement for splitting MG into two windows) |
| CATT [4] | **Proposal 5:** For UE PRS processing capabilities on latency reduction, Alt.3 can be supported.   * + Alt. 3 UE has to report its capability of PRS computation time (Tcompute)     - A time span (Tspan) is calculated from an end of the latest DL PRS resource in the PRS processing window that is used for a location information report to the end of the PRS processing window     - The value of Tspan is not expected to be smaller than the PRS computation time (Tcompute) . |
| Intel [9] | **Proposal 3:**   * For UE DL PRS processing capability support alternative 1 discussed at the previous meeting:   + During the first part of the window with duration of ~~at least~~ L-(T-N) msec, up to N msec of PRS symbols are expected to be buffered, where L is the duration of the PRS processing window   + The UE is expected to be capable of reporting measurements derived on the PRS measured in the first window after T-N msec from the end of first part of the PRS processing window   + UE is not expected to be configured a PRS processing window with duration smaller than T (i.e., L>T) |
| MTK [16] | **Proposal 3-1**: The processing window T ms contains the N ms mainly for the DL-PRS buffering. The remaining (T-N) ms are mainly used for computation in order to produce measurement report  **Proposal 3-2**: After T ms, UE is able to report the measurement based on a single instance within N ms  **Proposal 3-3**: UE doesn't need to additional report the DL-PRS computation time |
| Qualcomm [18] | **Proposal 10:** With regards to the processing window for MG-less Processing support the following (Alt. 1 in the previous discussion):   * During the first part of the window with duration of at least L-T msec, up to N msec of PRS symbols are expected to be buffered, where L is the duration of the PRS processing window, and (N,T) is the reported capability for MG-less PRS processing. * The UE is expected to be capable of reporting measurements derived on the PRS measured in the first window after T msec from the end of first part of the PRS processing window |

**FL comments**

It appears that there are three alternatives to be considered for this topic.

* Alt.1: Supported by [ZTE], Qualcomm, Intel
  + During the first part of the window with duration of [at least] L-(T-N) or (L-T) msec, up to N msec of PRS symbols are expected to be buffered, where L is the duration of the PRS processing window, and (N,T) is the reported capability for MG-less PRS processing.
  + The UE is expected to be capable of reporting measurements derived on the PRS measured in the first window after T msec from the end of first part of the PRS processing window
  + UE is not expected to be configured a PRS processing window with duration smaller than T (i.e., L>(T-N) or L>T
* Alt.2: Supported by ZTE, CATT
  + UE has to report its capability of PRS computation time (Tcompute)
  + A time span (Tspan) is calculated from an end of the latest DL PRS resource in the PRS processing window that is used for a location information report to the end of the PRS processing window
  + The value of Tspan is not expected to be smaller than the PRS computation time (Tcompute).
* Alt.3: Supported by Huawei/HiSilicon, vivo, MKT
  + No enhancement to PRS processing capability is defined

### Round 1

Based on the summary from the contributions, the FL has the following question.

### Question 4.1.1-1

* Which alternative do companies prefer with regards to PRS processing capability enhancement?
  + Alt.1
    - During the first part of the window with duration of [at least] L-(T-N) or (L-T) msec, up to N msec of PRS symbols are expected to be buffered, where L is the duration of the PRS processing window, and (N,T) is the reported capability for MG-less PRS processing.
    - The UE is expected to be capable of reporting measurements derived on the PRS measured in the first window after T msec from the end of first part of the PRS processing window
    - UE is not expected to be configured a PRS processing window with duration smaller than T (i.e., L>(T-N) or L>T
  + Alt.2
    - UE has to report its capability of PRS computation time (Tcompute)
    - A time span (Tspan) is calculated from an end of the latest DL PRS resource in the PRS processing window that is used for a location information report to the end of the PRS processing window
    - The value of Tspan is not expected to be smaller than the PRS computation time (Tcompute).
  + Alt.3
    - No enhancement is defined

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| --- | --- | --- |
| **Company** | **Alt** | **Comments** |
| vivo | Alt 3 |  |
| Qualcomm | Alt. 1 | To HW/vivo: If we go with Alt.3, the PRS resources can be in the end of the window. How would the UE be ready to report just after the window? Do you make the assumption that the UE would have more time after the window? How much time? |
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## Positioning SRS priority

The following sources provided their views on the priority of positioning SRS.

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| --- | --- |
| **Company** | **Proposals** |
| Nokia, NSB [6] | **Proposal 8**: RAN1 should study and work on new priority rules of transmitting SRS for positioning with other UL signals/channels, in order to reduce positioning latency for UL and DL+UL positioning methods. |
| Intel [9] | **Proposal 4:**  No priority indication for SRS for positioning is introduced in Rel.17 |
| Xiaomi [10] | **Proposal 5:** No priority indication for SRS is introduced in Rel-17. |
| CMCC [11] | **Proposal 4:** Support the following collision rule:   * If a PUSCH transmission with low priority overlaps in time with the periodic/semi-persistent SRS for positioning, the UE does not transmit the periodic/semi-persistent SRS for positioning in the overlapping symbols. * If a PUSCH transmission with low priority overlaps in time with the aperiodic SRS for positioning with low priority, the UE does not transmit the aperiodic SRS for positioning in the overlapping symbols. * If a PUSCH transmission with low priority overlaps in time with the aperiodic SRS for positioning with high priority, the UE does not transmit the PUSCH in the overlapping symbols.   **Proposal 5:** Up to UE capability, support priority indication of positioning SRS with:   * + Alt.1 Explicit indication by gNB;   The type of indication is indicated by RRC, and for semi-persistent and aperiodic SRS, the activation MAC-CE and the triggering DCI should be able to overwrite the priority indicated by RRC. |
| Qualcomm [18] | **Proposal 16:** Subject to UE capability, support the UE receiving explicitly signaling for SRS for positioning being higher priority than the SRS for MIMO of the same time-domain behavior. |

**FL comments**

This issue has been discussed for a couple meetings, and cannot be concluded. There was also explicit proposal not to introduce this feature.

### Round 1

Based on the summary from the contributions, the FL has the following proposal.

### Proposal 4.2.1-1 (for conclusion)

* No priority indication for SRS for positioning is introduced in Rel.17.

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| **Company** | **Yes/No** | **Comments** |
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## Measurement report scheduling enhancements

The following sources provided their views on the measurement report scheduling enhancements.

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| --- | --- |
| **Company** | **Proposals** |
| ZTE [2] | **Proposal 7**: In order to balance the positioning latency and accuracy, LMF can configure two response times in the location information request,   * UE is required to provide a first location information report before the first response time based on the measurements conducted in the PRS processing window. * UE is required to provide a second location information report before the second response time, where the second location information doesn’t necessarily require UE to provide measurements conducted in the PRS processing window.   **Proposal 9:** In order to reduce UE measurement time of a location information report, LMF should be allowed to select a subset of DL PRS from DL PRS configured in ProvideAssistanceData message for UE to measure and report the location information, where the subset of DL PRS can be indicated in RequestLocationInformation message.  **Proposal 10:** In order to get quick response of an early location information report, LMF should be able to configure an early location information report associated with DL PRS used to derive the early location information report.  **Proposal 11:** For the purpose of reporting new location measurements in time, Rel-17 should allow UE to report multiple early location information reports prior to a response time. |
| Nokia, NSB [6] | **Proposal 1:** UE could request the expected measurement report resource from the serving gNB via RRC signaling to minimize the positioning measurement report delay. |
| SONY [7] | **Proposal 7:** Support CG-PUSCH for positioning measurement reporting. |
| Samsung [12] | **Proposal 1:** Configured grant PUSCH type 1 and type 2 are used for positioning measurement report in order to reduce the latency.  **Proposal 2:** The DG PUSCH with high priority is considered for positioning measurement report in order to reduce the latency. |
| Apple [14] | **Proposal 5**: NW configures (as part of MG configuration or PRS processing window configuration) PUSCH resource for UE to report positioning measurements and/or location information   * The grant is specifically configured for positioning measurement report, e.g. Nx symbols after the end of last symbol of last DL-PRS resource, or after the end of MG on duration/PRS processing window * Nx is determined based on UE capability |
| Lenovo, Moto Mobility [19] | **Proposal 5:** Support assistance information between gNB and LMF for enabling lower latency UL CG-based measurement reports. RAN3 to be consulted for impacts. |

**FL comments**

For indication of PUSCH resource to carry the LPP measurement report, it has been discussed for a couple of meeting, and the suggestion from the opposing companies was to discuss it in RAN2 or RAN3 directly.

For CG-PUSCH and DG-PUSCH, it is not clear what the proposal itself entails, given that both CG-PUSCH and DG-PUSCH can be used to carry the LPP measurement report.

### Round 1

Based on the summary from the contributions, the FL has the following proposal.

### Proposal 4.3.1-1 (for conclusion)

* No enhancements on measurement report scheduling is introduced by RAN1 in Rel-17.

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| **Company** | **Yes/No** | **Comments** |
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## Rx beam sweeping factor

The following agreements were made in RAN1#106bis-e on this issue.

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| --- |
| Agreement:  Introduce a new UE capability on lower Rx beam sweeping factor (<8) to reduce the PRS measurement latency for FR2 positioning frequency layers.   * Send an LS to RAN4 to confirm.   MCC post meeting: Due to late decision, there was no time to the LS content to RAN4; postponed to next meeting. |

The following sources provided their views on Rx beam sweeping factor.

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| --- | --- |
| **Company** | **Proposals** |
| ZTE [2] | **Proposal 3**: Subject to UE capability, support LMF to explicitly request UE to report the measurement based on Rx beam sweeping factor equals to 8 or less than 8(e.g. 4) for FR2 positioning frequency layers. |
| Moderator (Huawei) [21] | Draft LS to RAN4 per agreement in RAN1#106bis-e. |

### Round 1

Based on the summary from the contributions, the FL has the following questions.

### Question 4.4.1-1

* Q1: Do you think the draft LS submitted in [21] as per the agreement made in RAN1#106bis-e on reduced number of Rx beam can be approved individually?
* Q2: Do you think it necessary for the LMF to explicitly indicate the Rx beam sweeping factor to the UE?

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| **Company** | **Comments** |
| vivo | Q1: Yes, whether the requirement can be satisfied with the reduced number of Rx beams should be discussed in RAN4  Q2: Waiting for RAN4 reply |
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# Others

The following proposals are considered not essential to the completion of the latency improvement work by RAN1.

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| --- | --- |
| **Company** | **Proposals** |
| vivo [3] | **Proposal 17:**   * Support on-demand PRS configured/requested in a PRS processing window.   **Proposal 18:**   * The request of the measurement via MAC-CE and NRPPa procedure should be supported. |
| CATT [4] | **Proposal 6:** AP-PRS and SP-PRS receptions triggered by serving gNB should be supported at least for single gNB positioning, in which a UE is informed to measure the DL PRS of the TRPs of the same gNB.  **Proposal 7:** Support reception of AP-PRS or SP-PRS triggered by DCI or MAC CE for multiple gNB positioning.  **Proposal 8:** Support reception of AP-PRS or SP-PRS triggered/configured by LMF through LPP message. |
| OPPO [5] | Proposal 1: The LMF shall request the same M-sample or 4-sample measurement for all the positioning methods to one UE. The UE shall expect the same M-sample or 4-sample measurement to be performed on all positioning methods configured to the UE. |
| Samsung [12] | **Proposal 3:**   * The LMF indicates whether the UE can use less than 4 samples. * The UE determines the number of samples to be used and indicates it to the LMF * Note: this applies for both UE-based positioning and UE-assisted positioning |
| Apple [14] | **Proposal 3**: NW provides assistance data to UE, based on which UE is configured with one or more MG configurations and A-PRS resources associated with each MG.   * Once MG is activated, the A-PRS associated with MG is consequently activated as well |
| Lenovo, Moto Mobility [19] | **Proposal 7:** Introduce a separate UE capability set of values PRS processing outside an MG. |

## Round 1

### Proposal 5-1

The suggestion from the FL is not to discuss those proposals.

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| **Company** | **Comments on the necessity of any specific proposal** |
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# Conclusion

## Proposals for Friday GTW of 1st week

## Proposals for Tuesday GTW of 2nd week