**3GPP TSG-RAN WG1 Meeting #108-e R1-2202513**

**e-Meeting, February 21st – March 3rd, 2022**

**Agenda Item: 8.5.4**

**Source: Moderator (Huawei)**

**Title: Summary #1 of [108-e-R17-ePos-04] latency improvements**

**Document for: Discussion and decision**

# Introduction

In RAN1#108-e, the following papers provided input on latency improvements for DL and DL+UL methods.

1. R1-2200923 Maintenance of PRS measurement outside MG Huawei, HiSilicon
2. R1-2201096 Maintenance on latency enhancement for NR positioning vivo
3. R1-2201196 Remaining issues on latency reduction for NR positioning ZTE
4. R1-2201242 Enhancements on Latency Reduction in NR Positioning OPPO
5. R1-2201364 Remaining issues on latency reduction for NR positioning CATT
6. R1-2201480 Remaining issues on latency improvements for both DL and DL+UL positioning methods NTT DOCOMO, INC.
7. R1-2201583 Remaining Issues on Latency Improvements for Positioning Methods Sony
8. R1-2201637 Maintenance of PHY Latency Reductions Nokia, Nokia Shanghai Bell
9. R1-2201774 Remaining issues on Rel-17 positioning latency reduction Apple
10. R1-2201827 Latency improvements for both DL and DL+UL positioning methods InterDigital, Inc.
11. R1-2201859 Remaining issues on latency enhancements CMCC
12. R1-2201947 Remaining issues on latency improvements for both DL and DL+UL positioning method Xiaomi
13. R1-2202017 Discussion on latency improvements for both DL and DL+UL positioning methods Samsung
14. R1-2202143 Maintenance on Latency Improvements for Positioning Qualcomm Incorporated
15. R1-2202294 Discussion on latency improvements for NR positioning LG Electronics
16. R1-2202392 Latency improvements for both DL and DL+UL positioning methods Ericsson

The following t-docs are submitted under agenda 5, which is related to latency improvements.

1. R1-2201209 Draft reply LS on lower Rx beam sweeping factor for latency improvement ZTE
2. R1-2202456 Discussion on low latency PRS measurement with MG Huawei, HiSilicon

RAN1 received the following LS prior to RAN1#108-e.

1. R1-2200889 Reply LS on latency improvement for PRS measurement with MG RAN2, Nokia
2. R1-2200899 Reply LS on lower Rx beam sweeping factor for latency improvement RAN4, CATT

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#107-e on this issue.

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| --- |
| **Agreement**  Preconfiguration of MG(s) in RRC is supported from RAN1 perspective.   * Each MG in the preconfiguration is associated with an ID * The information in the UL MAC CE for MG activation request by the UE can be one ID associated with the preconfiguration of the MG * Send an LS to RAN2 and RAN3   **Conclusion**  Include in the LS the following content:   * RAN1 understands it is up to RAN2 and/or RAN3 to decide how gNB determines the preconfiguration of MG(s).   **Conclusion**  For the MG activation request to the gNB by the LMF, it is up to RAN3 to design the necessary information to be transferred in the NRPPa message.   * Include it in the LS to RAN2 and RAN3.   [R1-2112783](file:///D:\works\1.3GPP%20works\RAN1-107\tdoc\R1-2112783.zip) Draft LS on PRS measurement with preconfiguration of MG(s) Moderator (Huawei)  Final LS endorsed in [R1-2112784](file:///D:\works\1.3GPP%20works\RAN1-107\tdoc\R1-2112784.zip)  **Agreement**  The DL MAC CE for MG activation indicates the ID associated with the preconfigured MG. |

## MG deactivation request and command

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| --- | --- |
| **Company** | **Proposals** |
| vivo [2] | **Proposal 1:**   * Confirm RAN2 agreement, MAC CE can be used to deactivate MG.   + UL MAC CE for positioning measurement gap deactivation request is supported   + DL MAC CE for positioning measurement gap deactivation is supported * NRPPa for positioning measurement gap deactivation request is supported. |
| OPPO [4] | Proposal 2: For MG deactivation, support the following two options:   * Option 1: gNB use a DL MAC CE to deactivate one MG and the UE can use a UL MAC CE to request MG deactivation * Option 2: Each activated MG is associated with a repetition number and when the indicated repetition number is reached, the activated MG stops |
| Apple [9] | **Proposal 1**: 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. |

**FL comments**

According to RAN2 LS R1-2200889/R2-2202052, RAN2 already agreed to introduce the MG deactivation request and command based on UL and DL MAC CE, respectively, it is not clear whether companies are willing to discuss other deactivation mechanism based on a life cycle (timer) or repetition number (counter).

### Round 1

**Proposal 2.1.1-1**

* RAN1 confirm the support of MAC CE based deactivation request and command as agreed by RAN2.
* RAN1 to discuss the following options for deactivation process
  + Option 1: repetition number based deactivation
  + Option 2: life cycle based deactivation
  + Option 3: no additional mechanism for MG deactivation is introduced

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| --- | --- | --- |
| **Company** | **Option** | **Comments** |
| ZTE |  | We don’t think the further discussion is needed in RAN1. RAN2 has introduced deactivation in MACCE, it is sufficient enough. The benefit of further optimization is unclear. |
| vivo | Option 3 |  |
| InterDigital | Agree with the first bullet | We support the first bullet since the agreements from RAN2 are clear. Our understanding is that Option 2 is about timer-based deactivation of the activated measurement gap? Can the proponents clarify? |
| Nokia/NSB | Option 3 | No need for RAN1 to confirm the first bullet. |
| CATT |  | No need of further discussion in RAN1 |
| Qualcomm | Option 3 | No need for RAN1 to confirm the first bullet. |
| CMCC | Option 3 | In our views, the MG deactivation procedure should be designed by RAN2, and at this maintenance stage, we prefer to confirm the MAC-CE deactivation request and command agreed by RAN2 without further enhancements. |
| Huawei, HiSilicon | Option 3 |  |
| Xiaomi | Option 3 | No need to discuss other mechanism for MG deactivation |
| Intel |  | We agree with ZTE and do not think that further discussion is needed in RAN1. |
| LGE | Option 1 and 2 | Even thouh RAN2 has agreed on MAC-CE for deactivation, the details are not agreed. In our understanding, if the MAC-CE for activation also includes either option #1 and option #2, additional signaling of MAC-CE for deactivation is not needed. In terms of resource utilization, it obviously would be helpful. Since RAN1 has the responsibility of positioning, we think RAN1 can dicuss it more details. Considering the fact, we prefer to add some sentence after both options as follows:   * RAN1 to discuss the following options for deactivation process   + Option 1: repetition number based deactivation (the repetition number can be provided in MAC-CE for activation)   + Option 2: life cycle based deactivation in MAC-CE for activation (the information about life cycle can be provided in MAC-CE for activation)   Option 3: no additional mechanism for MG deactivation is introduced |
| Ericsson | Option 3 | No need for RAN1 to confrirm RAN2 agreement. The first bullet is not needed.  For second bullet, we support Option 3. |
| OPPO | First preference: Option 1 | Our first preference is Option 1 but can live with Option 3. |

**FL comment**

Most companies believed that no further discussion in RAN1 on how deactivation process works.

Confirming RAN2 support from my understanding is that RAN1 could take that into account drafting the TS 38.214

To Ericsson, I think that there may still be some impact in TS 38.214.

### Round 2

The FL has the following proposal. Please indicate only if you have the concern on the following proposal.

### Proposal 2.1.2-1

* RAN1 confirm the support of MAC CE based deactivation request and command as agreed by RAN2.
* Note: Up to editor how to capture it.

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| **Company** | **No** | **Comments** |
| vivo | Yes |  |
| Qualcomm | Yes |  |
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## Maximum number of preconfigured MG

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| --- | --- |
| **Company** | **Proposals** |
| vivo [2] | **Proposal 2:**   * The maximum number of pre-configured MG is 16. |
| Huawei, HiSilicon [18] | Proposal 2: The maximum number of preconfigured MGs is 8. |

### Round 1

**Proposal 2.2.1-1**

* The maximum number of preconfigured MGs is
  + Option 1: 8
  + Option 2: 16

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| --- | --- | --- |
| **Company** | **Options** | **Comments** |
| ZTE | 2 | Option 2 can introduce more flexibility |
| vivo | Option 2 |  |
| InterDigital | Option 2 | Support to have more flexibility.in configuration |
| Nokia/NSB | Option 1 |  |
| CATT | Option 1 | It seems 8 preconfigured MGs is more than enough |
| Intel | Option 1 | 8 is enough |
| Ericsson | Slight preference for Opttion 1 | We have no strong view. Option 1 may be enough.  One question we have if whether there is any agreement on the maximum number of preconfigured PRS processing windows? If not, we suggest to agree the same maximum number for preconfigured PRS windows also. |

**FL comment**

I think 8 should be sufficient. Note that the MG-ID bitwidth in RRC and MAC CE depends on the number.

With regards to comments from Ericsson, I think there is a separate proposal in 3.10, which depends on whether the PRS processing window is preconfigured per UE or BWP. It is not clear whether Ericsson supports 8 per BWP.

### Round 2

The FL has the following proposal. Please indicate only if you have concern on the following proposal.

### Proposal 2.2.2-1

* The maximum number of preconfigured MGs is 8

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| **Company** | **No** | **Comments** |
| vivo |  | We slightly prefer 16. For example, UE may be configured with 4 PFLs. Since BWP switching may occur multiple times during PRS measurement (the relationship between potential BWP and PFL changes), in different cases, the UE may use pre-MG to measure 4 PFLs, 3 PFLs, 2 PFLs and 1 PFL, then there are up to 15 pre-MG configurations should be prepared up by serving gNB. |
| Qualcomm |  | We prefer 16 also. |
|  |  |  |

## Maximum number of MGs per activation/deactivation

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| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [18] | **Proposal 1:** The activation/deactivation request/command MAC CE should support carrying at least two IDs in the configuration.   * Include it in the LS reply to RAN2 and RAN4. |
| IDC [10] | **Proposal 4:** Only one measurement gap, selected out of preconfigured measurement gaps, is activaed via DL MAC CE |

### Round 1

**Proposal 2.3.1-1**

* The maximum number of MGs per activation/deactivation is
  + Option 1: 1
  + Option 2: 2

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| --- | --- | --- |
| **Company** | **Options** | **Comments** |
| ZTE |  | We prefer to let RAN2/4 decide this issue as RAN2 has a dedicated agenda to consider MG issues. From RAN1 perspective, we more prefer option 1 such that two MACCE can be used to activate/deactivate MGs per FR. |
| vivo | Option 1 | Considering CA is not supported for PRS, concurrent MG does not need to support in R17. So if two MG (for example two MG per FR) is overlap in time, only one MG can be chosen to measure. That is, only one MG can be used in a given time for positioning.  In addition, we acknowledge two non-overlapping MG per FR may be beneficial for latency. But it may be difficult to complete it in the maintenance phase. So we prefer option 1 in Rel-17. |
| InterDigital | Option 1 | We are not sure about the use case for supporting more than one active MGs. |
| Nokia/NSB |  | Agree with ZTE that this is not for RAN1 to discuss. |
| CATT | Option 1 |  |
| Huawei, HiSilicon | Option 2 | 2 is only used when UE supports per FR MG, and PRS includes both FR1 and FR2. |
| Xiaomi | Option 1 | We are not sure about the use case for 2 MGs |
| Intel | Option 1 |  |
| LGE |  | Similar view with ZTE and Nokia. |
| Ericsson | Option 1 | Activating one MG per MAC CE should be sufficient. If another MG needs to be activated a second MAC CE could be sent. Hence, Option 1 is sufficient. |
| OPPO | Option 1 | One MG per MAC CE is sufficient. DO not see the use case for 2 MGs |

**FL comment**

It appears that most companies support Option 1.

### Round 2

The FL has the following proposal. Please indicate only if you have concern on the following proposal.

### Proposal 2.3.2-1

* The maximum number of MGs per activation/deactivation is 1.

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| **Company** | **No** | **Comments** |
| Qualcomm | Yes |  |
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## Others

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| --- | --- |
| **Company** | **Proposals** |
| vivo [2] | **Proposal 3:**   * The time/frequency characteristics (i.e., periodicity/offset information, and frequency layer information) of PRS can be transmitted as assistance date for Pre-configured MG from LMF to the gNB side.   **Proposal 4:**   * Support a new requesting NRPPa signaling from LMF to request an MG or a PRS processing or to assist gNB to determine the use of MG or PRS processing window, including   + 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)   + Activated/deactivated indication   **Proposal 5:**   * To select one of the following options for avoiding duplicated MG request from both LMF and UE   + The LMF indicates whether the LMF requests MG by NRPPa in the LPP RequestLocationInformation message.   + Guarantee the MG activation is not later than the time when the location request is received. |
| Apple [9] | **Proposal 2**: 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 |

**FL comment**

* For Proposal 3 and Proposal 4 from vivo [2], RAN1 already agreed to leave it up to RAN3 to decide, while RAN3 already seemed to have made the agreement.

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| **Agreements:**  **LMF provides a full PRS configuration to gNB as assistance information, and the gNB determines the pre-configuration of MG.**  **A UE-associated class 1 procedure is used to provide a full PRS configuration to gNB as assistance information of the pre-configuration of MG. FFS on using new defined or existing signaling procedure.**  **Support to transfer the information related to the PRS measurement with MG over F1AP, similar to the legacy MG, but detail waits for RAN2.**  **Support the MG activation request by the LMF.**  **The signaling procedure of the MG activation request uses an UE-associated class 2 signaling procedure. FFS on whether to use new defined or existing signaling procedure?**  **Include the similar information to that in RRC LocationMeasurementIdication message in the MG activation request message.**  **LMF provides the assistance information to help gNB determine the PRS Processing Window configuration.**  **For activation request procedure initiated by non-LMF, an unified signaling procedure over NRPPa can be adopted for the delivery of pre-configured MG and PRS processing Window configuration information.**  **Support to transfer the information related to the PRS processing window configuration over F1AP, similar to the legacy MG, but detail waits for RAN2.** |

* For proposal 5 from vivo [2], this has been discussed, but reached no consensus. Perhaps better to let RAN2/RAN3 work out the solution if any.
* For the proposal from Apple [9], A-PRS is not discussed in this release.

### Round 1 (closed)

**Proposal 2.4.1-1**

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

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| **Company** | **Comments on the necessity of any specific proposal** |
| ZTE | OK with FL proposal |
| vivo | Thanks for the FL to align the RAN3 agreement, based on the above agreement, we found unified signaling can be used for pre-configured MG and PRS processing Window configuration, and MG activation request by LMF is similar to RRC LocationMeasurementIdication message.  But no agreement on PRS processing window requests. And directly reusing the MG activation request is not enough for PRS processing window activation for different positioning requirements(for example, gNB needs to know whether the current BWP (e.g. bandwidth) can satisfy the positioning requirement ). So, in our view, what parameter can assist gNB to choose the use of the PRS processing window can be discussed in RAN1. |
| Nokia/NSB | Agree with FL. |
| CATT | Fine with FL proposal |
| Huawei, HiSIlicon | Reply vivo, actually we felt that the wording from RAN3 may be somewhat not so accurate, e.g. non-LMF, activation request procedure v.s. delivery of pre-configured MG and PRS processing window configuration information..  **For activation request procedure initiated by non-LMF, an unified signaling procedure over NRPPa can be adopted for the delivery of pre-configured MG and PRS processing Window configuration information.**  But our understanding is that a unified signaling procedure over NRPPa may also be considered for MG/PPW activation. |
| Xiaomi | Fine with FL proposal |
| Intel | OK with FL’s proposal |
| LGE | Agree with FL’s suggestion. |
| Ericsson | Agree with FL |

**FL comment**

The discussion is closed.

# PRS measurement outside MG

## General information

The following agreements were made in RAN1#107-e on this issue.

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| --- | --- |
| **Agreement**  The following options are supported subject to UE capability for priority handling of PRS when PRS measurement is outside MG.   * + Option 1: UE may indicates support of two priority states.     - State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS     - State 2: PRS is lower priority than all PDCCH/PDSCH/CSI-RS   + Option 2: UE may indicate support of three priority states     - State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS     - State 2: PRS is lower priority than PDCCH and URLLC PDSCH and higher priority than other 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 all PDCCH/PDSCH/CSI-RS   + Option 3: UE may indicate support of single priority state     - State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS   Note: SSB is a separate issue.  **Agreement**  For the purpose of determining conditions for measuring the PRS outside of a MG, the expected 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 request RAN4 study and determine the threshold, 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.   * + Examples for the threshold: CP length, 50% of the OFDM symbol, 1ms   + Other options can also be considered by RAN4   + Note: the requirement on whether UE needs to calculate the expected Rx time difference and/or compare against the threshold is also a part of the study request   **Agreement**  At least the following parameters for PRS processing window from the gNB to the UE are supported.   * + Starting slot   + Periodicity   + Duration/length   + Cell and SCS information associated with the above parameters   Discuss during the maintenance phase on the necessity of other parameters including but not limited to   * + Processing type (associated with the corresponding UE capability 1A/1B/2)   + Band/CC-ID as needed depending on each scenario on which the PRS processing window is applied   + The above cell and SCS information to determine where/when the PRS processing window is applied   Note: Indication of processing type does not suggest UE indication of multiple capabilities among (1A/1B/2) is already supported, which is a separate discussion.  Note: Some of the parameters above may not be mandatory for a PRS processing window  **Agreement**  The priority of PRS for UE supporting two priority states and three priority states can at least be indicated in RRC.  **Agreement**  For capability 1A as per working assumption made in RAN1#106-e, the DL signalings/channels in a per UE fashion (i.e. both across NR & LTE) inside the PRS processing window are dropped if the DL PRS is determined to be higher priority.  For capability 1B as per working assumption made in RAN1#106-e, only the DL signalings/channels from a certain band inside the PRS processing window are dropped if the DL PRS is determined to be higher priority.   |  | | --- | | 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.) |   **Agreement**  PRS processing window request to the gNB by the LMF is supported from RAN1 perspective.   * + It is up to RAN3 to design the necessary information to be transferred in the NRPPa message.   + Note: It is up to gNB to determine the usage of measurement gap or PRS processing window   + Include it in the LS to RAN2 and RAN3.   **Agreement**  For PRS processing window configuration and indication, at least the following mechanism is supported   * + RRC (pre-)configuration for PRS processing window configuration and DL MAC CE activation for PRS processing window, respectively.   Include it in the LS to RAN2 and request RAN2 to decide whether DL MAC CE is feasible for this indication.  [R1-2112880](file:///D:\works\1.3GPP%20works\RAN1-107\tdoc\R1-2112880.zip) Draft LS on PRS processing window Moderator (Huawei)  Final LS is endorsed in [R1-2112881](file:///D:\works\1.3GPP%20works\RAN1-107\tdoc\R1-2112881.zip).    [R1-2112882](file:///D:\works\1.3GPP%20works\RAN1-107\tdoc\R1-2112882.zip) Draft LS on the condition of PRS measurement outside the MG Moderator (Huawei)  Final LS is endorsed in [R1-2112883](file:///D:\works\1.3GPP%20works\RAN1-107\tdoc\R1-2112883.zip). |

## PRS processing window configuration parameters

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| **Company** | **Proposals** |
| vivo [2] | **Proposal 6:**   * PRS processing window configurations can be associated with one or more cells, and each PRS processing window is associated with an ID. * PRS processing window activation and deactivation command are only applied to the current active BWP, and the starting slot and SCS are relative to the active BWP.   **Proposal 7:**   * Processing type is needed if multiple types (UE capability 1A/1B/2) per band for a UE are supported. * CC-ID(s) are needed for indicating the association of the PRS process window and cell (s).   **Proposal 8:**   * The priority state indication of PRS for option 1 and option 2 can be included in the configuration of PRS processing window since it is used to indicate the PRS priority with other DL signal/channels within the PRS processing window. |
| ZTE [3] | **Proposal 1:** Further support the following parameters for PRS processing window indication from the gNB to UE,   * Processing type (associated with the corresponding UE capability 1A/1B/2) * Band/CC-ID at least for Capability 1B * Positioning frequency layer ID in order to support a single positioning frequency layer in a PRS processing window |
| OPPO [4] | **Proposal 4:** No more parameters are needed for PRS processing window configuration. |
| CATT [5] | **Proposal 3:** The following parameters for PRS processing window from the gNB to the UE should be supported and added to higher layer parameters:   * + Processing type (associated with the corresponding UE capability 1A/1B/2)   + Band –ID as needed depending on each scenario on which the PRS processing window is applied.   + The above cell and SCS information to determine where/when the PRS processing window is applied |
| NTT DOCOMO [6] | **Observation 1:**   * Prior to discuss the necessity of parameter of processing type, we should discuss the following remaining issue in UE features agenda.   + Whether a UE can support multiple types or not. * If RAN1 discuss Band/CC-ID for PRS processing window, not only the necessity of parameter but also the design of PRSProcessingWindow should be considered. |
| Nokia, NSB [8] | **Proposal 7**: Do not support processing type, band/CC-ID, or additional cell and SCS information as parameters for the PPW. |
| IDC [10] | **Proposal 1:** A PRS processing window is configured per UE |
| CMCC [11] | **Proposal 1:** Support the following parameters for PRS processing window from the gNB to the UE:   * + Processing type (associated with the corresponding UE capability 1A/1B/2), at least for UE supports multiple capabilities 1A/1B/2;   + Band/CC-ID as needed depending on each scenario on which the PRS processing window is applied.   + It is up to RAN2 to decide the deactivation procedure of the PRS processing window. |
| Xiaomi [12] | **Proposal 1:** on parameters for PRS processing window from the gNB to the UE   * Not support ‘processing type’ since reporting only one UE capability is preferred. * Support ‘band ID’ for Cap. 1B only. |
| LGE [15] | **Proposal #2:**   * Regarding details of configuration for PPW, RAN1 should consider/adopt reusing the way of configuration for MG (e.g. parameters for MG configuration).   **Proposal #3:**   * If RAN1 supports reusing the parameter for MG configuration to PPW configuration, the followings should be considered:   + ‘Start subframe’ instead of ‘starting slot’ for PRS Processing Window configuration.   + ‘Timing advance’ to guarantee RF retuning time in the consideration that PPW starts at the time as SMTC window like as mgta for MG configuration. |
| Ericsson [16] | **Proposal 1** The initial configuration of the PRS processing window is sent over RRC signaling. For reconfigurations / PPW update, it is up to RAN2 to decide if a MAC CE is beneficial or if RRC reconfiguration is sufficient.  **Proposal 3** For UE declaring capability 1A or 1B, the PRS priority is set at the PPW level in the PPW signaling from the gNB to the UE.  **Proposal 4** For PRS priority indication for Ues with capability 2, discuss and downselect which among the following priority indication granularities to be supported:  a. PPW level: all PRSs present in the PPW are set to the same priority (a single priority is indicated at the PPW level)  b. PFL level: all PRSs present in the PPW and belonging to the same PFL are set to the same priority (PRSs in each PFL are indicated with one priority)  c. Resource set level: all PRSs present in the PPW and belonging to the same PFL and the same PRS resource set are set to the same priority (PRSs in same PFL and same PRS resource set are indicated with one priority)  d. PRS resource level: each PRSs present in the PPW are individually indicated a priority setting. |

**FL comments**

Configuration hierarchy

* Per UE
  + Supported by: vivo [2]?, IDC [10]
* DCM commented that the design of PRSProcessingWindow should be first considered in determining the necessity of band/CC ID.
* RAN2 also agreed that whether PRS processing window configuration is per BWP or not is up to RAN1 to decide.

Agreements:

Proposal 7: The PRS processing window configuration is provided via RRCReconfiguration message. Whether PRS processing window configuration is provided per BWP or not is up to RAN1 to decide.

* FL understands that per BWP configuration of PRS processing seems more align with the intention of introducing PRS processing window in the first place, i.e. to measure the PRS that is overlapped with the active DL BWP, and also the numerology and cell information can be derived from the associated BWP.

Processing type

* Supported by: vivo [2], ZTE [3], CATT [5]
* Not supported by: OPPO [4], Nokia [8], Xiaomi [12]
* DCM commented that processing type depends on UE capability of supporting multiple types

CC ID

* Supported by: vivo [2], ZTE [3]
* Not supported by: OPPO [4], Nokia [8]

Band ID

* Supported by ZTE [2], Xiaomi [12]
* Not supported by: OPPO [4], Nokia [8]

Positioning frequency layer ID

* Supported by: ZTE [3]

LGE commented that the configuration parameter of PRS processing window should be aligned with MG, e.g. changing starting slot to starting subframe.

Ericsson commented that the PRS priority can be PPW-level for type 1A and 1B, but can PPW level, PFL level, resource set level, resource level for type 2.

### Round 1

**Proposal 3.1.1-1**

* RAN1 to discuss whether PRS processing window is configured
  + Option 1: Per UE (Similar to MG configuration)
  + Option 2: Per BWP
  + Option 3: Other

|  |  |  |
| --- | --- | --- |
| **Company** | **Option** | **Comments** |
| ZTE | Option 2 | Option 2 is easier as PDCCH/PDSCH/CSI-RS is also configured per BWP. In such case, priority state configuration has more flexibility as in one BWP PRS can be prioritized and in another BWP PDCCH can be prioritized. |
| vivo |  | Before discussing whether the PRS processing window is configured per BWP, we would like to ask the majority whether the information is needed to be indicated to LMF?  If it is, considering the LMF does not know the BWP information, Per UE may be more suitable.  In addition, we would like to ask the supportive of per BWP PPW whether the PRS processing window will be changed with BWP? |
| InterDigital | Option 1 | Granularity of configuration of the processing window per UE is sufficient |
| Nokia/NSB |  | The UE can only receive the PRS inside the active BWP (when outside a MG). So is the intention of option 1 that the UE has a PPW configured which applies to multiple possible BWPs? If so we don’t think that is really practical from network perspective. So we prefer option 2. |
| CATT | Option 2 | Per UE seems not enough given that DL PRS can be sent in different PRS frequency layers with different configurations, and UE processing capability can be different for different bands or FRs. |
| Qualcomm | Option 1 | CC ID or Band ID can be added in the signaling depending on the type of the window. For Type-1A, there is no need of any CC/band ID. For Type-1B, Band-ID is enough. Depending on whether Type-2 will be a window that affects a specific band or a specific CC, we can make a decision accordingly.  To CATT: The “per-UE” it doesn’t mean that it applies to the whole UE. If we add a CC-ID or band-ID, there will not be any problem and would enable cross-band/CC indication also. |
| Huawei, HiSilicon | Option 2 |  |
| Xiaomi | Option 2 | Option 2 is more flexibility |
| Ericsson | Option 2 | It is agreed that for gapless measurements, the measurements are done within active BWP. Then, it makes sense to configure PRS processing windows per BWP. |
| OPPO | Option 2 | Per BWP is more flexibile and also more flexible. Regarding the question by vivo, our understanding is LMF does not need to know the configuration information. |

**Proposal 3.1.1-2**

* RAN1 to discuss whether additional parameter needed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Company** | **Processing type** | **CC ID** | **Band ID** | **Positioning frequency layer ID** |
| ZTE | Depends on if UE can support more than one of {type 1A, 1B, 2} | Yes | NO if CC ID is included.  Yes if CC ID is not included | Yes  We think support of single PFL measurement is sufficient in a measurement window |
| vivo | Depending on whether multiple types is introduced per band | Depending on the discussion of 3.1.1-1 |  | Depending on how LMF indicates the PRS processing window to serving gNB |
| Nokia/NSB | Depends on capability discussion. | No | No | No |
| Qualcomm | Yes if a UE is able to report multiple types in a band. We support having such feature. | No for Type-1A/1B. Yes if Type-2 is per-CC, otherwise it is not needed either since a band-ID will be enough | Yes for Type-1B and Type-2 (if it is per band) | We could accept it, but we tend to believe that the “band ID” is simpler. is the intention to add this is to disambiguate the case of multiple PFLs in a band with a PPW overlapping with both? Such scenario could happen in NR Rel-16 and the understanding was that the UE will TDM the processing. |
| Huawei, HiSilicon | Yes. Even if we do not support multiple types in the capability reporting. | No.  We believe this can be implicit if PRS processing window is configured per BWP | No.  We believe this can be implicit if PRS processing window is configured per BWP | No. |
| Xiaomi | No. we prefer to not support reporting more than one capability type | Depends on 3.3.1-1 |  |  |
| Ericsson | This depends on multiple values among {type 1A, 1B, 2} can be reported as part of UE capability. | This will depend on the conclusion of Proposal 3.1.1-1. If PRS processing window is configured at BWP level, the CC ID will not be needed. | This will depend on the conclusion of Proposal 3.1.1-1. If PRS processing window is configured at BWP level, the Band ID will not be needed. | No |

**Proposal 3.1.1-3**

* RAN1 to discuss whether the priority indication for the PRS in the PRS processing window is
  + Option 1: Per PRS processing window
  + Option 2: Per positioning frequency layer within the target PRS processing window
  + Option 3: Per DL PRS resource set within the target PRS processing window
  + Option 4: Per DL PRS resource within the target PRS processing window

|  |  |  |
| --- | --- | --- |
| **Company** | **Option** | **Comments** |
| ZTE | 1 | Option 2, 3, 4 will cause more complexity for latency requirements and need standard effort. |
| vivo | Option 1 | We think the priority indication is only used to compare the priority between PRS and other DL signals and channels. The priority between PRS should follow Rel-16 rules. |
| InterDigital | Option 1 | Option 2, 3 and 4 add more complexity to priority determination process. Our understanding of the past agreements related to PRS processing window is aligned with Option 1. |
| Nokia/NSB | Option 1 | It should be clear from prior agreement that the PRS priority applies in the window. Further granularity is unnecessary. |
| CATT | Option 1 |  |
| Qualcomm | Option 1 |  |
| CMCC | Option 1 |  |
| Huawei, HiSilicon | Option 1 |  |
| Xiaomi | Option 1 |  |
| Intel | Option 1 |  |
| LGE | Option 1 |  |
| Ericsson |  | We can accept Option 1 for progress. |
| OPPO | Option 1 | Option 1 is straightforward. |

**FL comment**

With regards to per-BWP or per-UE PRS processing window configuration

* Most companies prefer per BWP.
* Reply to vivio: My understanding is that PRS processing window will be configured for a BWP, which means for up to 4 BWP per CC configuration, up to 4 PRS processing configuration can be indicated. For some BWPs with numerology and bandwidth that is not likely to coincide with PRS bandwidth/numerology deployed, gNB will not configure PRS processing window for the BWP. Regarding the information exchange between LMF and gNB, maybe RAN3 may further discuss solutions. If BWP changes, the activated/to-be-activated PRS processing windows may follow the BWP change, similar to existing SP CSI-RS or SP SRS, I guess.
* Reply to IDC/Qualcomm: I think providing PRS processing window per BWP would mean that this PRS processing window is only intended to cover the PRS measurement that is wihin the target BWP. With this, maybe there is no need to explicit indicate band/CC ID or cell/SCS information, because those parameters could follow the BWP.

With regards to other parameters

* Most companies suggest that type should only be provided if multiple types are supported by UE for a band, while band ID and CC ID are not need if PRS processing window is already configured per BWP.
* Support of posiitoning frequency layer ID cannot have consensus.

With regards to the granularity of priority indicator

* Most companies are OK with Option 1.

### Round 2

The FL has the following proposal. Please indicate only if you have concern on the following proposal.

### Proposal 3.1.2-1 (GTW)

* The PRS processing window is configured per BWP.
* Processing type, to be selected from 1A, 1B and 2, will be provided associated with the PRS processing window if and only if multiple processing types per band in the UE capability signaling is supported.
* No need to provide band ID and CC ID associated with the PRS processing window.
* A single priority indicator is provided for a PRS processing window, which applies to all PRS within the PRS processing window.

|  |  |  |
| --- | --- | --- |
| **Company** | **No** | **Comments** |
| vivo |  | Sorry for the PRS processing window is configured BWP is not our preference  For us, the configuration is not equal to activation. From the perspective of configuration, the PPW can be configured per UE or PFL since the configuration can be only dependent on the PRS configuration. But whether the BWP can active the PPW to measure the PRS measurement can depend on the relationship between the BWP and PRS.  FL: “The configuration can be only dependent on the PRS configuration”, but whether the PRS can be measured outside MG is still BWP specific. For some BWPs, it is not possible since the BW/SCS is not aligned with the PRS. Then actually providing the PRS processing window per BWP seems to align with the intention of PRS measurement outside MG from the beginning. |
| Qualcomm | OK | We can accept it, but we really do think that the UE should have the option to report multiple processing types. |
|  |  |  |

## PRS processing window activation/deactivation

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| OPPO [4] | Proposal 5: Support the following two options for PRS processing window deactivation:   * Option 1: gNB use a DL MAC CE to deactivate one PRS processing window and the UE can use a UL MAC CE to request deactivation * Option 2: Each activated PRS processing is associated with a repetition number and when the indicated repetition number is reached, the activated PRS processing window stops |
| SONY [7] | **Proposal 1:** Support UE requests PRS processing window from serving gNB to enable low-latency UE-based positioning  **Proposal 2:** UE can provide assistance information (UAI) indicating serving gNB that the UE is capable to perform positioning outside the measurement gap. Subsequently, serving gNB can provide the response whether the UE is allowed to perform positioning measurement in certain time duration (e.g., only during periodic PRS transmission). |
| Nokia, NSB [8] | **Proposal 2**: Consider implicit deactivation of the MG (or PPW) when the UE can only make PRS measurement either inside or outside the MG. |
| IDC [10] | **Proposal 3:** UL MAC CE based request for a PRS processing window by the UE to the gNB is not supported |
| CMCC [11] | **Proposal 2:** PRS processing window request to the gNB by the UE is supported.   * + Use UL MAC-CE for PRS processing window activation request. |
| Qualcomm [14] | **Proposal 2:** For PRS processing window (PPW) activation request, support using an UL MAC CE for the UE to request one of the RRC (pre-)configured PRS processing windows.   * The information in the UL MAC CE for PPW activation request by the UE can be one ID associated with the preconfiguration of the PPW |

**FL comments**

UL MAC CE based PRS processing window activation/deactivation request

* Supported by: OPPO [4], SONY [7], CMCC [11], Qualcomm [14]
* Not supported by: IDC [10]

This issue has been discussed in the previous meeting, and there were concerns on the benefit, resulting in no consensus. It is not clear whether companies changed their position in this meeting on this topic.

For Option 2 proposed by OPPO [4], this situation can be evaluated based on the discussion on MG deactivation process in section 2.1.

For the implicit deactivation of MG (or PPW) proposed by Nokia [8], the understanding from the FL is that this addresses the concurrent activated MG/PPW, in which UE may choose to use either. However this procedure can be somehow left up to UE implementation, since both MG activation and PPW activation are provided by gNB.

### Round 1

**Proposal 3.2.1-1**

* Support PRS processing window activation request and deactivation request via UL MAC CE.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| ZTE | Yes |  |
| vivo |  | Based on the previous agreement, UL MAC CE for MG activation request by the UE can be one ID associated with the preconfiguration of the MG. So, we would like to confirm PRS processing window activation request is an ID or detailed window information. |
| InterDigital | No | We do not see benefits for this feature. For example, “Option 2: UE may indicate support of three priority states”, how does the UE request for the window? Does the UE request the priority level associated with the window as well? If that’s the case, what would be the consequence if the network configures a window with a priority level that is different from what the UE requested? The network should have a better view of the schedule and it is more natural for the network to configure the window. |
| Nokia/NSB | Okay |  |
| Qualcomm | Yes | We think a UE has good understanding of what is needed to be measured, and can only help the gNB to make a good decision. Worst-case, the gNB ignores the UE’s suggestion. Since already MG-based UL-MACCE has been added, the additional effort to add UL-MACCE PPW request is minimal. |
| CMCC | Yes | Similar mechanism can be reused as that defined for UE requests a (pre-)configured MG via UL MAC-CE |
| Huawei, HiSIlicon | No | We acknowledge that UE has better information than the network, however adding another UL MAC CE mechanism will inevitably complicate the specification.  For example, we may need to discuss when UE should use MG activation request UL MAC CE, and when UE should use PRS processing window activation request UL MAC CE, in case both are configured.  The current design of PRS processing window is that network control and manage the PRS processing window configuration and activation, and if UE believes tha the network decision is not perfect, UE may turn to MG request, via either RRC or UL MAC CE.  We prefer to limit the UE request to only MG. |
| Xiaomi | No | UL MAC CE for MG request is sufficient |
| Intel | No |  |
| LGE | Yes | We think following the mechanism for MG seems quite reasonable. For details, RAN1 needs to focus on activation/deactivation for MG at first and than we prefer to adopt same way for PRS processing window. |
| Ericsson | No | No need to introduce a second solution (UE based activation request via MAC CE). |
| OPPO | YES | MAC CE -based UE request shall be supported. |

**FL comment**

Theere is no consensus on supporting this feature. The suggestion from the FL is to conclude in RAN1 that UL MAC CE based PRS processing window activation/deactivation request is not supported.

### Round 2

The FL has the following proposal. Please indicate only if you have concern on the following proposal.

### Proposal 3.2.2-1 (for conclusion)

* From RAN1 perspective, PRS processing window activation/deactivation request by UL MAC CE is not supported.

|  |  |  |
| --- | --- | --- |
| **Company** | **No** | **Comments** |
| Qualcomm |  | To E//: Why did we introduce a 2nd solution for network-based MG request? I don’t recall the comment “No need to introduce a second solution” then.  The answer is simple: Because UEs and gNB have different information that need to take into account into their requests.  We think we should support this feature |
| Huawei, HiSilicon |  | Reply QC: From our side, we think that introducing a second UL MAC CE may overcomplicate the protocol design. Note that normally sending UL messages by the UE requires RAN2 RRC/MAC specification to regulate the UE behaviour, e.g. when to send it. |
|  |  |  |

## Priority with SSB

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| OPPO [4] | **Proposal 3:** For processing PRS outside MG, the gNB can indicate whether PRS has higher priority than serving cell SSB. |
| CATT [5] | **Proposal 1:** NCD-SSB and SSB in SMTC can be treated to be the same way as all PDCCH/PDSCH/CSI-RS within the PRS processing window for PRS measurement outside MG.  **Proposal 2:** CD-SSB always has higher priority than DL-PRS. |
| IDC [10] | **Proposal 2:** SSB from the serving cell always has higher priority than PRS during a PRS processing window |
| Xiaomi [12] | **Proposal 2:** Prefer higher priority for SSB than PRS. |
| Samsung [13] | **Proposal 1:** The priority between PRS resource and SSB can be high, low and equal inside the PRS processing window subject to UE capability.  **Proposal 2:** When SSB and PRS has equal priority, it’s up to UE implementation which one(s) to be measured. |

**FL comment**

With regards the priority of SSB, most companies in the previous meetings suggested that this can be done by RAN4. It is also FL understanding that RAN4 is generally considering the CSSF mechanism between PRS RRM and SSB RRM.

Different terminologies of SSB were used across contributions, and in order to check the position among companies on SSB, the FL listed the SSB in the finest granularity and requests companies to check the view.

### Round 1

**Proposal 3.3.1-1**

* Companies are encouraged to check the view on whether they are interested in determining the priority between PRS and the following SSB.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Company** | **PCell SSB (CD-SSB)**  From initial access/ServingCellConfigCommonSIB or configured by ServingCellConfigCommon | | | **SCell SSB (CD or non-CD-SSB)**  Configured by ServingCellConfigCommon | | **Neighbour cell SSB (CD or non-CD-SSB)** |
| **SSB acquiring MIB/SIB1** | **RLM-SSB/BFD-SSB** | **BM-SSB** | **BFD-SSB** | **BM-SSB** | **Neighbour cell SSB detected in SMTC** |
| InterDigital | Lower priority for PRS | Lower priority for PRS | Lower priority for PRS | At least for CD, lower priority for PRS | At least for CD, lower priority for PRS |  |
| Nokia/NSB | RAN4 | RAN4 | RAN4 | RAN4 | RAN4 | RAN4 |
| CATT | CD-SSB has higher priority than PRS | CD-SSB has higher priority than PRS | CD-SSB has higher priority than PRS | CD-SSB has higher priority than PRS. | CD-SSB has higher priority than PRS. | CD-SSB has higher priority than PRS. |
| Qualcomm | RAN4 | RAN4 | RAN4 | RAN4 | RAN4 | RAN4 |
| Huawei, HiSilicon | RAN4 | RAN4 | RAN4 | RAN4 | RAN4 | RAN4 |
| Samsung | We have general comments. There is no need to separate the case for SSB type or SSB purpose. The only key aspect is that, is there any required case, that UE has to measure/receive one particular SSB (not only index, but also the SSB location) as requested by gNB. To our understanding, there is not; so the reception priority between SSB and PRS could be equal and receive which could be up to UE. | | | | | |
| Xiaomi | Lower priority for PRS | | | | | |
| Ericsson | Fine to leave it to RAN4. | | | | | |
| OPPO | Our preference is the priority vs SSB can be configurable. But can live with leaving it to RAN4. | | | | | |

**FL comment**

There is still no consensus how the priority of SSBs are managed.

### Round 2

The FL has the following proposal.

### Proposal 3.3.2-1 (for conclusion)

* RAN1 understand that the priority between SSB and PRS is up to RAN4 to define.

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments**  Including whether an LS is needed. |
| CATT |  | We are fine to let RAN4 to decide. In this case, if we want to capture the priority between SSB and PRS in RAN1 specs, as we have done for other DL signals, there is a need to send LS to RAN4 to ask the feedback. |
| Qualcomm | Yes |  |
|  |  |  |

## PRS collision detection timeline

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 2:** Agree with the following UE behaviour for both high priority PRS and low priority PRS.   |  |  |  | | --- | --- | --- | |  | Case 1: PRS measurement is of higher priority | Case 2: PRS measurement is of lower priority | | 1A | UE is not expected to receive the DL signals and channels within the PRS processing window on all serving cells including SCG. | UE is not expected to receive the scheduled DL signals/channels in the PRS processing window on all serving cells including SCG, if the corresponding DCI is later than a threshold before the start of the PRS processing window and there is no DL signals/channels configured during the PRS processing window or scheduled during the PRS processing window with DCI earlier than a threshold before the start of the PRS processing window on any serving cell including SCG; otherwise the UE is not expected to receive the DL PRS within the PRS processing window. | | 1B | UE is not expected to receive the DL signals/channels within a PRS processing window on the serving cells in the same band as the DL PRS. | UE is not expected to receive the scheduled DL signals/channels in the PRS processing window on the serving cells in the same band as the DL PRS, if the corresponding DCI is later than a threshold before the start of the PRS processing window and there is no DL signals/channels configured during the PRS processing window or scheduled during the PRS processing window with DCI earlier than a threshold before the start of the PRS processing window on serving cells in the same band as the DL PRS; otherwise the UE is not expected to receive the DL PRS within the PRS processing window. | | 2 | UE is not expected to receive any DL signals/channels on a DL PRS symbol within the PRS processing window on the impacted serving cells | if the DL PRS is lower priority than the DL signals and channels, UE is not expected to receive the scheduled DL signals/channels on the DL PRS symbols on the impacted serving cells, if the corresponding DCI is later than a threshold before the symbol and there is no DL signals/channels configured on the symbol on the impacted serving cells; otherwise the UE is not expected to receive the DL PRS on the symbol within the PRS processing window | |
| Nokia [8] | **Proposal 5**: Add a buffer between the PDCCH and PRS in some cases of UE measurement of PRS outside the MG (e.g., for capability 2, state 2 of option 2 priority). |
| CMCC [11] | **Proposal 3:** Support to define the collision detection timeline to avoid the gNB dynamically schedules a PDCCH too close to the starting time of a PRS processing window. |
| Qualcomm [14] | **Proposal 8:** For an activated 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 the corresponding scheduling cell of  **Proposal 9:** For an activated 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 the corresponding scheduling cell of . |

**FL comment**

This has been proposed in RAN1#107-e, but due to the pressing need to complete the WI, was deprioritized. From the contribution, it appears that Huawei [1], Nokia [8], CMCC [11], Qualcomm [14] tend to agree to introduce this PRS collision detection timeline.

The difference is that

* Huawei [1] think that the collision detection timeline should only be considered for PRS being lower priority than data, and the impact is only limited to PDCCH used for dynamic scheduling.
* Nokia [8] think that the collision detection timeline should target PRS being lower priority than PDCCH and URLLC data for capability 2.
* CMCC [11] also think that collision detection timeline is about PDCCH dynamic schedule.
* Qualcomm [14] considers dynamic scheduled DL signals/channels [Proposal 8] and semi-persistent or configured DL signals/channels [Proposal 9?]. Qualcomm also consider potential impact due to PRS and DL signals/channels on different CCs.

### Round 1

**Proposal 3.4.1-1**

* RAN1 to discuss whether the PRS collision detection timeline should be defined
* RAN1 to discuss the circumstances to apply the timeline if the timeline is to be defined.
  + Q1: Should the timeline apply when PRS may be lower priority than data, e.g. lower than PDCCH and URLLC data (state 2 of option 2), or lower than all data (state 2 of option 1 or state 3 of option 2)?
  + Q2: Should the timeline only concern PDDCH that dynamically schedules DL signals/channels in the PRS processing window or also the semi-persistent/configured DL signals/channels in the PRS processing window?
  + Q3: Should the timeline apply to all PRS processing window capability types (1A, 1B, 2)?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments**  Including answers to Q1/Q2/Q3 |
| ZTE | Yes | We tend to agree QC, the timeline is quite similar as SRS carrier switching as priority comparison should be done between PRS and PDCCH/PDSCH/CSI-RS per band level for type 1B, per UE level for type 1A and per CC/band level for type 2. Hence, we can borrow the similar description from SRS carrier switching priority timeline.  However, we agree Q1 that it is sufficient to consider the timeline only if PRS is lower priority than data.  For Q2, semi-persistent PDSCH/CSI-RS should also be considered.  For Q3, we think all capability types should be considered. |
| vivo |  | Q1:Yes  Q2:dynamically only  Q3: capability 2 may not be needed. |
| Nokia/NSB |  | Agree with the first bullet.  Q1: Yes.  Q2: dynamically scheduled should be the higher priority item to fix first given the prior agreement explicitly mentions dynamically scheduled PDSCH.  Q3: Our understanding is that this issue is most critical for type 2 (where the PRS may be dropped on symbol level) but we are open to discuss the other types. |
| CATT | Yes | Q1: No. We don’t see the need to discuss it if PRS has lower priority than other DL channals/signals.  D2: Yes.  D3: No need for Capability 2, since the reception of PRS hase no impact on than other DL channals/signals. |
| Qualcomm | Yes | Q1: Ok to focus on the PRS lower priority than the colliding channels under the understanding that if PRS is higher priority, then, independent of the DCI/MAC-CE decoding time, the UE would eitehr way prioritize PRS. If that is the reasoning behind Q1, then it seems correct.  Q2: All cases should be addressed.  Q3: All capabilities are needed |
| CMCC | Yes | Q1: Yes  Q2: We believe it should be focus on the dynamic scheduling  Q3: At least for Cap 2, for Cap 1A/1B, we think that it can be up to gNB implementation, but we are open to discuss all capabilities. |
| Huawei, HiSilicon | Yes | Q1: Yes. We share the same understanding as Qualcomm that if PRS is higher priority, UE will anyway processing PRS irrespective of other data.  Q2: We believe that dynamic schedule data should be prioritized. For SP data/RS, it may have some ambiguity for the first occasion after activation/deactivation, and thus should be considered as the corner case.  Q3: Yes. Even for capability 1A, when PRS is lower priority than data, dynamic scheduling in any CC could have impact on the PRS processing. |
| Samsung | General Yes | One missing aspect in FL proposal is that, in which case the timeline is applied, because we see some of the proposed timeline is between DCI and start of PPW only, in which we did not find it is reasonable. We think this aspect should be discussed together with the 3 question.  Q1: yes  Q2: only dynamic. In addition, the “in PPW” means only inside the PPW?  Q3: yes |
| Xiaomi | Yes | Q1: yes  Q2: at least for dynamic scheduled data  Q3: all capability types are needed |
| Ericsson |  | Q1: It seems the implication of applying such a timeline when PRS is lower priority than PDCCH/PDSCH/CSI-RS is that UE will not be able to receive PDCCH during the priority window. For instance, assume a minimum timeline of N2 symbols is defined, consider the case that the UE does not receive a PDCCH N2 symbols priori to the start of the PRS processing window. Then, according to the timeline rule, the UE will start processing PRS in the processing window and gNB cannot schedule a PDCCH/PDSCH within the window, potentially across all CCs if the UE is capability 1A. This seems to go against the previously agreed working assumption:  “Note: When the UE determines higher priority for other DL signals/channels over the PRS measurement/processing, the UE is not expected to measure/process DL PRS which is applicable to all of the above capability options.”  So introducing further scheduling restrictions, especially for URLLC traffic, should be avoided which seems to be the issue with introducing processing timeline. This issue needs more discussion and we need to find a solution that avoids further scheduling restrictions.  Q2: We think introducing processing timeline as proposed above will introduce scheduling restrictions to PDCCH reception when PRS is lower priority within the PRS processing window which goes against previous working assumption. This issue needs further discussion.  Q3: We are not sure of introducing processing timeline. Q3 can be discussed once we come up with a solution that does not require further scheduling restrictions. |
| OPPO |  | Generally we are ok to dicuss this collision detection issue. But one thing we want to point out is that the UE always first buffer the data and the process it. One case metioning that DCI being very close to PPW: we do not think it is a vlid case. The UE can always finishing decoding the DCI and then determine the allocation of CSI-RS or PDSCH.  Q1:before we dicuss particular case, there is no clear answer for that. But generally yes.  Q2: the answer also depends on the case that is going to be dicussed and also considering the latency of DCI decoding. Some proposal seems to assume the DCI decoding latency is very large.  Q3:generally yes. |

**FL comment**

It appears most companies would like to see a timeline being defined.

Reply to SS: I think so. Outside the PRS processing window, we won’t discuss any PRS reception assumption.

Reply to Ericsson: My understanding is that for PRS being lower priority with Type-1A processing, any PDCCH monitoring or periodic/semi-persisitent CSI-RS reception configured within the PRS processing window will interrupt the entire PRS processing of Type-1A within the window. Then if there is indeed no PDCCH monitoring or periodic/semi-persistent CSI-RS in the PRS processing window, whether the PRS measurement will be interrupted is decided on the real time basis, i.e. dynamic scheduling. We have to acknowledge that there should be a buffering time period for the UE to decide whether the PRS in the Type-1A processing window is measured or dropped.

### Round 2

The FL has the following proposal.

### Proposal 3.4.2-1

* The PRS collision detection timeline is defined for the case when PRS may be lower prority than the dynamically scheduled DL signals/channels, which is applicable for all PRS processing window types (1A, 1B, 2).
  + FFS details, which are to be finalized in RAN1#108-e.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments**  Including what details should be discussed. |
| FL |  | My understanding is that the details include whether the time period is fixed in specification or subject to UE capability, how to deal with periodic/semi-persistent scheduled DL signals/channels, UE assumption if the timeline requirement is not met. |
| vivo |  | We doubt capability 2 needs to consider the issue since it can process PRS per symbol. |
| Qualcomm | Comment | Lets change it to “at least”   * The PRS collision detection timeline is at least defined for the case when PRS may be lower prority than the dynamically scheduled DL signals/channels, which is applicable for all PRS processing window types (1A, 1B, 2).   + Collision detection timelines with semi-static traffic can still be discussed during later stages of maintenance. |

## Low latency PRS processing capability

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| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 3:** For PRS processing window, at least the existing PRS duration calculation and signaling structure for PRS processing capability are reused. (FG 27-3-3)   * The changes to the existing FG 27-3-3 in R1-2200764 should be reverted.   **Proposal 4:** For PRS processing window with advance low latency feature   * Introduce an indication from network to enable the following operation that   + UE may only measure the first N ms PRS within a PRS processing window   + For processing type 1A and 1B, UE expects that the PRS processing window covers T-N ms after the last symbol of the first N ms PRS. * Introduce a new optional UE feature group with prerequisite FG being the original FG 27-3-3.  |  |  |  |  |  | | --- | --- | --- | --- | --- | | 27. NR\_pos\_enh | 27-3-3a | DL PRS Processing Capability outside MG – Advanced buffering capability | 1. DL PRS buffering capability: Type 1 or Type 2  a) Type 1 – sub-slot/symbol level buffering  b) Type 2 – slot level buffering  2. Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS bandwidth in MHz, which is supported and reported by UE s, where  a) T: {1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms  b) N: {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms  3. Max number of DL PRS resources that UE can process in a slot under it  a) FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHz  b) FR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHz  Note: UE that supports this feature and supports type 1A or type 1B capability processing in FG 27-3-2, may be indicated by the network to only process the first N ms PRS within the PRS processing window that extends T-N ms after the last symbol of the first N ms PRS | 27-3-3 | |
| vivo [2] | **Proposal 12:**   * The processing optimization of the PRS processing window is not supported (e.g. no corresponding enhancement for splitting MG into two windows). |
| ZTE [3] | **Proposal 2**: For the PRS processing capability in a PRS processing window, UE has to report its capability with at least of the combination {N, T},   * During the first part of the window with duration of 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, 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-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-N) msec |
| Samsung [13] | **Proposal 4:** The UE is expected to report measurement results derived on the PRS measured at the end of the PRS processing window. |
| Qualcomm [14] | **Proposal 4:** With regards to the processing window for MG-less Processing support the following (Alt. 1 in the previous discussion):   * Maximum duration of DL PRS symbols N in units of ms a UE can process in the first part of a PRS processing window assuming maximum DL PRS bandwidth in MHz, such that the UE is capable of reporting the measurements T-N ms after the last PRS symbol where   + N: {0.125, 0.25, 0.5, 1, 2, 3, 4, 5, 6, 8, 12} ms   + T: {N+4, N+5, N+6, N+8} ms * Note: 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 comment**

This issue has been discussed for a couple meetings, but no consensus was reached.

Huawei [1] suggested that the basic operation of PRS measurement outside MG should be defined based on the Rel-16 (N, T) structure, while a new low latency operation of PRS measurement outside MGs could be defined as an add-on feature stressing that key enhancements against Rel-16 should be that UE is only required to process the first N ms PRS within a PRS processing window, and that window length extends to post-buffer processing period only for type 1A and type 1B processing.

ZTE [3] proposed the same functionality as in RAN1#107-e, that the up to N ms PRS within the first part of the PRS processing window of L-(T-N) ms are expected to be buffered/processed by the UE, and post-buffering period takes at most T-N ms, and UE should be able to report the measurement. The minimum PRS processing window length is T-N ms.

Qualcomm [14] proposed to support the previous Alt.1 (R1-2112459), and define the corresponding capability by citing this operation and modify T in relation to N.

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| * + 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 |

Samsung [13] mentioned that UE should be able to report the measurement at the end of the PRS processing window.

vivo [2] do not support such an enhancement.

### Round 1

**Proposal 3.5.1-1**

* RAN1 to discuss whether and how the low latency PRS processing capability are defined.
  + Alt.1
    - During the first part of the window with duration of 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, 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-N, i.e., L>(T-N)
  + Alt.2
    - Introduce an optional UE feature to support an indication from network to enable the following operation that
      * UE may only measure the first N ms PRS within a PRS processing window
      * For processing type 1A and 1B, UE expects that the PRS processing window covers T-N ms after the last symbol of the first N ms PRS.
  + Atl.3
    - No enhancements of low latency PRS processing capability is defined
  + FFS new (N, T) values in the capability signaling

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| **Company** | **Alt** | **Comments** |
| ZTE | 1 | We don’t know what Alt 3 is. There is no PRS processing capability within PPW in legacy release. If we go for Alt 3, that is, UE is not able to process PRS in PPW.  Alt 2 is not aligned with the motivation of PPW especially for type 1A and 1B in which all other DL signals may be dropped even PRS is not overlapped with them.  As this issue has been discussed for several meetings, perhaps, we can consider support of both. Alternatively, support Alt 1 for some small value of N, and Alt 2 is used otherwise. |
| vivo |  | We think gNB knows UE capability and full PRS configuration, it can configure the appropriate window to UE. And there is no related enhancement in alternative methods (ie. MG enhancement).  So we prefer only to discuss new values or inform RAN4 to discuss new values first in Rel-17. |
| Nokia | 3 | Not a strong view but we tend to feel that Alt 3 is enough for the feature to work. |
| CATT |  | For Alt1.   * Should the second bullet, “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” be changed to : “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”?   The following figure is copied from R1-2202143. |
| Qualcomm | Alt. 1 | To CATT: Yes, it should be “T-N” msec after the last PRS symbol.  To vivo, Huawei: Alt. 3 is not enough, but for the sake of discussion lets assume say we try to make it work. First, Huawei, in their document acknowledges that clearly with this statement. They add the constraint, that the “N msec” are the earliest symbols in the PPW. Such a constraint does not exist in NR Rel-16, but, for the sake of discussion, lets assume we add that in NR Rel-17.  [1] “if we stick with the previous description of (N, T), the claimed functionality can be achieved considering the existing RAN4 PRS measurement period requirement , if the following conditions are met   * + At most N ms earliest symbols are received within the PRS processing window, i.e. ”   Then, what is missing is how long should the PPW be so that the UE is capable to report after the end of the PPW. There needs to be a time, after the “N msec” PRS symbols for the UE to quickly finish the processing; that was the intention behind the compromised WA that we reached. In Alt. 3, can the proponents clearly reply to the question: **How can a UE report the time needed to finish the processing after the end of the N msec PRS?**   * It seems one reasonable answer is: T-N, which goes back to Alt.1/2. I am actually confused on what are the implications of Alt 1 and 2 and why isnt a single alternative here, but we can leave this aside for now. * It seems, from the text in HW’s Tdoc, that their proposal is that we can use the “T\_last” as the time the UE needs to finish the processing. But, “T\_last” is a function of PRS periodicity; so the minimum requirements will be, lets say, 160 msec, if T\_PRS=160 msec. How is that addressing the low-latency positioning which is supposed to be the scope of all this subagenda?   is the measurement duration for the last PRS RSTD sample in positioning frequency layer *i*, including the sampling time and processing time, = + ,  *,* the least common multiple between and .   * If their proposal is to change “T\_last” to “T”, then still this doesn’t address the fact that the UE is required a period of time after the “N PRS symbols” to finish the processing; which is the reason we agreed on the **following**.   + 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   So, if want to make Alt.3 to work, we would have to say something like: “T\_last = T”, or even more aggressive, “T\_last = T-N”, and the UE, in Type 1A/1B requires this time to be within the PPW.  In other words, using simple principles, Alt. 3 converges to Alt 1/2 by noting that, in Alt. 3 we need add:   * At most N ms earliest symbols are received within the PRS processing window * The measurement duration of the last sample is T\_last = T or T\_last = T-N; For processing type 1A and 1B,UE expects that the PRS processing window covers the T\_last ms after the last symbol of the first N ms PRS   Then, there is the question of the values of “T”. How can a large value of “T”, be useful here? We cannot block the medium for 160 msec for example obviously. |
| Huawei, HiSilicon | Alt.2 | As the compromise, we support Alt.2, meaning that this is added as optional-optional UE capability, i.e. not in the basic FG of PRS measurement outside MG.  On the bullets of Alt.1   * + - 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   The timeline of being able to report the measurements relies on higher layer signaling processing, number of samples, number of Rx beam, and even the PRS resources in a slot. The factors cannot be simply by-passed by the statement in the bullet.   * + - UE is not expected to be configured a PRS processing window with duration smaller than T-N, i.e., L>(T-N)   We do not think this is valid for capability 2 UEs. We would be fine to limit it to capability 1A, and 1B. Note that for capability 2, there is no communication interruption. |
| Samsung |  | We shared the view of vivo that, network knows N, T and network knows PRS configuration, why cannot network configure a proper L to accommodate the N, and T in order to achieve the purpose of quick reporting? The value of T is already serving the purpose that let network now how much time UE needs to process the N ms PRS. There is no point of say UE is expected to capable of reporting the measurements after N-T from the end of the first part in the window. besides, whether UE is capable of reporting the results should also be statisfying RAN4 requirement on the quality.  More importantly, for low latency reporting, what a network can see as for “real” latency, from the PRS is transmitted to the measurement results are actually received. The UL resource are actually needed for the report. Assume you have the measurement after T, but you don’t have the resource to send the report, this will be counted as “real” latency. So what PHY design can do? Having a configured PUSCH resource can help reducing the real latency. |
| Qualcomm |  | To Samsung: But the available T values are very large to really meet the latency requirements. Also, the way RAN4 defines the latency, it depends on the T\_last which is related to the T\_PRS. So, no, the value “T” doesn’t really provide what is needed to the network.  To HW/HiSi/All, lets then focus on Type-1A/1B only, and decouple Type-2 UEs. What about the following:   * ***For Type-1A/1B PRS processing without MG and within a PRS processing window, introduce an additional per-band UE capability as follows:***   + ***A UE reports {N2,T2} for a band which correspond to the following capability***     - ***A UE is expected to measure only the first N2 ms PRS within a PRS processing window, when it is configured with a PRS processing window that covers T2-N2 ms after the last symbol of the last PRS symbol of the N2 ms PRS.***     - ***Discuss in the UE feature session the values {N2,T2}*** |
| Ericsson | Alt 2 | The use of “L” is not clear to us. We think the “N,T” model for PPW is enough to know when the UE is ready to resume normal data reception. |
| OPPO | Alt3 | The priority rule configured for PRS can sufficiently do the job. Why do we need to restrict the UE to the first part of L of the PPW N. If that happens, the means the configuration of N and L is not proper. The system should choose more proper values for L and N. Given a configuration of PPW, a reasonable UE will process the PRS as soon as possible whenever the configured prioroity allows it. Alt1 is just to specify something that is totally UE implementation. |

**FL comment**

It appears that companies are trying to understand each other, and low latency processing is indeed required to be enabled.

The answer from Qualcomm in the second reply seems to offer a compromise solution, but my understanding is that the first half of the first bullet should also be applied to Type 2.

### Round 2

The FL has the following prossal based on the latest version from Qualcomm.

### Proposal 3.5.2-1

* For Type-1A/1B PRS processing outside MG and within a PRS processing window, introduce an additional per-band UE capability as follows:
  + A UE reports {N2,T2} for a band, which corresponds to the following capability
    - A UE is expected to measure only the first N2 ms PRS within a PRS processing window, when it is configured with a PRS processing window that covers T2-N2 ms after the last symbol of the last PRS symbol of the N2 ms PRS.
* For Type-2 PRS processing outside MG and within a PRS processing window, introduce an additional per-band UE capability as follows:
  + A UE reports {N2, T2} for a band, which corresponds to the following capability
    - A UE is expected to measure only the first N2 ms PRS within a PRS processing window.
* Discuss in the UE feature session the values {N2,T2} for all types.

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| **Company** | **Yes/No** | **Comments** |
| vivo |  | Let us further clarify our concern, we acknowledge the latency will be extended if Nms PRS is not at the beginning of PPW and if more PRS needs to be processed than N ms in a sample. But considering N can be 0.25 ms, we wonder only measuring the PRS within the first N ms can satisfy the positioning requirement.  In addition, if there is no appropriate PUSCH adjacent to the PPW to report location information, the reduced latency of enhancement PPW(ie, low latency PRS processing capability) is also meaningless. But companies think the reporting issue can be solved by gNB implementation, so we think, a similar idea can be used for PPW.  FL: My understanding is that network may still decide to switch on/off this operation, then it should fallback similar to Rel-16 but without MG. |
| Qualcomm |  | To vivo: We are fine to increase “N” and not start from 0.25 msec. We also think that this value was already too small from rel-16, but was added under the context of FR2, and a UE buffering a single slot. In theory, even within a single slot, in FR2, one could receive 14 PRS resources orthogonally (comb-2/2-symbols), so it is not so restrictive.  To the 2nd comment from vivo: the relation of PUSCH close to the PRS was discussed before (both in RAN1 nd RAN2). Now that the serving gNB is responsible for setting up the PPW, it can make sure, by implementation, to schedule a PUSCH (grant-free or grant-based) after the PPW. However, a similar idea cannot be used for PPW. The gNB needs to know how long the PPW needs to be. If it is too short, then the UE will be dropping the measurement. Note that for PPW, the UE cannot request a length, only the network configures it. So, how would the network know what is the appropriate length for the PPW, if the UE cannot request a specific length? We have to use a UE capability. What UE capability can now say what should be the PPW length? There is no such capability unless we introduce one.  To FL: The proposed compromise shown above is OK for us. |
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## Fallback operation

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| **Company** | **Proposals** |
| ZTE [3] | **Proposal 3:** UE performs PRS measurement following the measurement period defined in Rel-16 when the conditions for PRS processing window are not met. |
| SONY [7] | **Proposal 3:** In case the conditions for the MG-less measurement are not met, the UE dropped the positioning measurement.  **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 PRS processing window. |
| Nokia, NSB [8] | **Proposal 1**: RAN1 to discuss if a UE should make measurements both inside the MG and outside a MG in the same measurement report.  **Proposal 3**: Specify a fallback method for the UE to switch from PRS measurement outside of MG to MG-based if the UE drops enough PRS. |
| CMCC [11] | **Proposal 4:** Support the UE fallback to MG-based PRS measurement for the PRS not satisfying the conditions.   * Note: The UE may keep measuring the PRS satisfying the conditions outside MG. |

**FL comment**

The proposals seemed to have been mentioned for a couple of meetings. Given that the overall structure of MG-based PRS measurement and MG-less PRS measurement is already quite clear, it is suggested to review whether the enhancements in the proposals are essential or not.

From the FL point of view, we haven’t decided whether the PRS processing window activation request can be sent by the UE. If not, it appears that network configures and activates the PRS processing window in light of that network understands that UE can do PRS measurement outside MG and network expects UE to do so. It is not clear with this, why any further action at UE is required.

### Round 1

**Proposal 3.6.1-1**

* RAN1 to discuss the following issues of fallback operations
  + Conditions of fallback
    - C1: conditions of PRS processing windows are not met
    - C2: interruption event, e.g. BWP switching
    - C3: UE drops enough PRS
  + Result of fallback
    - R1: Switch to MG-based measurement
    - R2: Drop the positioning measurement
    - R3: Perform both MG-based measurement and MG-less measurement

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| **Company** | **Yes/No** | **Comments**  Including comments to conditions (C1,C2,C3) and results (R1,R2,R3) |
| ZTE | Yes | * RAN1 needs to discuss **whether both MG and PPW can be configured/activated to UE concurrently**. Our view is Yes as only PPW is not stable. PPW may not work sometimes because of BWP switching, dynamic SFI, etc. Hence, if PPW is not available anymore, MG should still be used in order to satisfy the positioning requirement. * As the processing capabilities for MG and PPW may not be the same, we think the latency requirement / response times should be also configured independently. |
| InterDigital | No | From our point of view, MG is a stable solution. The UE requests for MG if the UE needs to make measurements. If the PRS processing window cannot be configured, the UE will use MG. Thus, we do not see a need to discuss a fallback solution. |
| Nokia/NSB | Yes | At least we should clarify (potentially also with RAN4) if the UE is expected to do both MG-based and MG-less measurement or if fallback should be enabled if the UE is dropping many PRS. Otherwise MG-less may actually cause higher latency. |
| CATT | Yes | C1 may be a fallback condition. Other conditions may be further defined by RAN4 in needed. The Result of fallback can be R1. |
| Qualcomm | No | Up to RAN4 to decide on such aspects, if needed. |
| CMCC | Yes | Fallback condition: C1 and C2  Fallback behavior: Share similar views as Nokia that we should first decide whether a UE can perform both MG-based and MG-less PRS measurement. |
| Huawei, HiSilicon | No | We think the link C1/C3-R1 is already covered by RAN2/RRC when deciding when to send the MG activation request MAC CE. |
| LGE | No | We think the issue can be solved if gNB configures enough time of PRS processing window. So, we think it is just up to gNB and RAN1 does not need to discuss it as high priority. |
| Ericsson | No | This can be discussed in RAN4. |
| OPPO | No | It can be dicussed by RAN4 and it is more like a system implementation issue. |

**FL comment**

There is no consensus to support the fallback operation. Most companies expressed that it should be up to RAN4 to decide.

### Round 2

The FL has the following proposal.

### Proposal 3.6.2-1 (for conclusion)

* RAN1 understand that it is up to RAN4 whether and how to define
  + Whether UE is expected to do both MG-based and MG-less measurement, and
  + Whether UE may be allowed to fallback to MG-based measurement when both are enabled.

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| **Company** | **Yes/No** | **Comments**  Including whether an LS is needed. |
| Qualcomm |  | We don’t think that the fallback behavior should be discussed |
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## Type 2 capability details

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| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 1:**   * For capability 2 as per working assumption made in RAN1#106-e   + For FR1 bands, the DL signals/channels from the target CC that contains the PRS inside the PRS processing window are dropped if the DL PRS is determined to be higher priority.   + For FR2 bands, the DL signals/channels from all the CCs on the band that contains the PRS inside PRS processing window are dropped if the DL PRS is determined to be higher priority. * For capability 1B and capability 2, whether or not UE may indicate for each target FR2 band, a set of bands on which reception of the DL signals/channels may be interrupted due to a common Rx beam is up to RAN4. |
| vivo [2] | **Proposal 10:**   * For capability 2, the DL signals/channels from certain DL CCs are affected if the DL PRS is determined to be higher priority.   **Proposal 11:**   * The additional enhancement for the single beam receiving in FR2 is not introduced in Rel -17 since it can be solved by UE directly indicating that capability 1B is not supported if only a single beam can be supported in FR2. |
| Qualcomm [14] | **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 FR2 band, impacts the downlink receiving in another FR2 band. |

**FL comment:**

This is the last remaining issue from the working assumption from RAN1#106-e.

### Round 1

**Proposal 3.7.1-1**

* RAN1 to discuss the impacted CCs when PRS is high priority than data for capability 2
  + Option 1: Only the target CC that contains the PRS/PRS processing window
  + Option 2: All CCs within the band that contains the PRS

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| **Company** | **Option** | **Comments** |
| ZTE | 1 | Option 1 is more preferred as it less impacts data transmission |
| vivo | Option 1 |  |
| CATT | Option 1 |  |
| Qualcomm |  | For FR2, it should be Option 2 due to the same-Rx-beam constraint. |
| Huawei, HiSilicon |  | Option 1 for FR1 and Option 2 for FR2. |
| Xiaomi | Option 2 | at least for FR2 |
| LGE |  | We have similari view with Qualcomm. |
| Ericsson | Option 1 | Option 2 will lead to larger interruption for PDCCH/PDSCH. So, we prefer to go with Option 1. |
| OPPO | 1 |  |

**Proposal 3.7.1-2**

* RAN1 to discuss the other impacted FR2 bands when PRS on a certain FR2 band is higher priority than data for capability 1B and 2
  + Option 1: RAN1 to define signaling from UE
  + Option 2: Leave up to RAN4 to decide

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| **Company** | **Option** | **Comments** |
| ZTE | 2 | We don’t have strong view on this point and slightly prefer Option 2. |
| Vivo |  | We prefer to up to UE implementation for common Rx beam cases, for example, UE directly indicates that capability 1B/2 is not supported if only a single beam can be supported in FR2. |
| CATT |  | Either Option 2 or up to UE implementation |
| Huawei, HiSilicon | Option 2. | RAN4 is discussing general handling of scheduling availability. |
| Ericsson | Option 2 | Leave up to RAN4 to decide. |
| OPPO | Option 2 | It can be up to UE implementation to choose proper Rx beam for processing. No need to dicuss in RAN1 |

**FL comments**

With regards to impacted CCs for capability 2, most companies prefer to support only the target CC, while some concerns were raised for FR2 bands.

For the target CC in another FR2 band that share a common Rx beam with the PRS band, most companies believe this can be done by RAN4.

### Round 2

The FL has the following proposal. The wording is adjusted to align with the previous agreement

### Proposal 3.7.2-1

* For capability 2 as per working assumption made in RAN1#106-e
  + For FR1, only the DL signals/channels from a certain CC inside the PRS processing window are dropped if the DL PRS is determined to be higher priority
  + For FR2, only the DL signals/channels from a certain band inside the PRS processing window are dropped if the DL PRS is determined to be higher priority
* For the DL signals/channels from a different FR2 band than the FR2 band of the DL PRS for capability 1B and 2, subject to dropping due to the same Rx beam across mutilple FR2 bands if the DL PRS is determined to be higher priority, it is up to RAN4 to define.
  + Send an LS to RAN4.

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| **Company** | **Option** | **Comments** |
| Qualcomm | OK | We can accept the above progress |
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## Multiple processing types per band

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| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 5:** Do not support the capability reporting enhancement to allow UE to report support of multiple processing types among 1A, 1B, and 2. |
| NTT DOCOMO [6] | **Observation 1:**   * Prior to discuss the necessity of parameter of processing type, we should discuss the following remaining issue in UE features agenda.   + Whether a UE can support multiple types or not. * If RAN1 discuss Band/CC-ID for PRS processing window, not only the necessity of parameter but also the design of PRSProcessingWindow should be considered. |
| Qualcomm [14] | **Proposal 2:** 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.   * Note: It will be network’s decision which type of PPW shall be activated |

**FL comment:**

This has been discussed for a couple of meetings, even in the UE feature thread.

There was a typo in Huawei’s proposal.

### Round 1

**Proposal 3.8.1-1 (continued)**

* RAN1 to discuss whether UE may indicate support of more than one processing types on a band on which it supports PRS processing outside the MG inside the PRS processing window.
  + Alt.1: 1
  + Alt.2: >1

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| **Company** | **Alt** | **Comments** |
| ZTE | Alt. 2 | If Alt.2 is supported, the processing capabilities should be separate for different types. |
| Vivo | Alt 1 |  |
| CATT | Alt 1 |  |
| Qualcomm | Alt. 2 | We think it is very useful for both UEs and the network to have such a feature.   * UE vendors need to make a decision whether to support any of such features. There is a clear tradeoff of complexity between Type-1A/1B/2, and for the same processing/memory budget, depending on the Type, different PRS processing capabilities can be reported. * If the UE cannot provide multiple types, it will have to make a “hard decision” to pick, one of the types, making impossible to signal that the other types are also supportable, and therefore hardcoding the “overhead” of such a feature. * If the gNB is aware of the multiple types, it could decide to tradeoff between the highest-overhead type and the lowest-overhead type depending on the latency QoS and scenario of interest. E.g., if it is not a very low latency request, configure a Type-1B/2 PPW, but if it is a low-latency request, configure Type-1A. * This network flexibility would not be possible if a single Type is supported. |
| Huawei, HiSilicon | Alt. 1 | We prefer to make it simple in this release. |
| Samsung | Alt.2 | We think multiple capability type is useful sometime. |
| Xiaomi | Alt 1 | We are not sure about the use case for alt 2 |
| LGE | Alt. 1 |  |
| Ericsson | ok for Alt 2 | Alt 2 may provide network to choose which processing type to configure among the processing types supported by the UE. |
| OPPO | Alt1 | Alt2 might give more flexibility to the network but it cause complicate implementation to the UE side. And the use case is not clear. |

**FL comment**

This is somewhat a key issue discussed for more than a single meeting. It is recommended to treat the proposal in GTW. In the meantime, it is encouraged to continue discussion till the GTW.

### Round 2

The proposal is the same as round 1.

### Proposal 3.8.1-1 (GTW)

* RAN1 to discuss whether UE may indicate support of more than one processing types on a band on which it supports PRS processing outside the MG inside the PRS processing window.
  + Alt.1: 1
  + Alt.2: >1

|  |  |  |
| --- | --- | --- |
| **Company** | **Alt** | **Comments** |
| vivo | Alt 1 |  |
| CATT | Alt 1 |  |
| Qualcomm | Alt. 2 | We really think that Alt. 2 serves all parties: UEs, gNB, operators.  Can the proponents of Alt. 1 please provide technical arguments why they think Alt. 2 is not useful? |
| Huawei, HiSilicon | Alt. 1 | From our side, we would prefer to finalize the capability design for a single processing type per band, and evaluate the workload for introducing multiple.  One concern from our side on multiple processing types is that the capabilities are reported to gNB (type, priority states options) and LMF (PRS processing capability) separately. It appears that if PRS processing capabilities would be different for different types, LMF would anyway indicate the “assumed type” to the gNB, which lacks feasibility discussion and requires a lot of cross-WG discussion |

## Rx timing difference

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| vivo [2] | **Proposal 9:**   * One or multiple values ( CP length, 50% of the OFDM symbol, 1ms) can be supported based on the UE capability for the threshold of Rx timing difference. |
| Nokia, NSB [8] | **Proposal 4**: Enable UE to use local estimate of ExpectedRSTD for comparing the received time difference with the threshold for measurement outside of MG. |
| Ericsson [16] | **Proposal 5** The threshold to determine whether the PRS from the non-serving cell satisfy the condition of PRS measurement outside MG is only applicable for UEs with capability 2. |

**FL comments**

With regards to the proposal from vivo [2], RAN4 seemed to have discussed the LS to RAN1 regarding defining the thresholds as a UE capability, which was not approved in the end.

For the proposal from Nokia [8], the understanding from the FL is that it may actually require UE to measure the target PRS to get the “local estimate of Expected RSTD” in order to determine whether Rx timing difference is within the threshold.

For the proposal from Ericsson [16], the understanding from the FL is that although the discussion earlier implies the “synchronization threshold” should be applicable to all capabilities, other companies may have a second thought for that.

### Round 1 (closed)

**Proposal 3.9.1-1**

* RAN1 to discuss whether to progress on the following aspects for Rx timing difference to determine the condition of PRS measurement outside MG.
  + Q1: Whether the threshold can be UE capability
  + Q2: Whether the Rx timing difference can be calculated based on local estimate of Expected RSTD
  + Q3: Whether the threshold only applies to the UE with capability 2

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| ZTE | No | We prefer to wait for RAN4’s consensus. |
| vivo | Q1 or Q3 |  |
| Nokia/NSB | Yes | Q1: We are okay with UE capability but think it is up to RAN4  Q2: We are afraid that some companies are missing the fact that the granularity of the expected RSTD is 4\*Ts. If we only allow the LMF to configure the expected RSTD and then the UE is forced to use that only for determining if the Rx timing difference is sufficient then we fear this feature as a whole will be much less useful. Especially in periodic reporting cases where the assistance data may or may not be updated frequently.  To FL, our understanding is that the UE can have a local estimate of Expected RSTD (e.g., from prior PRS measurement or other signal measurement like CSI-RS). We are okay to clarify that this does not assume the UE would measure the current PRS occasions for the local estimate.  Q3: We are unclear why for capability 1A or 1B the UE would not need to check the Rx timing difference before receiving non-serving cell PRS without a MG. |
| CATT | Q3 |  |
| Qualcomm | No | We prefer RAN4 to continue the discussions |
| Huawei, HiSilicon | No | Prefer to let RAN4 discuss this.  Reply to Nokia, we believe that in this case, UE may choose to measure more than network expected (based on assistance data), but should that be left up to UE implementation? |
| LGE | No | RAN4 would take the issue. |
| Ericsson |  | Q1: No, the threshold is provide to the UE by the network to limit the amount of PRS that are applicable.  Q2: No, it should be provided.  Q3: agree. In our view, capability 1A and 1B already exclude all PRSs processing in the window if the data is prioritized, and vice versa. In that case all PRSs in the AD can be processed (if prioritized) since there is no data overlapping, or for low priority PRS, data wil be received and no PRS will be processed. |
| OPPO | No | Leave it to RAN4 |

**FL comments**

There was no consensus to further discuss this. The recommendation from the FL is to close this discussion for this meeting.

## Maximum number of preconfigured PRS processing window

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| vivo [2] | **Proposal 13:**   * The maximum of PRS Processing Windows can be 16. * The concurrent PRS processing window is not supported. |

**FL comments**

This may also be related on the PRS processing configuration details. For example, whether the PRS processing window is configured per UE or per BWP (as mentioned in RAN2)

Agreements:

Proposal 7: The PRS processing window configuration is provided via RRCReconfiguration message. Whether PRS processing window configuration is provided per BWP or not is up to RAN1 to decide.

### Round 1

**Proposal 3.10.1-1**

* The maximum number of preconfigured PRS processing windows is 16
  + Option 1: Per UE
  + Option 2: Per BWP

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| ZTE |  | Is this the same proposal as Proposal 3.1.1-1? if So, we can discuss them together. |
| vivo |  | Option 1, but it may relate to the discussion of 3.1.1-1 |
| Nokia/NSB |  | Same as proposal 3.1.1-1 |
| CATT |  | Option 2 |
| LGE |  | The proposal would be related with Proposal 3.1.1-1. We prefer to disuss them together. |
| Ericsson |  | Option 2 |
| OPPO |  | Option 2 |

**FL comment**

The proposal seemed to have caused some confusion. Let’s focus on the numbers per BWP and per UE.

### Round 2

### Proposal 3.10.2-1

* Please indicate the maximum number of preconfigured PRS processing window in the following table.

|  |  |  |
| --- | --- | --- |
| **Company** | **Maximum number per BWP if PRS processing window is configured per BWP** | **Maximum number per UE if PRS processing window is configured per UE** |
| FL |  | Similar to the maximum number of preconfigured MG |
| CATT | No more than the maximum number of preconfigured MG |  |
|  |  |  |

## Maximum number of PRS processing window per activation/deactivation

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| vivo [2] | **Proposal 13:**   * The maximum of PRS Processing Windows can be 16. * The concurrent PRS processing window is not supported. |
| Qualcomm [14] | **Proposal 6:** Simultaneously processing of multiple PRS processing windows on different CCs/Bands is not supported for the MG-less PRS processing feature: The UE is not expected to be activated with multiple PRS processing windows that overlap. |

### Round 1

**Proposal 3.11.1-1**

* The maximum number of PRS processing windows per activation/deactivation is 1

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| ZTE | Yes |  |
| vivo |  | We don’t think this proposal is aligned with our proposals, since there is no wording related to ‘concurrent or simultaneous PRS processing window’. We propose to modify it as the following  Proposal 3.11.1-1:  The maximum number of concurrent PRS processing windows is 1 |
| InterDigital | Yes |  |
| Nokia/NSB | Yes |  |
| CATT | Yes |  |
| Qualcomm | Yes | We also think that the word “concurrent” is important to be kept. This is not about just a simple signaling optimization (e.g. sending single MAC-CE to activate mutluple vs sending multiple MAC-CE), but it should be about, how many the UE is expected to be received concurrently. |
| Huawei, HiSilicon | No | We think 2 should be supported.  Reply to vivo and Qualcomm, we are confused by the wording “concurrent”. Does it mean UE cannot have multiple PRS processing window activated at the same time? However, according to Qualcomm’s explanation, it appears that how many (what) UE is expected to receive simultaneously is already covered by 3.12. |
| Xiaomi | Yes |  |
| Intel | Yes |  |
| LGE | YES |  |
| Ericsson | Yes |  |
| OPPO | Yes |  |

**FL comment**

It appears that most companies support single PRS processing window activation/deactivation per MAC CE.

### Round 2

The FL has the following proposals. Please indicate only if you have concern on the following proposal.

### Proposal 3.11.2-1

* The maximum number of PRS processing windows per activation/deactivation is 1.

|  |  |  |
| --- | --- | --- |
| **Company** | **No** | **Comments** |
| vivo |  | Based on the PRS configuration and UE capability, up to 4 PFLs can be configured to UE. If more than one PFL can be configured to UE, based on the RAN4 requirement, those PFL are needed to be measured. In addition, considering some companies propose the PPW is per BWP, we don’t think a PPW can be used for multiple PFLs like MG. So, we wonder if only 1 PPW can be activated, the requirement can be satisfied. Or does the majority only want the PPW used in one PFL scenario?  FL: It was discussed by another companies that PRS processing window can be activated/deactivated sequentially to allow UE to measure multiple PFLs. In addition, it is still possible that one (per BWP) PRS processing window can be used for multiple positioning frequency layers, if the PRS in the multiple positioning frequency layers share the same numerology, and the bandwidths of them can be both/all covered by the BWP in which the PRS processing window is configured. |
|  |  |  |
|  |  |  |

### Proposal 3.11.2-2

* The maximum number of concurrently activated PRS processing windows is 1.

|  |  |  |
| --- | --- | --- |
| **Company** | **No** | **Comments** |
| vivo |  | Agree |
|  |  |  |
|  |  |  |

## Number of PFLs in an instance of a PRS processing window

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Qualcomm [14] | **Proposal 5:** 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 6:** Simultaneously processing of multiple PRS processing windows on different CCs/Bands is not supported for the MG-less PRS processing feature: The UE is not expected to be activated with multiple PRS processing windows that overlap. |

**FL comment**

Proposal 5 from Qualcomm [14] is a reasonable assumption.

Proposal 6 from Qualcomm [15] seems a little bit unclear in that the first part is aligned with Proposal 5, but the second part seemed not aligned with the first part. Even if the PRS processing windows associated with different positioning frequency layers overlap, UE may still only be required to process one at a time. It appears that more discussion and clarification is needed.

### Round 1

**Proposal 3.12.1-1**

* 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.
* RAN1 to further discuss whether additional restriction on the overlapping between the activated PRS processing windows associated with PRS from different positioning frequency layers.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments**  Including additional restriction on the overlapping between the activated PRS processing windows. |
| ZTE | Yes |  |
| vivo |  | We think only PRS within an active BWP can be measured. But the first bullet point a single PFL can be measured, whether means the active BWP may include multiple PFL(s)?  For the second bullet, if only one window can be activated, why do we need to discuss the overlapping issue |
| InterDigital | Yes |  |
| Nokia/NSB |  | Okay with first bullet. |
| CATT |  | Support the first bullet. |
| Qualcomm | Yes |  |
| Huawei, HiSilicon | Yes | Do not see the need for the second bullet. |
| Xiaomi | Yes |  |
| Ericsson |  | We think PRSs within a BWP can be measured, and these could be across multiple PFLs. |

**FL comment**

It seems that most companies are OK with the first bullet, while some hesitance were shown on the second one.

Reply vivo: My interpretation is that this may be possible to have multiple PRS processing window activated at the same time (which may be further precluded if we adopt proposal 3.11.2-2). However for a given time instance, only a single positioning frequency layer can be processed by the UE. UE could do round-robin across multiple positioning frequency layers and across multiple PRS processing windows similar to Rel-16.

### Round 2

The FL has the following proposal. Please indicate only if you have concern on the proposal.

### Proposal 3.12.2-1

* 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.

|  |  |  |
| --- | --- | --- |
| **Company** | **No** | **Comments** |
| vivo |  | Sorry, we are still confused about the proposal, but we would like to check whether the following modification is right if removing “each single instance of”  Inside ~~each single instance of~~ a PRS processing window, a single PFL can be measured.  If it is right, we prefer removing “each single instance of”, otherwise, more clarification is needed.  FL: My understanding is that “single instance may be needed, if a single (per-BWP) PRS processing window can cover the measurement of multiple positionng frequency layers. However, I also do not think there is any technical drawback if “each single instance of” is removed. |
|  |  |  |
|  |  |  |

## Text proposal

The following TPs were provided.

|  |  |
| --- | --- |
| **Company** | **Text proposals** |
| Huawei, HiSilicon [1] | **TP1**  =================== START of TP ===================  The UE is expected to measure the DL PRS outside the measurement gap, subject to UE capability, if the DL PRS is inside the active DL BWP and has the same numerology as the active DL BWP and is within the DL PRS processing window indicated by higher layer parameter [*PRSProcessingWindow*].  For receiving the DL PRS outside the measurement gap and within the DL PRS processing window, the UE may be indicated by higher layer parameter [*PRS-priority-indicator*] subject to UE capability that  - the DL PRS is higher priority than all the DL signal/channels except SSB, or  - the DL PRS is lower priority than PDCCH and the PDSCH scheduled by DCI formats 1\_1 or 1\_2 with the priority indicator field in the corresponding DCI format set to 1, and is higher priority than other DL signals/channels except SSB, or  - the DL PRS is lower priority than all the DL signals/channels except SSB.  When the UE is expected to measure the DL PRS outside the measurement gap and is indicated by the higher layer parameter [*ProcessingType*] for Type-1A processing  - if the DL PRS is higher priority than the DL signals and channels, the UE is not expected to receive the DL signals and channels within the PRS processing window on all serving cells including SCG;  - if the DL PRS is lower priority than the DL signals and channels, the UE is not expected to receive the scheduled DL signals/channels in the PRS processing window on all serving cells including SCG, if the corresponding DCI is later than [*SchedulingThresholdBeforePPW*] before the start of the PRS processing window and there is no DL signals/channels configured during the PRS processing window or scheduled during the PRS processing window with DCI earlier than [*SchedulingThresholdBeforePPW*] before the start of the PRS processing window on any serving cell including SCG; otherwise the UE is not expected to receive the DL PRS within the PRS processing window.  When the UE is expected to measure the DL PRS outside the measurement gap and is indicated by the higher layer parameter [*ProcessingType*] for Type-1B processing  - if the DL PRS is higher priority than the DL signals and channels, the UE is not expected to receive the DL signals/channels within a PRS processing window on the serving cells in the same band as the DL PRS;  - if the DL PRS is lower priority than the DL signals and channels, the UE is not expected to receive the scheduled DL signals/channels in the PRS processing window on the serving cells in the same band as the DL PRS, if the corresponding DCI is later than [*SchedulingThresholdBeforePPW*] before the start of the PRS processing window and there is no DL signals/channels configured during the PRS processing window or scheduled during the PRS processing window with DCI earlier than [*SchedulingThresholdBeforePPW*] before the start of the PRS processing window on serving cells in the same band as the DL PRS; otherwise the UE is not expected to receive the DL PRS within the PRS processing window.  When the UE is expected to measure the DL PRS outside the measurement gap and is indicated by the higher layer parameter [*ProcessingType*] for Type-2 processing  - if the DL PRS is higher priority than the DL signals and channels, the UE is not expected to receive any DL signals/channels on a DL PRS symbol within the PRS processing window on the impacted serving cells;  - if the DL PRS is lower priority than the DL signals and channels, UE is not expected to receive the scheduled DL signals/channels on the DL PRS symbols on the impacted serving cells, if the corresponding DCI is later than [*SchedulingThresholdBeforePPW*] before the symbol and there is no DL signals/channels configured on the symbol on the impacted serving cells; otherwise the UE is not expected to receive the DL PRS on the symbol within the PRS processing window;  - The impacted serving cells refer to the serving cell with the active DL BWP that covers the DL PRS bandwidth and has the same numerology as the DL PRS for FR1, and the serving cells in the same band as the DL PRS for FR2.  =================== END of TP =================== |
| CMCC [11] | **TP2**  <omitted text>  The UE is expected to measure the DL PRS outside the measurement gap, subject to UE capability, if the DL PRS is inside the active DL BWP and has the same numerology as the active DL BWP and is within the DL PRS processing window indicated by higher layer parameter [*PRSProcessingWindow*]. For receiving the DL PRS outside the measurement gap and within the DL PRS processing window, the UE determines the DL PRS priority with [other DL signals or channels except SSB] as indicated by higher layer parameter [*PRS-priority-indicator*] or as implied by UE capability.  When the UE is expected to measure the DL PRS outside the measurement gap if it is supporting [capability 1A] and if the DL PRS is determined to be higher priority than the DL signals and channels inside the PRS processing window, those DL signals and channels are not expected to be measured by the UE. When the UE is expected to measure the DL PRS outside the measurement gap if it is supporting [capability 1B] and if the DL PRS is determined to be higher priority than the DL signals and channels inside the PRS processing window, those DL signals and channels in the same band as the DL PRS are not expected to be measured by the UE. When the UE is expected to measure the DL PRS outside the measurement gap if it is supporting [capability 2] and if the DL PRS is determined to be higher priority than the DL signals and channels inside the PRS processing window, those DL signals and channels are not expected to be measured by the UE on the overlapped symbols with the DL PRS.<omitted text>  **TP3**  <omitted text>  The UE is expected to measure the DL PRS resource outside the active DL BWP or with a numerology different from the numerology of the active DL BWP if the measurement is made during a configured measurement gap. When the UE is expected to measure the DL PRS resource, the UE may request a measurement gap via higher layer parameter *NR-PRS-MeasurementInfoList* [12, TS 38.331] or as specified in clause X of [10, TS 38.321]. The UE may be preconfigured with one or more measurement gaps each associated with an [ID]. When the UE requests activation or deactivation a measurement gap as specified in clause [X] of [10, TS 38.321]it can request one of the preconfigured measurement gaps by referring to the [ID]. The UE may have one of the preconfigured measurement gap(s) activated or deactived as specified in clause[X] of [10, TS 38.321].  <omitted text> |

**FL comments**

The TP may be later discussed based on the existing progress.

### Round 1

### Proposal 3.13.1-1

* The TPs are to be further checked after the progress during the meeting.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments**  Including comments to the TP1, TP2, and TP3. |
| vivo |  | Okay for TP3.  For the TP2 related part, the Huawei version is okay for us.  For the PRS collision timeline part, it depends on the discussion of 3.4. |
| Ericsson |  | On TP1, we agree with only part of the TP. The following part of the TP can be agreed as there is already corresponding agreements in RAN1:  \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  The UE is expected to measure the DL PRS outside the measurement gap, subject to UE capability, if the DL PRS is inside the active DL BWP and has the same numerology as the active DL BWP and is within the DL PRS processing window indicated by higher layer parameter [*PRSProcessingWindow*].  For receiving the DL PRS outside the measurement gap and within the DL PRS processing window, the UE may be indicated by higher layer parameter [*PRS-priority-indicator*] subject to UE capability that  - the DL PRS is higher priority than all the DL signal/channels except SSB, or  - the DL PRS is lower priority than PDCCH and the PDSCH scheduled by DCI formats 1\_1 or 1\_2 with the priority indicator field in the corresponding DCI format set to 1, and is higher priority than other DL signals/channels except SSB, or  - the DL PRS is lower priority than all the DL signals/channels except SSB.  \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  The other parts of TP1 needs further agreement. So we can take them later. |
| FL |  | Let’s continue reviewing on the TPs |
|  |  |  |
|  |  |  |
|  |  |  |

## Others

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| vivo [2] | **Proposal 14**   * Support on-demand PRS configured/requested in a PRS processing window. |
| Nokia, NSB [8] | **Proposal 6:** RAN1 to support PRS processing outside of MG indicator as an additional parameter for UE-initiated on-demand DL PRS request. |
| Samsung [13] | **Proposal 3:** The default PRS priority state can be always higher than all PDCCH/PDSCH/CSI-RS. |
| Ericsson [16] | **Proposal 2** For UE declaring capability 1A or 1B, the LMF PPW request to the gNB includes the following:  a. a way the gNB to identify the UE (details of which can be left to RAN2)  b. PPW length, start and periodicity. |

**FL comment**

* The proposals from vivo [2] and Nokia [8] should be discussed in on-demand PRS agenda
* The proposal from Samsung [13] depends on RAN2 signaling design
* The proposal from Ericsson [16] depends on RAN3 discussion, which RAN1 agreed to leave up to RAN3.

### Round 1 (closed)

**Proposal 3.14.1-1**

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

|  |  |
| --- | --- |
| **Company** | **Comments on the necessity of any specific proposal** |
|  |  |
|  |  |
|  |  |

No feedback. Let’s close this discussion.

# Other latency improvements features

## 1-sample PRS processing

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| OPPO [4] | Proposal 1: The LMF shall request the same M=1-sample or 4-sample measurement for all the positioning methods to one UE. The UE shall expect the same M=1-sample or 4-sample measurement to be performed on all positioning methods configured to the UE. |
| CATT [5] | **Proposal 4:** Adopt option 1 for definition of numOfSamples-perMeasurement: a single numOfSamples-perMeasurement applies for all PFLs. |
| LGE [15] | **Proposal #1:**   * For request location information, introduce a parameter for distinguishing between a specific case (e.g. 1<=M<4 sample(s)) and the normal case (e.g. 4 samples) which is accompanied in request location information. The parameter can be included in the following IEs:   + Common IEs for request location information (e.g. CommonIEsRequestLocationInformation)   + Positioning method specific IEs (e.g. NR-DL-TDOA-ProvideLocationInformation, NR-DL-AoD-ProvideLocationInformation, NR-Multi-RTT-ProvideLocationInformation, etc.) |

**FL comment**

The proposals from components seem useful clarification, however it is not clear whether RAN1 could make the decision.

### Round 1

**Proposal 4.1.1-1**

* RAN1 to discuss
  + Issue 1: Whether the M-sample indication is applicable
    - Alt.1: per UE that is for all concurrent NR positioning methods
    - Alt.2: per NR positioning method
  + Issue 2: Whether the M-sample indication is applicable
    - Alt.1: for all positioning frequency layers
    - Alt.2: per positioning frequency layer

|  |  |  |
| --- | --- | --- |
| **Company** | **Alt** | **Comments** |
| ZTE | Alt 1 for both | In our view, for some measurement, single operation may be implemented for different positioning methods for simplicity. Hence, Alt. 2 may not be preferred. |
| vivo |  | Issue 1: Alt 1  Issue 2: for latency reduction perspective, the M should be applicable for all PFLs, but M-sample capability is a per band capability, we doubt single-sample can be supported for all PFLs |
| Nokia/NSB |  | Not for RAN1 to decide/discuss |
| CATT | Alt 1 for both |  |
| Huawei, HiSilicon | Alt.1 for both |  |
| Intel | Alt 1 | Issue 1: Alt 1  Issue 2: Alt 1 |
| LGE | Alt.1 for both |  |
| Ericsson | Alt1 for both. |  |
| OPPO | Alt1 for both |  |

**FL comment**

Most companies prefere to have Alt.1 for both issues.

### Round

The FL has the following proposal. Please indicate only if you have concern on the proposal.

### Proposal 4.1.2-1

* The M-sample indication is applicable for all concurrent NR positioning methods and for all positioning frequency layers

|  |  |  |
| --- | --- | --- |
| **Company** | **No** | **Comments** |
| Qualcomm | No | For Issue 2: we are K with Alt. 2  Sorry we didn’t reply before. Each method should have a separate M-sample location request. What does it mean “concurrent methods”? Does it mean, methods that the UE receives with a single location request?  What if there are concurrencies across methods that are on different location requests? Why would there be relation between the 2 requests?  What if the LMF wants to ask the UE to do one method to get a fast response, but at the same time, ask for a 2nd method in order to get a more accurate report a bit later.  Overall, We think that the indication request should be per-method.  FL: Just to clarify my understanding here.  Qualcomm want Alt.2 for Issue 1 (instead of issue 2)?  My understanding of “concurrent methods” is restricted to a single LPP session, that corresponds to a single LCS request. (see TS 37.355)  A single LPP session is used to support a single location request (e.g., for a single MT-LR, MO-LR or NI-LR). Multiple LPP sessions can be used between the same endpoints to support multiple different location requests (as required by TS 23.271 [3]).  For 2 LCS requests, my understanding is that two LPP sessions needs to be established, which uses different “correlation identifier” (or “routing identifier”) in TS 24.571.  So if two LCS requests need two differnet QoS (latency/accuracy) requirement and may even received by LMF at different times, it should be safe from the LMF to configure two separate LPP sessions.  On LMF asking UE to do one method to get a fast response, and another to get a normal response for a better accuracy, I am not sure whether RAN2 can implement this in LPP, but the current *time* Qos in LPP is in the CommonIEsRequestLocationInformation, which is applicable to all positioning methods (including GNSS if concurrently in a LPP session). There were proposals to enhance early measurement reporting (similar to early fix), but it was not agreed in RAN1 after so many meetings. |
|  |  |  |
|  |  |  |

## Reduced Rx beam sweeping factor

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| vivo [2] | **Proposal 15**   * The Rx beam sweeping factor is determined by UE itself. |
| ZTE [17] | **1. Overall Description:**  RAN1 would like to thank RAN4 for the Reply LS R1-2200899 (R4-2202678) on lower Rx beam sweeping factor for latency improvement.  In RAN1, a new UE capability has been agreed for lower Rx beam sweeping factor, i.e. FG 27-9 listed in LS R1-2200780/ R1-2200781. However, the candidate values of lower Rx beam sweeping factor is still FFS. So RAN1 will adopt the candidate values {1, 2, 4, 6} provided from RAN4.  Furthermore, RAN1 would like to support LMF signalling to configure UE performing measurements with a reduced Rx beam sweeping factor. The candidate values of the reduced Rx beam sweeping factor configured by LMF can be {1, 2, 4, 6} as well.  **2. Actions:**  RAN1 respectfully asks RAN4 to take the above information into account. |

**FL comment**

The reply from RAN4 indicates that

* RAN4 will further study whether UE needs to be configured by LMF to perform measurements with a reduced Rx beam sweeping factor.

The understanding from the FL is that whether the Rx beam sweeping factor is determined by UE or indicated by LMF is up to RAN4 to decide.

### Round 1 (closed)

**Proposal 4.2.1-1**

* It is up to RAN4 to study whether the Rx beam sweeping factor is determined by the UE or indicated by the LMF.

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| **Company** | **Yes/No** | **Comments** |
| ZTE |  | If majority companies think this can be done by RAN4, we are fine. |
| vivo |  | We prefer to up to UE, we can accept to up to RAN4 if the majority think it is should be decided by RAN4. |
| Nokia/NSB |  | RAN4. |
| CATT | Yes |  |
| Huawei, HiSilicon | Yes |  |
| LGE | Yes |  |
| Ericsson | Yes |  |

**FL comment**

Most companies think that it should be up to RAN4 to decide. The reply from RAN4 already indicates that they will study this. The discussion is closed.

## MAC CE activation/deactivation delay

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| **Company** | **Proposals** |
| Qualcomm [14] | **Proposal 1:** For a UE configured with preconfigured Measurement gap(s) for Positioning,   * when a UE receives an activation command, as described in clause [6.1.3.X] of [10, TS 38.321], for a preconfigured Measurement Gap for Positioning activation, and when the UE would transmit a PUCCH with HARQ-ACK information in slot n corresponding to the PDSCH carrying the selection command, the corresponding actions in [10, TS 38.321] and the UE assumptions shall be applied starting from the first slot that is after slot where is the SCS configuration for the PUCCH.   **Proposal 7:** For a UE configured with Positioning Processing Window(s),   * when a UE receives an activation command, as described in clause [6.1.3.X] of [10, TS 38.321], for a PRS processing window activation, and when the UE would transmit a PUCCH with HARQ-ACK information in slot n corresponding to the PDSCH carrying the selection command, the corresponding actions in [10, TS 38.321] and the UE assumptions shall be applied starting from the first slot that is after slot where is the SCS configuration for the PUCCH. |

**FL comments**

The proposals from Qualcomm [14] seems straightforward, and fit in the description of TS 38.214. However, it is not clear from the FL understanding whether the deactivation should also be added to the proposal.

### Round 1

### Proposal 4.3.1-1

* For a UE configured with preconfigured Measurement gap(s) for Positioning, when a UE receives an activation command, as described in clause [6.1.3.X] of [10, TS 38.321], for a preconfigured Measurement Gap for Positioning activation, and when the UE would transmit a PUCCH with HARQ-ACK information in slot n corresponding to the PDSCH carrying the selection command, the corresponding actions in [10, TS 38.321] and the UE assumptions shall be applied starting from the first slot that is after slot where is the SCS configuration for the PUCCH.
* For a UE configured with Positioning Processing Window(s), when a UE receives an activation command, as described in clause [6.1.3.X] of [10, TS 38.321], for a PRS processing window activation, and when the UE would transmit a PUCCH with HARQ-ACK information in slot n corresponding to the PDSCH carrying the selection command, the corresponding actions in [10, TS 38.321] and the UE assumptions shall be applied starting from the first slot that is after slot where is the SCS configuration for the PUCCH.

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| **Company** | **Yes/No** | **Comments**  Including suggested wording in the TP, and whether to endorse the TP directly or leave it up to editor to incorporate the proposal/agreement in specification |
| ZTE | Yes in principle | The exact wording can be polished further or up to editor. For example, PUSCH may also be used for HARQ-ACK delivery. |
| vivo |  | The proposal is generally okay except for the wording about” the selection command” which is unclear to us. |
| Huawei, HiSilicon | Yes in principle | The selection command could be replaced by “activation command”. |
| Ericsson | Yes |  |
| FL |  | Let’s continue to review the TP. |
| Qualcomm | Yes |  |

## Others

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| --- | --- |
| **Company** | **Proposals** |
| ZTE [3] | **Proposal 4**: 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 5:** 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. |
| SONY [7] | **Proposal 6:** Support CG-PUSCH for positioning measurement report enhancements in order to reduce the latency. |

**FL comment**

The above proposals are considered non-essential and have been discussed for a few meetings without consensus.

### Round 1 (closed)

**Proposal 4.4.1-1**

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

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| **Company** | **Comments on the necessity of any specific proposal** |
| ZTE | The proposals from ZTE is related with section 3.6, i.e. if both MG and PPW can be configured concurrently. We can discuss these issue together. |
| vivo | To be honest, if there is no appropriate PUSCH adjacent to the PPW to report location information, the reduced latency of enhancement PPW(ie, low latency PRS processing capability) is also meaningless.  But companies think the reporting issue can be solved by gNB implementation, so we think, a similar idea can be used for PPW. |
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# LS-in

## R1-2200889 Reply LS on latency improvement for PRS measurement with MG RAN2, Nokia

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| **1. Overall Description:**  RAN2 thanks RAN1 for the LS on latency improvement for PRS measurement with MG. RAN2 discussed the signaling support for pre-configured measurement gap for positioning solution and reached the following conclusions/agreements. Please note that DL MAC CE can also be used for positioning measurement gap deactivation as well as activation.  Agreements:  The pre-configured Measurement Gap Configurations for Positioning are provided via *RRCReconfiguration* message. The pre-configured Measurement Gap Configurations for Positioning are included in IE *MeasGapConfig*.  The content of the pre-configured Measurement Gap Configurations for Positioning includes at least the existing measurement gap parameters together with an ID identifying each Measurement Gap Configuration for Positioning.  The existing RRC *LocationMeasurementIndication* procedure to request the positioning measurement gaps can still be used by a UE, even when pre-configured measurement gaps are provided to the UE.  Agreements:  A new UL MAC CE for positioning measurement gap activation and deactivation request is introduced.  The new UL MAC CE for positioning measurement gap activation and deactivation request includes at least the ID of the pre-configured positioning measurement gap configuration for which the activation/deactivation is requested. Other parameter are FFS.  A new DL MAC CE for positioning measurement gap activation and deactivation command is introduced for positioning latency reduction.  The new DL MAC CE for positioning measurement gap activation and deactivation command includes at least the ID of the pre-configured positioning measurement gap configuration which has been configured/activated by the gNB. Other parameter are FFS.  The Scheduling Request should be triggered when there is no PUSCH and UL MAC CE for positioning measurement gap activation/deactivation request is triggered.  Agreements:  On the concurrent measurement gap, RAN2 wait for further input from RAN1/RAN4.  - On the Network-Controlled Small Gap, RAN2 wait for further input from RAN1/RAN4.  **2. Actions:**  **To RAN1/RAN4**  **ACTION:** RAN2 respectfully asks RAN1/RAN4 to take above agreements on pre-configured measurement gap for positioning into account. |

### Round 1

### Proposal 5.1.1-1

* It appears no reply LS in particular to the content is needed. The related RAN1 discussion is already included in section 2.1.

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| **Company** | **Comments to the incoming LS** |
| Nokia/NSB | Agree with FL. |
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## R1-2200899 Reply LS on lower Rx beam sweeping factor for latency improvement RAN4, CATT

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| 1 Overall description  RAN4 thanks RAN1 for the LS on lower Rx beam sweeping factor for latency improvement. RAN4 discussed the issue and reached the following agreements:   |  | | --- | | * RAN4 confirm that it is feasible to introduce a new UE capability on lower Rx beam sweeping factor (<8) to reduce the PRS measurement latency for FR2 positioning frequency layers. * Reduced Rx beam sweeping factor (<8) capability can be applicable without any additional conditions   + No impact on positioning measurement accuracy requirements for UEs supporting the capability   + Positioning measurement period requirements will be reduced for UEs supporting the capability * The following Rx beam sweep numbers are supported for reduced Rx beam sweeping factor (<8) UE capability: {1, 2, 4, 6}. * RAN4 will further study whether UE needs to be configured by LMF to perform measurements with a reduced Rx beam sweeping factor. |   RAN4 kindly asks RAN1 to take the above information into account in the following work on NR positioning enhancements.  2 Actions  **To RAN WG1:**  **ACTION:** RAN4 kindly asks RAN1 to take the above information into account in the following work on NR positioning enhancements. |

### Round 1

### Proposal 5.2.1-1

* It appears no reply LS in particular to the content is needed. The related RAN1 discussion is already included in section 4.2.

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| **Company** | **Comments to the incoming LS** |
| Nokia/NSB | Agree with FL. |
| CATT | Agree with FL. |
| LGE | Same view to FL. |
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## R2-2203597 LS to RAN1 on positioning issues needing further input

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| |  |  |  | | --- | --- | --- | | **Preconfigured MG** | The gNB may activate the pre-configurated measurement gap upon receiving the request from a UE or LMF."  **Issue:** FFS on whether MG activation/deactivation request from the LMF can also be applicable to R16 MG configuration in addition to positioning MG preconfiguration, i.e. Can LMF ask the gNB to configure the MG (e.g. via RRC) directly? | **RAN1 provides further clarifications on the issue;** | | **PRS processing window** | **Issues:**  FFS:Whether PRS processing window configuration is provided per BWP or not is up to RAN1 to decide.  FFS: Whether UE can be configured with multiple PRS processing windows should be decided by RAN1.  FFS on the max number of PPW configurations (from Stage 2 discussion)  FFS: whether UE should monitor PDCCH during RAR window/msgB window ot contention resolution timer for the affected symbols by PPW | **RAN1 provides further clarifications on the issue;** | |

### Round 1

### Proposal 5.3.1-1

* Please indicate your input to RAN2 request on preconfigured MG.

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| **Company** | **Comments** |
| vivo | We prefer LMF cannot ask the gNB to configure the MG (e.g. via RRC) directly? |
| FL | Just to clarify my understanding here since the reply LS is urgent.  For the question from RAN2, my interpretation is that RAN2 wonder whether it is possible that LMF sends the MG activation request to the gNB, but gNB, instead of sending DL MAC CE to activate the preconfigured MG, sends RRCReconfiguration to configure the MG to the UE. I understand that “directly” may be misunderstood by RAN1, but that from my perspectively, is the most reasonable explanation.  **My tentative reply to the question would be**  It is RAN1 understanding that upon reception of MG activation request from the LMF, gNB may still configure the MG with RRC as in Rel-16. RAN1 also understand that gNB behaviour for this is up to gNB implementation, and gNB does not expect to be asked by the LMF to configure MG with RRC. |
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### Proposal 5.3.1-2

* Please indicate your input to RAN2 request on PRS processing window

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| **Company** | **Comments** |
| FL | I think the first three issues are already covered by previous discussion. It appears only the last issue is new. |
| vivo | Agree with FL’s view, and provide our views as follows Sub bullet 1: it depends on the discussion of Proposal 3.1.2-1Sub bullet 2/3: Yes, we prefer the maximum number of PPW can be 16.Sub bullet 4: based on the priority agreement, we wonder it can be solved by all PDCCH/PDSCH/CSI-RS can include RAR window/msgB window **Agreement**  The following options are supported subject to UE capability for priority handling of PRS when PRS measurement is outside MG.   * + Option 1: UE may indicates support of two priority states.     - State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS     - State 2: PRS is lower priority than all PDCCH/PDSCH/CSI-RS   + Option 2: UE may indicate support of three priority states     - State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS     - State 2: PRS is lower priority than PDCCH and URLLC PDSCH and higher priority than other 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 all PDCCH/PDSCH/CSI-RS   + Option 3: UE may indicate support of single priority state     - State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS   Note: SSB is a separate issue. |
| FL | I think that the question from RAN2 on the first FFS is due to the following MAC description with regards to MG. 5.14 Handling of measurement gaps During a measurement gap, the MAC entity shall, on the Serving Cell(s) in the corresponding frequency range of the measurement gap configured by *measGapConfig* as specified in TS 38.331 [5]:  1> not perform the transmission of HARQ feedback, SR, and CSI;  1> not report SRS;  1> not transmit on UL-SCH except for Msg3 or the MSGA payload as specified in clause 5.4.2.2;  1> if the *ra-ResponseWindow* or the *ra-ContentionResolutionTimer* or the *msgB-ResponseWindow* is running:  2> monitor the PDCCH as specified in clauses 5.1.4 and 5.1.5.  1> else:  2> not monitor the PDCCH;  2> not receive on DL-SCH.  So even in a MG, RACH procedure still takes higher priority than measurement. The question to RAN1 is that when there should be a similar exception for PRS processing window.  Maybe RACH processing should be higher priority because the procedure is triggered by UE in the first place e.g. when BFR or RLF happens  **My tentative reply to the question would be**  It is RAN1 understanding that UE should monitor PDCCH during RAR window/msgB window or contention resolution timer for the affected symbols by the PRS processing window. |

# Conclusion