**3GPP TSG-RAN WG1 Meeting #106b-e R1-2100446**

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

**Agenda Item: 8.5.4**

**Source: Moderator (Huawei)**

**Title: FL summary #2 of 8.5.4 latency improvements for DL and DL+UL methods**

**Document for: Discussion and decision**

# Introduction

In RAN1#106b-e, the following papers provided input on latency improvements for DL and DL+UL methods.

1. R1-2108733 Enhancements to positioning latency improvements Huawei, HiSilicon
2. R1-2108881 Discussion on latency reduction for NR positioning ZTE
3. R1-2108978 Discussion on latency enhancement for NR positioning vivo
4. R1-2109054 Enhancements on Latency Reduction in NR Positioning OPPO
5. R1-2109227 Further discussion on latency reduction for NR positioning CATT
6. R1-2109255 Discussion on latency improvement for positioning methods China Telecom
7. R1-2109285 Discussion on latency improvement for positioning CMCC
8. R1-2109366 Views on PHY Latency Reductions Nokia, Nokia Shanghai Bell
9. R1-2109414 Latency improvements for both DL and DL+UL positioning method Xiaomi
10. R1-2109493 Discussion on latency improvements for both DL and DL+UL positioning methods Samsung
11. R1-2109614 Solutions for NR Positioning Latency Reduction Intel Corporation
12. R1-2109682 Discussion on latency improvements for both DL and DL+UL positioning methods NTT DOCOMO, INC.
13. R1-2109793 Considerations on latency improvements for NR positioning Sony
14. R1-2110038 Views on Rel-17 positioning latency reduction Apple
15. R1-2110091 Discussion on latency improvements for NR positioning LG Electronics
16. R1-2110149 Latency improvements for both DL and DL+UL positioning methods InterDigital, Inc.
17. R1-2110190 Remaining issues on Latency Improvements for Positioning Qualcomm Incorporated
18. R1-2110257 Physical latency improvement aspects MediaTek Inc.
19. R1-2110300 Enhancements for Positioning Latency Reduction Lenovo, Motorola Mobility
20. R1-2110352 Latency improvements for both DL and DL+UL positioning methods Ericsson

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

[106bis-e-NR-ePos-04] Email discussion/approval on latency improvements for both DL and DL+UL positioning methods with checkpoints for agreements on October 14 and 19 – Su (Huawei)

# Measurement gap enhancements

## General information

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

|  |
| --- |
| Agreement:For the purpose of positioning latency reduction, with potential support of a new mechanism of MG request, consider the following options with a decision to be made in RAN1#106b.* Option. 1: by LMF (via a NRPPa message)
* Option. 2: by UE (via UCI or UL MAC CE)

Agreement:For the purpose of positioning latency reduction, with potential support a new MG activation and deactivation procedure, consider the following options with a decision to be made in RAN1#106b (and RAN4 to be informed about any decision made)* Option. 1: DCI
* Option. 2: DL MAC CE
* Option. 3: UE autonomously applies the MG

FFS whether deactivation can be implicit via configurable number of the MG occasions |

## MG activation request (H)

The following sources provided their views on MG activation request.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 2:** For the MG request, only support LMF based request, and the request may indicate either one of the following:* Full configuration of PRS for the UE to measure
* Time span and frequency information of the PRS measurement
 |
| ZTE [2] | **Proposal 5:** For the sake of latency reduction related to the measurement gap, Rel-17 should allow LMF to request measurement gap. |
| vivo [3] | **Proposal 4:** * The MG request including the activated/deactivated indication (Option 1-B) by the LMF can be supported first if the information is transmitted in the NRPPa Request location information (via a UE-associated NRPPa message)

**Proposal 6:** * If the MG request is by the UE, the Pre-configured MG should be supported considering the latency reduction and overhead of signaling.

**Proposal 7:** * For the case of MG request from UE
	+ MG Request including the activation/deactivation indication is from UE to gNB by MAC CE.
	+ MG activation/deactivation of a pre-configured MG can be from gNB to UE by DCI or MAC CE
 |
| OPPO [4] | Proposal 3: Support the UE to use MAC CE to request a MG configuration. |
| CATT [5] | **Proposal 6:** For the purpose of positioning latency reduction, with potential support of a new mechanism of MG request, support both of the following options:• Option. 1: by LMF (via a NRPPa message).• Option. 2: by UE (via UCI or UL MAC CE). |
| China Telecom [6] | **Proposal 1:** Rel-17 should support a new mechanism of MG request by UE via UCI or UL MAC CE at least for UE-based positioning methods. |
| CMCC [7] | **Proposal 2:** For the purpose of positioning latency reduction, with potential support of a new mechanism of MG request, support the following options:* Option. 1: by LMF (via a NRPPa message)
* Option. 2: by UE (via UCI or UL MAC CE)
 |
| Nokia, NSB [8] | **Proposal 2**: Do not support option 1 or option 2 for MG request mechanisms.  |
| Xiaomi [9] | **Proposal 1:** Support MG request by both LMF and UE. |
| Samsung [10] | **Proposal 5:** Both option 1(by LMF) and option2 (by UE) could be supported for the MG request; |
| Intel [11] | **Proposal 1:*** + To reduce latency of NR positioning with MGs for DL PRS processing define the following enhancements
		- …
		- Support new mechanism for MG request from LMF to gNB via NRPPa signaling
			* Signaling details are left up to RAN3
	+ Inform RAN2/RAN3/RAN4 capturing outcome of the RAN1 discussion on MG enhancements for NR positioning latency reduction with a request to implement necessary NRPPa/LPP signaling
 |
| DCM [12] | **Proposal 1:** * Rel-17 should support at least UE-initiated MG request via lower layer signaling
 |
| SONY [13] | **Proposal 3:** Support new mechanism of measurement gap request using both options:* From LMF to gNB via NRPPa
* From UE to gNB via UCI
 |
| LGE [15] | **Proposal 2:** * For the purpose of positioning latency reduction, RAN1 can support all options (initiated by LMF (option #1) and by UE (option #2)) for MG request.
 |
| IDC [16] | **Proposal 2:** For latency reduction, the UE can make a request for a measurement gap to the gNB via UL MAC-CE |
| Qualcomm [17] | **Proposal 4:** For low latency MG request, support request of MG(s) with an UL MAC-CE from the UE. |
| MTK [18] | **Proposal 2-1**: The new mechanism of MG request is initiated by LMF through NRPPa**Proposal 2-2**: For new mechanism of MG request, the corresponding information to assist gNB for proper MG arrangement for a UE, for example the frequency layer/band for measurement, and DL-PRS configuration of neighbouring gNBs could be further discussed in RAN2 |
| Lenovo, MotM [19] | **Proposal 2:** Option 1 request of the MG by the LMF via a NRPPa message can at least be supported. |

The positions of companies are shown below.

* Option 1 (By LMF)
	+ Supported by (11): Huawei/HiSilicon, ZTE, vivo, CATT, CMCC, Xiaomi, Samsung, Intel, SONY, LGE, MTK
	+ Not supported by: Nokia/NSB
* Option 2 (By UE)
	+ Supported by (12): vivo, OPPO, CATT, CTC, CMCC, Xiaomi, Samsung, DCM, SONY, LGE, IDC, QC
	+ Not supported by: Nokia/NSB

**FL comments:**

According to the understanding of the FL

* Option 1 (by LMF) can go in parallel with the LPP RequestLocationInformation initiated by the LMF, but UE is not allowed to choose the PRS to measure.
* Option 2 (by UE) must go after UE receives the LPP RequestLocationInformation initiated by the LMF, but UE has the freedom to choose which PRS to measure to the gNB. The second level details of Option 2 (UCI or UL MAC CE) should also be decided.

It is also the FL’s understanding that the MG request initiated by LMF or UE may include information beyond measurement gap itself, e.g. information related to PRS, which should be resolved if either Option is adopted.

In addition, Rel-16 and earlier release already specified UE RRC based location measurement indication to facilitate MG configuration, which can serve as the fallback method, but this may not be latency friendly.

### Round 1

Based on the input, the FL has the following initial question.

### Question 2.1.1-1

* Companies are invited to provide inputs to the following options with regards to MG activation request.
	+ Option 1: by LMF (via a NRPPa message)
	+ Option 2: by UE (via UCI or UL MAC CE)
	+ Option 3: both Option 1 and Option 2 are supported
	+ Option 4: neither Option 1 or Option 2 is supported

|  |  |  |
| --- | --- | --- |
| **Company** | **Options** | **Comments:** *Please indicate why Option 1 or Option 2 should NOT be supported.* |
| vivo | Option 1 if measurement request can be transmitted to gNB | The latency can be reduced significantly based on the two enhancements, and if the relationship between PRS and BWP can be known to gNB, whether to activate MG or use active BWP can also be decided by gNBIn addition, we prefer to introduce the perconfiguration of MG. If it is introduced, the MG configuration may only need to be transmitted once when PRS is a cell-specific signal and the same for all the UE in a cell, but if not, the MG activation should be transmitted for each UE and each requesting (e.g. every time BWP switches). |
| CATT | Option 3 | We consider MG activation request by LMF and by UE can be used for supporting different scenarios. For example, Option 1 may be more usefulfor LMF-initialted on-demand PRS, while Option 2 can be used in more general cases. |
| Qualcomm | Option 2 (UL MAC CE) | Why Option **~~2~~1** should not be supported:* Overall, having another entity configure what the UE needs is not a robust solution that is bound to lead to many errors in real scenarios:
	+ When/How does the serving gNB know that the MG configuration has to stop or reconfigure? When the UE has the control of requesting a MG, it will ask for a new one whenever a new PFL needs to measured, or a different subset of PRS resources need to be measured
	+ It may happen that the UE gets a location request and sends back an error, and the serving gNB will just go ahead and configure a MG without really a need.
	+ The spec allows, after the location request is received, for the UE to send and AD request. In this case, the LMF would be asking the serving gNB to configure a MG without even having configured AD to the UE. Overall, it will be over over-configuring/over-provisioning MG and lead to waste of resources.
	+ What happens if after the location request, there is a serving cell change? In the legacy approach (when the UE is responsible for the MG request), the UE, after the serving cell change will ask a new measurement gap from the new serving cell. Now, the LMF is not aware of such a change. DL methods are supposed to work seamlessly during serving cell changes.
 |
| Nokia/NSB | Option 4 | We feel that the gains in option 1 are not clear and that there are still many open questions. For Option 2 we feel that the specification impact is very high and we only have 1 meeting left.  |
| Qualcomm2 |  | To Nokia: Option 2 has very limited spec impacts: Transfer the RRC message of MG request from the RRC spec to the MAC-CE. RAN1 can make some agreements this and the next meeting, and then let RAN2 continue/finish the work. We did the same for SP-SRS activation/deactivation in NR Rel-16.  |

### Round 2

## MG activation (H)

The following sources provided their views on MG activation.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 3:** Support activation and deactivation of MG(s) via a MAC CE.* The MAC CE can include the MG pattern ID defined in TS 38.133.

**Proposal 4:** Support MG(s) activation by MAC CE with adaptive offset.* The adaptive offset is determined to be the first subframe containing the next PRS measurement occasion after T+3ms, where T corresponds to the slot containing the PUCCH carrying the HARQ-ACK for the initial transmission of the DL MAC CE.
 |
| ZTE [2] | **Proposal 11**: Support measurement gap triggering along with BWP switching (at least for DCI based BWP switching) when the conditions for DL PRS measurement in the PRS processing window cannot be satisfied after BWP switching. |
| vivo [3] | **Proposal 5:** * The MG activation via DL DCI or DL MAC CE can be supported if it only includes activation and deactivation indication.
	+ FFS pre-configured MG indication for indicating one of multiple pre-configured MG and/or indicating a positioning MG
 |
| OPPO [4] | Proposal 4: Support using MAC CE to activate a MG configuration and the MAC CE command can indicate:* A MG configuration
* A number of repetitions for the indicated MG configuration and the MG configuration stops when the indicated number of repetitions are finished.
 |
| CATT [5] | **Proposal 7:** Support a new MG activation and deactivation procedure by either DCI or DL MAC CE to reduce the latency (either Option 1 or Option 2 in RAN1#106-e’s agreement).**Proposal 8:** To reduce latency, the aperiodic MG for NR positioning should be introduced in Rel-17.  |
| China Telecom [6] | **Proposal 2-1:** Rel-17 should support the DCI to activate/deactivate the MG.**Proposal 2-2:** The DL MAC CE can be used to activate/deactivate the MG if the pre-configured MG is supported in Rel-17. |
| CMCC [7] | **Proposal 3:** For the purpose of positioning latency reduction, with potential support a new MG activation and deactivation procedure, support one of the following options:* Option. 1: DCI
* Option. 2: DL MAC CE
 |
| Nokia, NSB [8] | **Proposal 3**: Option 1 of DCI based MG activation/deactivation is not supported. **Proposal 4:** Option 3 of UE autonomously applying the MG is not supported.  |
| Xiaomi [9] | **Proposal 2:** Support triggering of on-demand measurement gap by MAC CE or DCI.**Proposal 3:** Suggest to associate a state ID with a PRS configuration, a measurement gap configuration and a PRS measurement report configuration, and MAC CE or DCI can activate/deactivate or trigger the PRS measurement report by indicating a state ID. |
| Samsung [10] | **Proposal 6:** Support Option 2, i.e., DL MAC CE is used for a new MG activation and deactivation procedure. |
| Intel [11] | **Proposal 1:*** + To reduce latency of NR positioning with MGs for DL PRS processing define the following enhancements
		- …
		- …
		- Support DCI signaling to activate pre-configured MG for DL PRS processing by UE
			* RAN1 to discuss necessary DCI formats / fields
	+ Inform RAN2/RAN3/RAN4 capturing outcome of the RAN1 discussion on MG enhancements for NR positioning latency reduction with a request to implement necessary NRPPa/LPP signaling
 |
| DCM [12] | **Proposal 2:** * We prefer the following option for a new MG activation and deactivation procedure
	+ Option. 2: DL MAC CE
 |
| SONY [13] | **Proposal 2:** Support triggering/activation of MG(s) for positioning measurement with layer-1 signalling (e.g., via DCI).These options can be used for different use-cases (e.g. UE-assisted, and UE-based positioning) and to provide flexibility in the deployment of positioning services. |
| LGE [15] | **Proposal 3:** * For the purpose of positioning latency reduction, RAN1 can support both DCI and MAC-CE for MG activation/deactivation. Also, following can be applied.
	+ Major information through DCI, detail (or minor) information through DCI.
 |
| IDC [16] | **Proposal 3:** Activation or deactivation of a measurement gap can be done via DL MAC CE. |
| Qualcomm [17] | **Proposal 5:** For low latency MG configuration, support configuration and/or activation of MG(s) with a DL MAC-CE from the UE.**Proposal 6:** From RAN1 perspective, it is beneficial to support autonomous MG for Positioning, wherein the UE, after it receives a low-latency location request, it is allowed to drop other DL signal processing/traffic during one or more window(s) of time subject to an explicit allowance from the serving gNB.* Note: Coordination between UE-serving gNB-LMF may be specified to ensure seamless operation of the autonomous MG for Positioning.
* Send an LS to RAN4 with the above agreement
 |
| Lenovo, MotM [19] | **Proposal 3:** Activation/deactivation signalling Option 1: DCI and Option 2: DL MAC CE are feasible, although Option 2 is slightly more preferred. |

The positions of companies are shown below.

* Option 1 (By DCI)
	+ Supported by (10): ZTE, vivo, CATT, CTC, CMCC, Xiaomi, Intel, SONY, LGE (jointly), Lenovo/MotM
	+ Not supported by: Nokia/NSB
* Option 2 (By DL MAC CE)
	+ Supported by (12): Huawei/HiSilicon, vivo, OPPO, CATT, CTC, CMCC, Xiaomi, DCM, LGE (jointly), IDC, QC, Lenovo/MotM
	+ Not supported by:
* Option 3 (By autonomous gap)
	+ Supported by: QC
	+ Not supported by: Nokia/NSB

**FL comments:**

According to the understanding of the FL

* Option 1 should require further discussion on the DCI format, DCI field configuration in advance, search space set configuration. In addition, how the MG pattern (including MGL, MGRP, MG offset) maps to the DCI code points should be resolved to make the basic functionality work.
* Option 2 should require further discussion on the MAC CE payload, but the baseline should be move what is available in RRC to MAC CE.
* Option 3 should require further discussion on whether notification to the gNB to avoid potential resource waste is needed.

### Round 1

Based on the input, the FL has the following initial question.

### Question 2.2.1-1

* Companies are invited to provide inputs to the following options with regards to MG activation.
	+ Option 1: by DCI
	+ Option 2: by DL MAC CE
	+ Option 3: by autonomous gap
	+ Option 4: both Option 1 and Option 2 with potential jointly indication in DCI and DL MAC CE

|  |  |  |
| --- | --- | --- |
| **Company** | **Options** | **Comments:** *Please indicate why the Options should NOT be supported.* |
| vivo | Option 1 or 2 |  |
| CATT | Opion 1 or 2 | Our preference is Option 2.  |
| Qualcomm | Option2 or Option 3 | Option 1 is an overkill, with a lot of specification changes needed. Option 3 has limited spec impact from RAN1 pespective , and the remaining work would go to RAN4. OK with Option 2 since it will be “copying over” the RRC message in MACCE; likely smaller spec impact from Opton 1 (but higher compared to Option 3) |
| Nokia/NSB | No options | Similar to comments on section 2.1 there is large spec impact Option 1 and 2 with many open questions. Yet we only have 1 meeting left. Prefer to work on finishing the MG-less feature which has latency gains.  |

### Round 2

## Preconfiguration of MGs (M)

The following sources provided their views on preconfiguration of MGs.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 1:** Preconfiguration of MGs for the purpose of latency reduction should be up to RAN4 to decide. |
| vivo [3] | **Proposal 2:** * Before MG configuration, the time/frequency characteristics (i.e., periodicity/offset and/or frequency layer information) of PRS should be transmitted to gNB in advance.

**Proposal 3:** * The pre-configured MG should be transmitted to LMF by NRPPa signaling and transmitted to UE by RRC signaling.
* The pre-configured MG parameter should be transmitted to UE/LMF, and include the following information.
	+ The common configuration parameters (e.g. MGRP, MGL, etc.)
	+ Initial status of pre-configured MG: activated, deactivated
	+ The pre-configured ID for indicating one of multiple pre-configured MG, or indicating a positioning MG
 |
| China Telecom [6] | **Proposal 2-2:** The DL MAC CE can be used to activate/deactivate the MG if the pre-configured MG is supported in Rel-17. |
| CMCC [7] | **Proposal 1:** For the purpose of positioning latency reduction, support pre-configuration of multiple MGs by the gNB. |
| Intel [11] | **Proposal 1:*** + To reduce latency of NR positioning with MGs for DL PRS processing define the following enhancements
		- Support pre-configuration of multiple MG patterns for DL PRS processing by UE
			* Signaling details are left up to RAN2
	+ Inform RAN2/RAN3/RAN4 capturing outcome of the RAN1 discussion on MG enhancements for NR positioning latency reduction with a request to implement necessary NRPPa/LPP signaling
 |
| SONY [13] | **Proposal 1:** gNB provides the configuration of supported MG(s) for positioning latency improvements to UE / LMF. |
| Lenovo, MotM [19] | **Proposal 4:** Support multiple pre-configured measurement gaps for latency reduction together with applicable assistance information from the LMF. |

The preconfiguration of MG is supported by the following sources

* vivo, CTC, CMCC, Intel, SONY, Lenovo/MotM

**FL comments:**

There is also concern raised by companies, e.g. when the preconfiguration is provided, how gNB could be able to determine the preconfiguration of MG prior to any positioning related procedure, how latency can be achieved if the preconfiguration is provided in an on-going LCS procedure (since the preconfiguration itself is already part of the concern latency period).

It is also the FL understanding that we are approaching the physical layer function freeze target, and we need to also complete the higher layer parameter list. This work seems less essential.

### Round 1

Based on the input, the FL has the following initial question.

### Question 2.3.1-1

* Companies are invited to provide inputs to the preconfiguration of MGs.
	+ Q1: Should preconfiguration of MGs be provided before LMF receives any LCS request for the UE or provided after LMF instigates the LCS procedure for the UE.
	+ Q2: How gNB determines the patterns of the preconfiguration of MGs for a UE, e.g. MGL, MGRP, MG offset.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| vivo | Yes | First, preconfiguration of MGs has been supported for RAN4, and it is more flexible for activation and deactivation. In addition, if the measured PRS is a cell-specific signal(ie, the assistance information is transmitted by broadcast), preconfiguration of MGs can be transmitted once to gNB for all the UE. It can reduce the signaling overhead. |
| Nokia/NSB |  | We feel this issue can be low priority given the time remaining in rel-17.  |
| Qualcomm | No | If we go with DL-MAC-CE to activate a MG, there may not be a need to have a preconfiguration step, since MAC-CEs can carry enough bits.  |

### Round 2

## MG sharing with RRM (L)

The following sources provided their views on MG sharing enhancement with RRM.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| ZTE [2] | **Proposal 6:** Enhance the measurement gap sharing scheme to prioritize the NR PRS measurement inside a measurement gap. RAN1 should send an LS to RAN4 on the benefits identified by RAN1.  |
| vivo [3] | **Proposal 8:** * Priority rules should be considered for MG sharing, for example,
	+ For high priority PRS positioning, the CSSF is 1
 |
| Qualcomm [17] | **Proposal 1:** For Measurement gaps shared between Positioning and mobility measurements, support increased priority of processing of Positioning resources when low-latency Positioning Measurements are expected by the UE. * Send an LS to RAN4 with this agreement
 |

There is limited input on this issue.

**FL comments:**

It is the FL understanding that this enhancements belongs to RAN4 expertise.

### Round 1

Based on the input, the FL has the following initial proposal.

### Proposal 2.4.1-1

* Potential enhancements to latency reduction with respect to MG sharing with other RRM procedures is up to RAN4 to decide.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia/NSB | Yes | Agree with proposal.  |
|  |  |  |

## Other proposals

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Intel [11] | **Proposal 1:*** + To reduce latency of NR positioning with MGs for DL PRS processing define the following enhancements
		- …
		- …
		- …
		- Optimize Rel.16 measurement gap patterns (e.g., period, length, type) for NR DL PRS processing by UE and send LS to RAN4 with a recommendation to define new MG patterns for positioning
	+ Inform RAN2/RAN3/RAN4 capturing outcome of the RAN1 discussion on MG enhancements for NR positioning latency reduction with a request to implement necessary NRPPa/LPP signaling
 |

It is the FL understanding that MG pattern enhancements belongs to RAN4 expertise. It is suggested for the interested companies to bring this to RAN4 directly.

# MG-less PRS measurement

## General information

The following working assumption was made in RAN1#106-e on this issue.

|  |
| --- |
| 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.)
* For the purpose of this feature, PRS-related conditions are expected to be specified, with the following to be down-selected:
	+ Alt. 1: Applicable to serving cell PRS only
	+ Alt. 2: Applicable to all PRS under conditions to PRS of non-serving cell.
* 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.
* Further study
	+ Further details of which other DL signals/channels to be prioritized
	+ How the UE determines DL PRS’s priority based on one or more of the following:
		- Opt. 1: Based on indication/configuration from serving gNB
		- Opt. 2: Other options (e.g., implicit, signalling from LMF, etc)
	+ Whether UE can do the measurement for both inside MG (if MG is configured) and outside MG in a measurement period
	+ How to do the PRS measurement when the conditions cannot be satisfied, e.g. when BWP switching happens
	+ Prioritization conditions of processing PRS over other DL channels/signals or vice versa.
* Send an LS to RAN2, RAN3 and RAN4 informing them of this working assumption and requesting feedback in case they have concerns.
 |

## Confirm the working assumption (H)

The following sources provided their views on confirming the previous working assumption.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| OPPO [4] | **Proposal 5:** Support measuring DL PRS resource within active BWP and with same numerology outside measurement gap and confirm the WA. |
| CATT [5] | **Proposal 1:** Support the working assumption made in RAN1#106-e related to PRS measurement outside the MG. |
| Nokia, NSB [8] | **Proposal 5**: Confirm the prior working assumption on MG-less PRS reception.  |
| DCM [12] | **Proposal 3:** The working assumption made at RAN1#106-e meeting regarding PRS measurement outside MG should be confirmed |
| SONY [13] | **Proposal 4:** Confirm the working assumption on support PRS measurement outside the MG that is subjected to UE capability, within a PRS processing window, and UE measurement inside the active DL BWP with PRS having the same numerology as the active DL BWP. |
| Qualcomm [17] | **Proposal 12:** Confirm the RAN1#106-e working assumption on PRS processing outside of MG |
| Ericsson [20] | **Proposal 1** Confirm the working assumption made in RAN1#106-e to support DL measurements based on DL PRS without the UE having to request measurement gaps. |

Confirmation of the previous working assumption is supported by the following sources

* OPPO, CATT, Nokia/NSB, DCM, SONY, QC, Ericsson

**FL comments:**

Also other source may not explicitly mention in their proposal to confirm the working assumption, it is general considered they are OK to confirm it, since some of them are proposing to resolve the FFSs in the working assumption.

### Round 1 (closed)

Based on the input, the FL has the following initial proposal.

### Proposal 3.1.1-1

* Confirm the following working assumption made in RAN1#106-e.

|  |
| --- |
| 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.)
* For the purpose of this feature, PRS-related conditions are expected to be specified, with the following to be down-selected:
	+ Alt. 1: Applicable to serving cell PRS only
	+ Alt. 2: Applicable to all PRS under conditions to PRS of non-serving cell.
* 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.
* Further study
	+ Further details of which other DL signals/channels to be prioritized
	+ How the UE determines DL PRS’s priority based on one or more of the following:
		- Opt. 1: Based on indication/configuration from serving gNB
		- Opt. 2: Other options (e.g., implicit, signalling from LMF, etc)
	+ Whether UE can do the measurement for both inside MG (if MG is configured) and outside MG in a measurement period
	+ How to do the PRS measurement when the conditions cannot be satisfied, e.g. when BWP switching happens
	+ Prioritization conditions of processing PRS over other DL channels/signals or vice versa.
* Send an LS to RAN2, RAN3 and RAN4 informing them of this working assumption and requesting feedback in case they have concerns.
 |

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| vivo | Yes |  |
| CATT | Yes |  |
|  |  |  |

After GTW, it is agreed to continue work with the standing working assumption.

## Applicability to PRS from non-serving cells (H)

The following sources provided their views on PRS measurement outside MG from non-serving cell.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 6:**  Support PRS measurement outside MG for the PRS from the non-serving cell if the timing of the serving cell and the non-serving cell can be aligned.* Note: This means that UE may use single FFT to process the PRS from the serving cell and non-serving cells.
 |
| ZTE [2] | **Proposal 9**: Support UE to receive DL PRS from both serving cell and non-serving cell, where search window determined by an expected RSTD value and an expected RSTD uncertainty value between the DL PRS from serving cell and non-serving cell should be smaller than a threshold(e.g the cyclic prefix length determined by the serving cell). |
| vivo [3] | **Proposal 13:** * At least, the PRS from the serving cell and/or the non-serving cell(s) synchronized to the serving cell can be measured in the PRS process window.
 |
| OPPO [4] | **Proposal 6:** PRS processing outside MG is applied to serving cell PRS only. |
| CATT [5] | **Proposal 2:** Support Alt. 2 for PRS-related condition in RAN1#106-e, with the following modification:Alt. 2: Applicable to all PRS under conditions to PRS of both serving cell and non-serving cells. |
| CMCC [7] | **Proposal 5:** The PRS measurement within the PRS processing window is applicable to all PRS of a non-serving cell that is aligned to the serving cell. |
| Apple [15] | **Proposal 2**: For PRS measurement without/outside MGs, support subject to UE capability, the PRS from the serving cell and non-serving cell can be received and measured within UE’s active DL BWP. |
| IDC [16] | **Proposal 6:** Support assignment of the same prioritization level to PRS transmitted from the neighbouring cells |
| Qualcomm [17] | **Proposal 7:** For the MG-less PRS processing feature, the UE does not expect to process a DL PRS if the maximum expected receive difference between the PRS resource and the serving cell of the active BWP, is larger than a fraction X of the OFDM symbol.* FFS: X
 |
| Ericsson [20] | **Proposal 4** In Rel-17, support DL measurements based on DL PRS without the UE having to request measurement gaps is limited to serving cell PRS only. |

The positions of companies are shown below.

* Supported by (8):
	+ Huawei/HiSilicon (Synchronized)
	+ ZTE (RSTD less than a threshold)
	+ vivo (Synchronized)
	+ CATT
	+ CMCC (Aligned to the serving cell)
	+ Apple
	+ IDC
	+ Qualcomm (UE not expected to process the PRS with maximum expected receive difference larger than a fraction X of an OFDM symbol)
* Not supported by (2):
	+ OPPO
	+ Ericsson

**FL comments:**

On the supporting companies to extend the PRS to the non-serving cell, most think that the neighbouring PRS should be synchronized/time aligned with the PRS from the serving cell. However, there is also potential difference in their expression, either network should ensure they are synchronization, or UE is only expected to process those synchronized.

Considering that we are approaching the physical layer function freeze target, and that we have too many unresolved issues for MG-less PRS measurement, e.g. priority, PRS processing window indication, it is FL’s understanding that restricting PRS to only from the serving cell can reduce the potential signaling exchange between LMF, UE and the serving gNB.

### Round 1

Based on the input, the FL has the following initial question.

### Question 3.2.1-1

* Companies are invited to provide inputs to the following options on applicability of PRS cells for the measurement outside MG.
	+ Alt. 1: Applicable to serving cell PRS only
	+ Alt. 2: Applicable to all PRS under conditions to PRS of non-serving cell.
		- The conditions at least include that the Rx timing difference between PRS from the non-serving cell and that from the serving cell is within a threshold

|  |  |  |
| --- | --- | --- |
| **Company** | **Alternative** | **Comments:** *Please indicate why Alt.1 or Alt. 2 should NOT be supported.* |
| vivo | Alt 2 | We prefer to add an FFS before sub-bullet about the condition |
| CATT | Alt 2 | We share the similar view as vivo to add FFS to the sub-bullet |
| Nokia/NSB | Alt 2 | Same view as vivo  |
| Qualcomm | Alt. 2  | We are in the last couple of meetings, so we prefer to write down what other conditions we can potentially envision.These should be spelled out directly, so that we can either try to make a decision this meeting, or try to understand what companies consider as potential conditions. Can vivo/CATT/Nokia provide a specific alternative on what should be an alternative condition? |

### Round 2

## PRS processing window and priority indication (H)

The following sources provided their views on PRS processing window and priority indication.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 5:** Support * To reuse the MG request by the LMF for the purpose of PRS measurement window configuration determination by the gNB
* To reuse the MG activation/deactivation MAC CE by the gNB for the purpose of PRS measurement window activation/deactivation.
* To add priority indication for PRS over other DL channels/signals in the MAC CE, if the MAC CE activates the PRS processing window.
 |
| ZTE [2] | **Proposal 8**: Serving gNB should have the following information with respective to the DL PRS processing window,* Serving gNB should know UE’s capabilities for the PRS processing window.
* Serving gNB can suggest the configuration of PRS processing window to LMF, e.g. the start time, maximum duration, the type (Capability 1 or Capability 2).
* Serving gNB should be informed of the configuration of PRS processing window determined by LMF.
* Serving gNB should be informed of the DL PRS resources that are expected to be measured in the PRS processing window as requested by LMF.
 |
| vivo [3] | **Proposal 11:** * PRS processing window can be described by the following parameters
	+ Starting slot and symbol of PRS processing window
	+ Periodicity of PRS processing window
	+ Duration of PRS processing window
	+ PRS processing window type, e.g. Pre UE or Per Band, or Per CC window.
	+ PRS priority inside the PRS processing window, e.g. PRS priority indication
	+ Frequency related to PRS processing window, e.g. Point A of PRS within PRS processing window

**Proposal 12:** * PRS processing window can be configured by LMF in the LPP signaling when UE supports PRS processing capability outside MG.

**Proposal 14:** * Subject to UE capability, if PRS prioritization over all other DL signals/channels in all symbols inside the window, all the PRS from the serving cell and/or the non-serving cell(s) can be measured in the PRS process window.
 |
| OPPO [4] | **Proposal 7:** When processing PRS outside MG:* The DL PRS and SSB can be mapped to the same symbol and which one of SSB or PRS has higher priority is indicated by the system.
* PRS resource has higher priority than PDCCH, PDSCH and CSI-RS

Proposal 8: Processing PRS outside MG has higher priority than all UL channels/signals.**Proposal 9:** When LMF requests positioning measurement results, the LMF indicates a configuration of PPW and the configuration of PPW includes the following parameters:* The periodicity and slot offset of PPW
* The length of time window
* The number of occurrences of PPW.
 |
| CATT [5] | **Proposal 3:** All DL signals/channels (PDCCH, PDSCH, CSI-RS, PT-RS, and non cell-defining SSB) except for cell-defining SSB can be de-prioritized relative to DL-PRS by default, and cell-defining SSB has the highest prioritization by default.**Proposal 4:** Support both of the following options for informing UE that other DL signals/channels are prioritized over the DL PRS:• Opt. 1: Based on indication/configuration from serving gNB.• Opt. 2: Other options (signalling from LMF, etc). |
| CMCC [7] | **Proposal 4:** The PRS processing window can be determined implicitly by the UE.* FFS: Additional signalling among the UE, LMF and gNB for the determination of the window.

**Proposal 6:** Support introducing physical layer priority for DL PRS and DL signals/channels at least carrying the LPP signalling. |
| Xiaomi [9] | **Proposal 4:** Support LMF to indicate the high priority PRS during the PRS processing window to serving gNB and UE.**Proposal 5:** Consider of simultaneous reception of PRS and data by different panel for MPUE by panel specific measurement gap.**Proposal 6:** The priority of PRS should be differentiated for different latency requirement. |
| Intel [11] | **Proposal 2:*** + For support of DL PRS measurement without measurement gaps, strive for simplified solutions that minimize impact to specification and other WGs
 |
| Apple [14] | **Proposal 1**: 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, PRS is prioritized over all other DL signals/channels, from all DL CCs (per UE), in all symbols inside the window.
 |
| IDC [16] | **Proposal 1:** Support both measurement gap-less measurement of PRS via a prioritization windowing and fast MG configuration**Proposal 4:** Support explicit indication of prioritization level of PRS**Proposal 6:** Support assignment of the same prioritization level to PRS transmitted from the neighbouring cells |
| Qualcomm [17] | **Proposal 8:** For the MG-less PRS processing feature, downselect between the following options how the UE determines that a DL PRS is higher priority than other DL signals:* Alt. 1: UE receives an explicit signaling from the serving gNB
* Alt. 2: UE receives an explicit signaling from the LMF (LMF has previous coordinated with the serving gNB)
* Alt 3: PRS is implicitly determined that it is higher priority than any other DL channel/channel in the processing window duration.

**Proposal 9:** Support to support the following priority options in the processing window: * PRS is higher priority than any other DL signal/channel
* PRS is higher priority than any other DL signal/channel except URLLC channels.
	1. FFS details of what is considered a URLLC channel, e.g., dynamically scheduled PDSCH whose Ack has high-priority
* PRS is lower priority than all other DL signals/channels
 |
| MTK [18] | **Proposal 3-2**: If gNB has the knowledge of UEs being under location request for measurement, and gNB still schedules data to these UEs around certain DL-PRS instances, the UEs may treat that the data processing has higher priority over DL-PRS measurement on these instances |
| Ericsson [20] | **Proposal 2** Support the LMF configuration of the PRS prioritization window to the UE via LPP signaling.**Proposal 3** Support the LMF configuration of the PRS prioritization window to the serving gNB via NRPPa signaling.**Proposal 5** For the UE to determine whether DL PRS shall be prioritized or not, the priority of at least the following channels/signals relative to DL PRS can be indicated by the gNB to the UE:(i) Dynamic scheduled traffic/reference signals (e.g., PDCCH, dynamically scheduled PDSCH, aperiodic CSI-RS including aperiodic TRS)(ii) Periodic/semi persistent signals and channels (e.g., SPS PDSCH, semi-persistent CSI-RS, periodic CSI-RS including periodic TRS) |

The proposal are somewhat diverse to address the remaining FFS from the previous working assumption. The positions of companies on the important matters considered by the FL are shown below.

**Priority indication**

* Option 1: by gNB
	+ Supported by: Huawei/HiSilicon, CATT, Ericsson
* Option 2: by LMF
	+ Supported by: CATT, Xiaomi
* Option 3: implicit without indication
	+ Supported by: MTK

**PRS processing window (PPW) indication**

* Option 1: by LMF
	+ Supported by: vivo, OPPO, Ericsson
* Option 2: by gNB
	+ Supported by: Huawei/HiSilicon
* Option 3: implicit without indication
	+ Supported by: CMCC

**DL channels/signals subject to priority consideration**

* Option 1: By default CD-SSB has highest priority, and PRS can have higher priority than other DL signals/channels (e.g. PDCCH, PDSCH, CSI-RS, PT-RS, non-CD SSB)
	+ Supported by: CATT
* Option 2: Three priority statuses to select based on priority indication
	+ PRS is higher priority than any other DL signals/channels.
	+ PRS is higher priority than any other DL signals/channels except URLLC channels
		- FFS details of what is considered a URLLC channel, e.g., dynamically scheduled PDSCH whose Ack has high-priority
	+ PRS is lower priority than all other DL signals/channels
	+ Supported by: QC
* Option 3: DL signals and channels are grouped into dynamic schedule traffic/RS and periodic/semi-persistent scheduled signals/channels
	+ Supported by: Ericsson

**FL comments:**

For DL channels subject to priority consideration, the understanding from the FL is that we may group the DL signals/channels into multiple predefined priority levels, and PRS can be inserted between them.

### Round 1

Based on the input, the FL has the following initial proposal, and questions.

### Question 3.3.1-1

* Companies are invited to provide inputs to the following options with regards to the source of priority indication.
	+ Option 1: by gNB
	+ Option 2: by LMF
	+ Option 3: implicit without indication, e.g. PRS is implicitly determined that is higher priority than any other DL signals/channels in the PRS processing window duration
	+ Note that either options, there could be coordination between LMF and the UE serving gNB.

|  |  |  |
| --- | --- | --- |
| **Company** | **Options** | **Comments:** *Please indicate why the Options should NOT be supported.* |
| vivo | Option 2 | In our view, based on the requirement and PRS configuration, LMF can indicate the PRS priority first，and then UE can combine the priority of other DL signals/channels to determine PRS priority. |
| CATT | Option 1 and 2 |  |
| Nokia/NSB | FFS option 1 and 2 | We prefer to further study between option 1 and 2 as there are open questions in our view on how the gNB would know which PRS to indicate as high priority (e.g., if UE is allowed to measure PRS from non-serving cells).  |
| Qualcomm | Option 1 & comments | We understand one potential procedure as follows:* The LMF is aware of the UE’s capabilities with regards to the Processing-window based PRS and the associated PRS processing capabilities.
* LMF sends a request to the serving gNB that it wants the UE to measure PRS with high priority with a PRS processing window. This could be an NRPPa message that also includes potential PRS processing window configuration parameters.
* The gNB sends such a request to the UE (e.g. through DL MAC-CE). It could be the same MAC-CE that is used to configured the PRS processing window.
 |

### Question 3.3.1-2

* Companies are invited to provide inputs to the following options with regards to the source of PRS processing window indication.
	+ Option 1: by gNB
	+ Option 2: by LMF
	+ Option 3: implicit without indication, e.g. UE calculates the PRS processing window based on some rules
	+ Note that either options, there could be coordination between LMF and the UE serving gNB.

|  |  |  |
| --- | --- | --- |
| **Company** | **Options** | **Comments:** *Please indicate why the Options should NOT be supported.* |
| vivo | Option 2 | At least，we prefer LMF recommending a PRS processing window for other nodes(e.g. UE or gNB) at least. |
| CATT | Option 1 |  |
| Nokia/NSB | Option 2 | We prefer LMF to configure the window but there may be some involvement of the gNB.  |
| Qualcomm | Option 1 & comments | We understand one potential procedure as follows:* The LMF is aware of the UE’s capabilities with regards to the Processing-window based PRS and the associated PRS processing capabilities.
* LMF sends a request to the serving gNB that it wants the UE to measure PRS with high priority with a PRS processing window. This could be an NRPPa message that also includes potential PRS processing window configuration parameters.
* The gNB sends such a request to the UE (e.g. through DL MAC-CE). It could be the same MAC-CE that is used to configured the PRS processing window.
 |

**Proposal 3.3.1-3 (closed)**

* Define P (P>=1) DL signals/channel groups G1, …, GP­, with priority order G1 > G2 > …> GP, and the PRS priority can be indicated to be higher than G1 or lower than GN or between Gi and Gi+1.
	+ FFS: N
	+ FFS: DL signals/channels in each Gi

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
|  |  |  |
|  |  |  |
|  |  |  |

According to the GTW, it is suggest to discuss solid proposals based on contribution, thus I added the following question. Also based on comments from Apple, I added Option 4.

### Question 3.3.1-3

* Companies are invited to provide inputs to the following options with regards to the concerned DL signals channels subject to priority indication.
	+ Option 1: By default CD-SSB has highest priority, and PRS can have higher priority than other DL signals/channels (e.g. PDCCH, PDSCH, CSI-RS, PT-RS, non-CD SSB)
	+ Option 2: Three priority statuses to select based on priority indication
		- PRS is higher priority than any other DL signals/channels.
		- PRS is higher priority than any other DL signals/channels except URLLC channels
			* FFS details of what is considered a URLLC channel, e.g., dynamically scheduled PDSCH whose Ack has high-priority
		- PRS is lower priority than all other DL signals/channels
	+ Option 3: DL signals and channels are grouped into dynamic schedule traffic/RS and periodic/semi-persistent scheduled signals/channels
	+ Option 4: Only two priority statuses to select based on priority indication
		- PRS is higher priority than any other DL signals/channels
		- PRS is lower priority than any other DL signals/channels

|  |  |  |
| --- | --- | --- |
| **Company** | **Options** | **Comments** |
| Qualcomm | 2 or 4 | With regards to Option 1: It is unclear why high Priority PRS should be lower priority than SSB: SSB measurements are periodic, even if the UE misses one then it would still be OK overall; high priority PRS will likely be some single shot measurements. Furthermore, RRM measurement requirements (e.g. mobility measurements & relation to PRS processing and their prioritization) is typically addressed by RAN4, so not sure if we need to treat option 1 now. We could also be OK to put in Opton 2 or 4, “FFS: Whether SSB processing needs to be treated separately”, if this would allow to make progress amongst option 1/2/4. With regards to Option 3, even though we acknowledge that “timing based” prioritization has been done for SRS transmissions, we think that for PRS a more “definite” aspect would be needed: PRS burst is typically long, and has multiple resources, TRPs, sets, etc. We are not sure that we really want to optimize the scenario that one PRS resource is dropped because it collides with a AP-CSIRS, while other PRS resource on the same burst is measured because it collides with a P-CSIRS. We prefer to have a “clean cut”: Either all PRS inside the window is measured, or are dropped if there are collisions with any channel. In Option 2, URLLC was excluded because we thought that these are very special cases, and based on the previous discussion in the previous meeting that such channels must have higher priority than PRS.  |
|  |  |  |
|  |  |  |

### Round 2

## PRS measurements both inside MG and outside MG (H)

The following sources provided their views on PRS measurements both inside MG and outside MG

|  |  |
| --- | --- |
| vivo [3] | **Proposal 9:** * UE is not expected to perform the measurement outside MG if MG is requested or configured.

**Proposal 10:** * When MG is not configured, subject to UE capability, whether to request MG or perform PRS outside MG is decided by UE itself
	+ if the overlapping bandwidth of active BWP and PRS can satisfy the performance requirement, UE measurement can be inside the active BWP. Otherwise, the UE can request MG(s) or BWP switching.
 |
| CATT [5] | **Proposal 5:** Subject to UE capabilities, support UE to do the measurement for both inside MG (if MG is configured) and outside MG in a measurement period. When the conditions cannot be satisfied, e.g., when BWP switching happens, support UE to do the DL PRS measurement inside the MG only. |
| Nokia, NSB [8] | **Proposal 6**: Specify a fallback method for the UE to switch from MG-less to MG-based if the UE drops enough PRS. **Proposal 7**: A UE should be able to measure the PRS both outside and inside of a MG where applicable. Note: Any changes to RAN4 requirements can be discussed directly by RAN4.  |
| Qualcomm [17] | **Proposal 10:** Leave it up to UE implementation whether to do simultaneous processing of PRS within an MG and outside an MG. Any measurement period requirements can be defined assuming one type of PRS processing or the other.  |
| MTK [18] | **Proposal 3-1**: LMF provides gNB the information regarding the UEs being under location request. This procedure is applicable for both measurement with gaps and measurement without gaps since the gap configuration is determined by gNB |

**FL comments:**

The proposal are quite diverse. It is also the FL understanding that if UE is performing both MG-less and MG-based measurement, the RAN4 requirement will be complicated.

### Round 1

Based on the input, the FL has the following initial proposal.

### Proposal 3.4.1-1

* Rel-17 will not specify the case when UE does the measurement for both inside MG (if MG is configured) and outside MG in a measurement period.
* UE is expected to perform PRS measurement inside the MG if MG to measure PRS is in use and perform PRS measurement outside the MG if the PRS processing window is in use.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| vivo | Yes |  |
| Nokia/NSB | No | We feel the MG-less feature is more useful and practical if the UE can also use a MG in the same measurement report. We would prefer continue discussing and/or involve RAN4.  |
| Qualcomm | Not needed | RAN4 could discuss this eventually |

## Conditions not satisfied (M)

The following sources provided their views on UE behaviour when conditions for PRS measurement outside MG are not satisfied, e.g. BWP change.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| vivo [3] | **Proposal 10:** * When MG is not configured, subject to UE capability, whether to request MG or perform PRS outside MG is decided by UE itself
	+ if the overlapping bandwidth of active BWP and PRS can satisfy the performance requirement, UE measurement can be inside the active BWP. Otherwise, the UE can request MG(s) or BWP switching.
 |
| CATT [5] | **Proposal 5:** Subject to UE capabilities, support UE to do the measurement for both inside MG (if MG is configured) and outside MG in a measurement period. When the conditions cannot be satisfied, e.g., when BWP switching happens, support UE to do the DL PRS measurement inside the MG only. |
| SONY [13] | **Proposal 5:** Define UE behaviour when positioning measurement (outside measurement gap) cannot be satisfied due to interruption event.**Proposal 6:** Support a UE to provide positioning measurement report based on the partial reception of PRS resource(s) in case there is an interruption (e.g. BWP switching) during positioning measurement time window.**Proposal 7:** UE can provide assistance information (UAI) indicating serving gNB that the UE is feasible to perform positioning outside the measurement gap. Subsequently, serving gNB can provide the response whether the UE is allowed to perform positioning measurement (e.g., when it is needed). Hence, there is no additional latency.  |
| Apple [14] | **Proposal 3**: support under UE capability an indication to switch to a BWP associated with positioning measurements, by* Alt1: UE-specific DCI
* Alt2: GC-DCI

**Proposal 4**: 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. * A MG and PRS resources associated with that MG may be triggered/activated by DCI or MAC-CE signaling
* Alternatively, once A-PRS is activated, the MG associated with A-PRS is consequently activated as well
 |

**FL comments:**

For this issue, the input is also diverse. According to the understanding of the FL, some sources are addressing conditions not met prior to UE performing any measurement at all, while some sources are addressing conditions not met during the MG-less PRS measurement, e.g. BWP switching happens when UE is doing measurement, which makes the measurement no longer valid.

In either case, it relies on how RAN4 specifies the requirement. I would suggest postpone the discussion until the solution of MG-less/MG-based PRS measurement is clear and see if the solutions can cover this.

### Round 1

Based on the input, the FL has the following initial question.

### Question 3.3.1-1

* Do you agree to postpone the discussion to see if the progress on MG-based and MG-less PRS is sufficient to cover the case when conditions for MG-less PRS measurement are not satisfied?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia/NSB | yes |  |
| Qualcomm | Yes |  |
|  |  |  |

# M-sample PRS processing

## General information

The following agreement was made in RAN1#106-e on this issue.

|  |
| --- |
| Agreement:Subject to UE capability, support LMF to explicitly request UE to report the measurement with either M-sample or 4-sample, if RAN4 has supported M-sample measurement.* FFS signalling details.
 |

The following sources provided their views on M-sample PRS processing.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| OPPO [4] | Proposal 1: Introduce a new UE capability for supporting M-sample measurement* the UE can report the supported M value. M = 1 is one candidate value

**Proposal 2:** The LMF shall request the same M-sample or 4-sample measurement for all the positioning methods to one UE. The UE shall expect the same M-sample or 4-sample measurement to be performed on all positioning methods configured to the UE.  |
| Nokia, NSB [8] | **Proposal 12:** It is beneficial from RAN1 perspective to support M=1 sample measurements. RAN1 asks RAN4 to confirm the feasibility of the single DL PRS processing sample under assumption of relaxation of the Rel-16 NR positioning accuracy requirements. |
| Samsung [10] | **Proposal 3:** * The LMF indicates whether the UE can use less than 4 samples.
* The UE determines the number of samples to be used and indicates it to the LMF
 |
| Intel [11] | **Proposal 3:*** + Parameter *M* for UE DL PRS processing is configurable from the set of values {1, 4}
		- LMF indicates which value is expected to be used by UE for DL PRS processing
			* Signaling details are left up to RAN2
 |
| 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.)
 |
| Qualcomm [17] | **Proposal 2:** Support only M=1 for low-latency enhancements and de-prioritize specification support for M=2 and M=3. * Introduce a UE capability whether a UE supports single-sample PRS processing
 |
| Lenovo, MotM [19] | **Proposal 1:** RAN1 to wait until RAN4 has considered the Rel-17 requirements for M-sample measurements, in addition to Rel-16 positioning accuracy requirements. |
| Ericsson [20] | **Proposal 6** Support measurement reports for RSRP and RSTD based on a single PRS measurement, i.e. Nsample= 1. |

There is a majority support to include M=1. However other sources would also consider other values.

**FL comments:**

Whether M can take 1, 2, and 3 depends on whether RAN4 specifies the requirements for M=1, 2, and 3, respectively, with e.g. relaxed performance requirement or changes of side conditions. It is not likely that all values will be specified by RAN4.

### Round 1

Based on the input, the FL has the following initial proposal.

### Proposal 4.1.1-1

* For the PRS processing sample number M, at least M = 1 is supported.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia/NSB | Yes | Support.  |
| Qualcomm | Yes |  |
|  |  |  |

### Round 2

# Other open issues

## Positioning report resource (M)

The following sources provided their views on positioning report resource (i.e. PUSCH resource).

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Nokia, NSB [8] | **Proposal 1**: UE could request the expected measurement report resource from the serving gNB via RRC signaling to minimize the positioning measurement report delay. |
| Xiaomi [9] | **Proposal 7:** Support PRS measurement report by PUSCH including configured grant PUSCH and dynamic grant PUSCH. |
| Samsung [10] | **Proposal 1:** Configured grant PUSCH type 1 and type 2 are used for positioning measurement report in order to reduce the latency. **Proposal 2:** The DG PUSCH with high priority is considered for positioning measurement report to reduce the latency. |
| SONY [13] | **Proposal 8:** Support CG-PUSCH for positioning measurement reporting. |
| Apple [14] | **Proposal 5**: At least for the case of M-BWP switching, NW configures (as part of M-BWP configuration and/or indication) PUSCH resource for UE to report positioning measurements and/or location information* The grant is specifically configured for positioning measurement report, e.g. Nx symbols after the end of last symbol of last DL-PRS resource, or after the end of M-BWP
* Nx is determined based on UE capability
 |
| LGE [15] | **Proposal 4:** * For latency reduction of positioning measurement reporting, preconfigured resource based measurement reporting (e.g., CG-based PUSCH) should be introduced.

**Proposal 5:** * If CG-based PUSCH is applied for positioning measurement report, ‘the lower layer signaling for triggering/activation of measurement gap(s) (MG(s)) (which is discussed as a method for MG enhancement in the previous meeting [2]) can be reused for activation of CG-based PUSCH resources for positioning measurement reporting.

**Proposal 6:** * The information for indicating which CG-based PUSCH is used for is necessary to be included in lower layer signaling for triggering/activation of MG(s) when CG-based PUSCH is supported for the MG without case.
 |
| Lenovo, MotM [19] | **Proposal 6:** Support Type 1 and Type 2 UL CG-based transmissions for position measurement reporting.**Proposal 7:** Support assistance information between gNB and LMF for enabling lower latency UL CG-based measurement reports. RAN3 to be consulted for impacts.**Proposal 8:** Support partial reporting and/or measurement dropping for UL CG-based measurement reporting. |

**FL comments**

For expected PUSCH resource indication to the gNB, the issue has been discussed in the past meetings, and some companies think that this should not be discussed in RAN1. There was also citation according to RAN3 summary that RAN3 was already address this issue in RAN1#106-e.

For DG-PUSCH and CG-PUSCH, it is not clear what specification impact is, since both are already supported to convey the LPP signaling.

### Round 1

Based on the input, the FL has the following initial questions.

### Question 5.1.1-1

* Do you agree to leave the discussion to RAN2/RAN3 on expected PUSCH resource indication to the gNB that is used to carry the LPP measurement report?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia/NSB | No | We still feel it would be better for RAN1 to indicate to RAN2/3 that we find this beneficial since this falls under “PHY latency” definition from the SI even if we agree the main spec impact is outside of RAN1.  |
|  |  |  |
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### Question 5.1.1-2

* Do you agree that there is no RAN1 specification impact on the use of DG-PUSCH or CG-PUSCH to carry the LPP measurement report?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia/NSB | Yes |  |
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## UE PRS processing capabilities (H)

The following sources provided their views on potential modification to the UE PRS processing capabilities.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| ZTE [2] | **Proposal 12**: For the UE capability design for DL PRS measurements in a PRS processing window, at least consider one of the following options,* Type 1 PRS processing capability: UE has to report its capability with at least of the combination {R, P},
* A PRS processing window is divided into PRS buffering window and PRS computation window. The PRS computation window starts right after the end of the PRS buffering window. UE is only expected to receive the DL PRS in the PRS buffering window.
* UE shall take P msec of time (the length of PRS computation window) to process up to R msec of symbols containing PRS resources expected to be received by the UE in the PRS buffering window
* Type 2 PRS processing capability: UE has to report its capability of PRS computation time (T)
* A time span (N) is calculated from an end of the latest DL PRS resource in the PRS processing window that is used for a location information report to the end of the PRS processing window
* The value of N is not expected to be smaller than the PRS computation time (T) .
 |
| Nokia, NSB [8] | **Proposal 13:** In order to avoid measurement latency, UE processing capability should fit in the PRS resource allocation. We propose at least to add a condition of measurement, that is  - *T* ms < *P* ms where *T* ms is a UE processing time and *P* ms is PRS resource time window that network expects UE measurements. |
| Samsung [10] | **Proposal 4:** If the PRS processing window is supported for PRS measurement outside the measurement gap, a new set of UE PRS processing capabilities is required. |
| Intel [11] | **Proposal 4:*** + Introduce additional values {1, 2, 4}ms for parameter T of UE DL PRS processing capability with measurement gaps
	+ i.e., T: {1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
 |
| Qualcomm [17] | **Proposal 11:** For MG-less PRS processing capability, and for each separate MG-less PRS processing UE capability (Cap. 1A, Cap 1B, Cap 2), the UE may report an (N,T) value with the following relation to the processing window: * During the first part of the window with duration of at least N msec, up to N msec of PRS symbols are expected to be received by the UE.
* After the second part of the window, with a T-N msec length, which starts after the end of the first window, a UE is expected to be capable of reporting measurements derived on the PRS measured in the first window.
 |
| Lenovo, MotM [19] | **Proposal 9:** Introduce additional T values for UE (N,T) processing capabilities. |

**FL comments**

The feature should be essential to low latency.

### Round 1

Based on the input, the FL has the following initial proposals.

### Proposal 5.2.1-1 (Closed)

* Introduce smaller number for T in the existing UE PRS processing capability (N, T) as per FG 13-1 in TR 38.822.
	+ FFS: the numbers include {1ms, 2ms, 4ms}
	+ FFS any restriction on the relation between T and PRS processing window duration

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| vivo |  | Support the intention，but the second FFS is unclear for us |
|  |  |  |
|  |  |  |

After GTW session, this is to be handled in the UE feature discussion.

### Proposal 5.2.1-2

* For PRS measurement inside the PRS processing window, support the following processing optimization for latency reduction:
	+ UE is only expected to buffer the PRS for the first N msec of the PRS processing window, and UE is expected to be capable of reporting measurement after T-N.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| vivo |  | We would like to confirm the relationship of T，N and PRS processing window. And the connection between N msc and PRS configuration so that the UE is can only buffer the PRS for the first N msec… |
| Qualcomm | Generally supportive – suggest rewording | There can be gaps in the first part of the PRS processing window (e.g. non consecutive PRS symbols, or UL gaps). So, even though we generally agree with the intention, i think it is more correct to phrase it something like the following:* ***During the first part of the window with duration of at least N msec, up to N msec of PRS symbols are expected to be buffered.***
* ***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.***
 |
|  |  |  |

### Round 2

## SRS priority (M)

The following sources provided their views on SRS priority for the purpose of latency reduction.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| CMCC [7] | **Proposal 7:** The SRS for positioning priority enhancements is within the WI scope, and should be further studied. **Proposal 8:** Support introducing physical layer priority indication for SRS for positioning. |
| Nokia, NSB [8] | **Proposal 8**: RAN1 should study and work on new priority rules of transmitting SRS for positioning with other UL signals/channels, in order to reduce positioning latency for UL and DL+UL positioning methods. |
| IDC [16] | **Proposal 5:** For multi-RTT, the same level of priority should be assigned to both PRS and SRSp |

**FL comments**

This issue has been discussed in the past meeting. It is not clear to the FL whether the situation has changed.

### Round 1

Based on the input, the FL has the following initial proposal.

### Proposal 5.3.1-1

* Support priority indication of positioning SRS.
	+ Alt.1 Physical layer indication
	+ Alt.2 Same priority as DL-PRS if indicated.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia/NSB | Yes | Suggestion down selection at the next RAN1 meeting.  |
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### Round 2

## Number of Rx beams (M)

The following sources provided their views on reducing the number of Rx beams for FR2.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| ZTE [2] | **Proposal 7**: UE should report Rx beam sweeping factor according to the UE capability. Meanwhile, LMF should be able to request the value of Rx beam sweeping factor used for a location information report. |
| Qualcomm [17] | **Proposal 3:** For low latency positioning, support a UE to report as a UE capability the $N\_{rxbeam}$ for the case that the UE receives a low-latency positioning request. * Send an LS to RAN4 with this agreement
 |

### Round 1

Based on the input, the FL has the following initial proposals.

### Proposal 5.4.1-1

* Introduce a new UE capability on the number of Rx beams (<8) to reduce the PRS measurement latency for FR2 positioning frequency layers.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia/NSB | Yes | Should send LS to RAN4 to confirm.  |
| Qualcomm | Yes | OK with the LS.  |
|  |  |  |

### Round 2

## Lower layer triggered measurement and report (M)

The following sources provided their views on low layer triggered measurement and report (including AP/SP PRS).

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| vivo [3] | **Proposal 16:** * The request of the measurement via MAC-CE and/or physical layer procedure should be supported.
 |
| CATT [5] | **Proposal 10:** AP-PRS and SP-PRS receptions triggered by serving gNB should be supported for single gNB positioning, in which a UE is informed to measure the DL PRS of the TRPs of the same gNB. **Proposal 11:** Reception of AP-PRS or SP-PRS triggered by LMF through LPP message should be supported. **Proposal 12:** UE can be triggered to receive periodic PRS through DCI or MAC CE to reduce the latency for PRS measurement outside the MG. |

**FL comments**

This proposal has been discussed for a couple of meetings. It is not clear how this can work given the existing LCS architecture, and the benefit thereof.

### Round 1

Based on the input, the FL has the following initial questions.

### Question 5.5.1-1

* Do you agree to introduce a mechanism of lower layer triggered PRS measurement, e.g. MAC CE or physical layer?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| vivo | Yes | We would like to separate the LPP signaling into NRPPa signaling and lower-layer signaling, and the NRPPa signaling can carry the measurement request and MG configuration/or activation. |
| Nokia/NSB | No |  |
| Qualcomm | No | Would not lead to Latency reduction given existing LCS architecture.  |

### Question 5.5.1-2

* Do you agree to introduce LPP-based AP/SP PRS triggering mechanism?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia/NSB | No |  |
| Qualcomm | Comments | What does LPP-based AP/SP PRS mean? Just a high layer configured PRS with a start/end time? |
|  |  |  |

## Early fix and multiple location reports (M)

The following sources provided their views on enhancements to early fix and support of multiple location reports corresponding to multiple response times.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| ZTE [2] | **Proposal 1:** 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 in ProvideAssistanceData message for UE to measure and report the location information.**Proposal 2:** In order to get quick response of an early location information report, LMF should be able to configure an early location information report associated with some DL PRS used to derive the early location information report.**Proposal 3:** For the purpose of reporting new location measurements in time, Rel-17 should allow UE to report multiple early location information reports prior to a response time.**Proposal 10**: In order to balance the positioning latency and accuracy, LMF can configure two response times in the location 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.
 |
| Lenovo, MotM [19] | **Proposal 5:** RAN1 to support explicit priority indications to increase flexibility of the UE processing and help decouple low and high latency measurement reports transmitted to the LMF, which can be applicable to the following:* Assistance Data (e.g., subset of PRS resources, TRP, beam info)
* Measurement and Reporting Configurations (enable multiple latency response times)
 |

**FL comments**

This proposal has been discussed for a couple of meetings. It is not clear whether companies are interest to discuss it.

### Round 1

Based on the input, the FL has the following initial proposal.

### Proposal 5.6.1-1

* Support R>=2 response times indication in LPP location request message.
	+ FFS: PRS to measure for each response time.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
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### Round 2

# Other proposals

The proposals from following sources cannot be categorized in the previous aspects, and is only supported by a single source.

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Huawei, HiSilicon [1] | **Proposal 7:** If UE does not receive the activation MAC CE, UE may fallback to Rel-16 by sending the LocationMeasurementIndication to the gNB for MG configuration. |
| vivo [3] | **Proposal 1:** * Physical layer latency reduction should be independent of scheduled location time.

**Proposal 15:** * To support on-demand PRS configured/requested in a PRS processing window.

FL: It is not clear to me what the specification impact for this proposal besides “PRS processing window” as part of the on-demand PRS. It is suggest to firstly discuss whether “PRS processing window” can be a on-demand parameter. |
| CATT [5] | **Proposal 9:** For on-demand DL PRS, support the following methods related to the MG configuration for reducing the positioning latency: 1. Either a UE or a serving gNB may inform LMF about the existing MG configuration for the UE.
2. LMF may determine and send the recommended transmission time of on-demand DL PRS for a UE to the gNBs based on the UE’s capability of whether to support positioning measurement without a MG.
3. LMF informs UE of the expected MG before on-demand PRS is configured to UE by LMF.

FL: It is not clear to me why this has to be specifically associated with on-demand PRS. What is the parameter for the on-demand PRS? |
| Nokia, NSB [8] | **Proposal 9:** RAN1 should study mechanisms for controlling and/or assessing the way the UE performs positioning measurements, e.g. how flexible the beamed IF measurement is, and how long each measurement gap needs to be. **Proposal 10:** RAN 1 should study solutions which can accommodate a reduced positioning session, in the sense that they allow for a reduced measurement report from UE, based on the RX beam information of the UE.FL: Is it about the number of Rx capability for a better measurement period estimation?**Proposal 11***:* RAN 1 should study mechanisms and/or revise the current SRS transmission/reception procedure to optimize for latency, particularly for higher carrier frequencies and for densely populated cells. |
| Ericsson [20] | **Proposal 7** Do not support lower PRS periodicities for DL PRS in rel17.a. Note: periodicity of measurement reporting is a separate discussion |

## Round 1

For some proposals, it is difficult for the FL to understand the motivation, so the FL is requesting proponents to offer suggestions on how to merge the proposal with the previous discussion points. Otherwise, it is generally encouraged for interested companies to bring the issue in future meeting.

### Suggestions from proponents

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
|  |  |  |
|  |  |  |
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## Round 2

# Conclusion

## Monday GTW session

The following proposals are suggest for Monday’s GTW session.

**Proposal 3.1.1-1**

* Confirm the following working assumption made in RAN1#106-e.

|  |
| --- |
| 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.)
* For the purpose of this feature, PRS-related conditions are expected to be specified, with the following to be down-selected:
	+ Alt. 1: Applicable to serving cell PRS only
	+ Alt. 2: Applicable to all PRS under conditions to PRS of non-serving cell.
* 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.
* Further study
	+ Further details of which other DL signals/channels to be prioritized
	+ How the UE determines DL PRS’s priority based on one or more of the following:
		- Opt. 1: Based on indication/configuration from serving gNB
		- Opt. 2: Other options (e.g., implicit, signalling from LMF, etc)
	+ Whether UE can do the measurement for both inside MG (if MG is configured) and outside MG in a measurement period
	+ How to do the PRS measurement when the conditions cannot be satisfied, e.g. when BWP switching happens
	+ Prioritization conditions of processing PRS over other DL channels/signals or vice versa.
* Send an LS to RAN2, RAN3 and RAN4 informing them of this working assumption and requesting feedback in case they have concerns.
 |

**Proposal 3.3.1-3**

* Define P (P>=1) DL signals/channel groups G1, …, GP­, with priority order G1 > G2 > …> GP, and the PRS priority can be indicated to be higher than G1 or lower than GN or between Gi and Gi+1.
	+ FFS: N
	+ FFS: DL signals/channels in each Gi

**Proposal 5.2.1-1**

* Introduce smaller number for T in the existing UE PRS processing capability (N, T) as per FG 13-1 in TR 38.822.
	+ FFS: the numbers include {1ms, 2ms, 4ms}
	+ FFS any restriction on the relation between T and PRS processing window duration