**3GPP TSG RAN WG1 #101-E** [**R1-200zzzz**](file:///E:\1%20Meetings\RAN1\2020%2005_TSRR1_101\Inbox\R1-200zzzz.doc)

**e-Meeting, May 25th – June 5th, 2020**

**Source: Moderator (Intel)**

**Title: Summary of E-mail Discussion [101-e-NR-Pos-01]**

**Agenda item: 7.2.8.1**

**Document for:** **Discussion and Decision**

1. Introduction

This contribution is a part of the Rel.16 maintenance work on NR Positioning. It provides summary of RAN WG discussion [101-e-NR-Pos-01] with the following scope:

[101-e-NR-Pos-01 Email discussion/approval on UE capabilities for NR positioning focusing on the following until 5/29; if necessary, endorse associated TPs by 6/4 – Alexey (Intel)

* From summary on DL PRS ([R1-2004726](file:///E:\1%20Meetings\RAN1\2020%2005_TSRR1_101\Inbox\R1-2004726.doc))
  + Whether to define DL PRS processing capability for the case w/o measurement gap (3-1, 8-1, 9-2)
  + Values of X (3-3, 4-4, 5-1, 6-1, 9-2)
  + Based on outcome, decide whether to prepare TPs to capture DL PRS processing capability (3-5, 9-3) and in which specification
* From summary on UL SRS ([R1-2004718](file:///E:\1%20Meetings\RAN1\2020%2005_TSRR1_101\Inbox\R1-2004718.doc))
  + Capabilities for SRS carrier switching (Issue 13)

1. DL PRS Processing Capability
   1. Case w/o Measurement Gap

### Initial Discussion and Proposal

Companies are encouraged to express further views on whether and why to define/not define DL PRS processing capabilities for the case w/o measurement gap configured.

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| **Company Name** | **Comments** |
| Huawei/HiSilicon | After further check with our RAN4 colleagues, as RAN4 will define the condition for UE to request MG, rather than UE discretion based on the PRS processing load, we think defining a new processing capability with MG is important to allow PRS processing without MG. If UE does not report this capability, UE does not support PRS processing without MG.  Otherwise, we propose that PRS processing without MG is not supported in this Release and send an LS to RAN4. |
| ZTE | We are not clear how to define a new processing capability without MG since the scheduling of other signals/channels dynamically changed as some other companies pointed out. In some slots, there may not be other signals scheduled, the situation is similar as that with MG, then the new capability seems not used in this case. In some other slots, most of UE CPU may be occupied by some other signals, UE may not be able to process PRS, even the new capability without MG is defined. Maybe proponents can clarify how to handle these issues. |
| Qualcomm | Similar views as Huawei/HiSi: If UE does not report this capability, UE does not support PRS processing without MG. If this capability is not agreed, then it means that PRS processing without MG is not supported. We don’t see why we have to remove this feature, when we already have all the tools available to fix this: The UE can report one more (N,T) and # PRS resources per slot for this case.  With regards to collisions with other channels, this has already been treated: The spec says that the UE would deprioritize the PRS processing if it collides with other DL/UL signals and channels. With respect to processing capability, the assumption would be that there is no collision with other higher-priority channels. |
| vivo | This exact issue has been intensively discussed in RAN1#100b-e. At that time, it has been concluded that not much value and no support of UE DL PRS processing capability for the case when MG is not configured. We don’t see any new argument to support this feature in this meeting.  Our understanding is that whether to configure measurement gap for a UE is determined by the serving gNB. Even if this UE processing capability without gap is provided to the LMF, the LMF cannot determine the corresponding assistant data as whether a UE is configured with a measurement gap is unknown to the LMF. Throughout the whole Rel-16 positioning discussion, there’s no assumption that measurement gap configuration for UE would be available to LMF.  So we think there is no need to support this capability for the case without gap configuration. |
| LG | We are not supportive of defining DL PRS processing capability without measurement gap configuration. As we already have mentioned in our contribution, the UE needs to process other signals especially for data but expecting the amount of data scheduling is not easy. The DL PRS processing capability has been already defined for the configured measurement gap, which could be used as an upper bound for the case wo measurement gap configured. If the configured PRS resources at a UE exceeds processing capability of the UE, it could be up to UE implementations. That is, the UE could determine which PRS resources to be processed according to its preference.  If the DL PRS processing capability for wo measurement gap configuration is introduced, it might be defined as a lower bound of DL PRS processing capability with an exception of the dedicated hardware resource for data processing. Then, even if the UE can process more DL PRS resources when the amount of data to be processed is low, the PRS resources would be configured limitedly depending on the UE capability. |
| OPPO | Share the same view as Huawei and Qualcomm. If there no such UE capability, how to determine proper configuration for UE? If the configuration is determined regardless UE’s real capability, how to predict the performance. As result, if UE does not report this capability, UE does not support PRS processing without MG. Thus RAN4 should not specify any requirement for this case. |

If company is in favor to define DL PRS processing capability for the case w/o measurement gap configured please also provide if any additional specific changes are needed for this case (e.g. values of (N,T,B,X), definitions, etc.).

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| **Company Name** | **Comments** |
| Huawei/HiSilicon | We propose for UE to report another pair of (N,T) with the common B.  X value is the same as the one with MG, but its definition can be revised to the ratio between PRS span in milli-seconds and the reported T. |
| Qualcomm | The UE can report one more (N,T) and # PRS resources per slot for this case, assuming the same bandwidth B. “X” will be the ratio of PRS instance to PRS periodicity. |
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Based on comments, it seems there is no consensus to support additional definition of DL PRS processing capability for the case when UE is not configured with a measurement gap. At the same time, it may be agreeable to apply the same capability for both cases (UE when it is not scheduled for data reception/transmission can achieve similar DL PRS processing capabilities as an upper bound).

**FL Proposal #1**

* **RAN1 to select between the following alternatives:**
  + **Alt.1: DL PRS processing capability for the case w/o MG configured is not defined** 
    - **UE does not support DL PRS processing w/o MG configured in Release 16**
  + **Alt.2: DL PRS processing capability for the case w/o MG configured is not defined**
    - **DL PRS processing is left up to UE implementation, subject to existing RAN1 WG agreements**
  + **Alt.3: The same DL PRS processing capability is assumed for both cases with and without MG**
    - **For the case without MG configured, it is assumed as an upper bound for DL PRS processing**
    - **For the case with MG configured, it is assumed as a minimum bound for DL PRS processing**

Companies are invited to provide further views on proposal above

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| **Company Name** | **Comments** |
| ZTE | Alt.2 |
| Samsung | Alt.2 |
| OPPO | Support Alt.1  For Alt.2 and Alt.3, RAN4 should not specify any requirement for this case. |
| Huawei/HiSilicon | Alt.1, and we need an LS to RAN4. |
| CATT | Alt.2, and send an LS to RAN4 |
| Qualcomm | We would like to update our views and pick Alt. 1 for the following reasons: Alt 2 may still create confusion in RAN4, and even in RAN1, whether a new UE capability is needed. It will also create issues in deploying this feature going forward, since it will not be clear what it means “up to UE implemetnation” and whether a specific UE/product really supports it, and under which assumptions and PRS configurations. Such ambiguity should be avoided if possible.  Based on the current discussion, it may be preferred in Rel-16, for RAN1 to provide a clear statement that:  A UE is not expected to process DL PRS unless it is received within a configured Measurement gap.  Such a statement is closer to Alt. 1 and not to Alt. 2, sorry for the confusion. |
| vivo | Alt. 2 |
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### Revision #1 of FL Proposal #1

Based on comments received so far, it seems group can agree to not define DL PRS processing capability for the case when no MG configured to UE. It is still open question whether to support DL PRS processing for the case when no MG is configured. Therefore, it is proposed to discuss revised proposal #1:

**Revision #1 of FL Proposal #1**

* **DL PRS processing capability for the case w/o MG configured is not defined**
* **RAN1 to select between the following alternatives during RAN1#101-E:**
  + **Alt.1: UE does not support DL PRS processing w/o MG configured in Release 16**
  + **Alt.2: DL PRS processing is left up to UE implementation, subject to existing RAN1 WG agreements**

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| **Company Name** | **Comments** |
| Huawei/HiSilicon | Alt.1, and we need an LS to RAN4.  I hope everyone in the group understands if RAN4 does not specify any requirement for processing without MG, UE will not implement this feature, and even if UE implements this feature, network cannot assume any performance expectation, which makes the feature non-functional for commercial deployment.  We are OK to leave it to Rel-17 as I guess IIoT needs PRS processing without MG. |
| Qualcomm | Alt. 1. As described from HW, Alt. 2 will eventually result to the same outcome, but it is prone of misinterpretations and unnecessary ambiguity. Leaving the whole feature of PRS processing up to UE implementation, would result to not being supported realistically, so we need to be upfront and say it without hiding it. |
| MTK | Alt. 1.  But we have different idea from HW about IIOT case. For the robots, probably positioning is more important than data transmission. So the larger MGL/MGRP ratio (more than 30%) could be considered. We can think about this in Rel-17 |
| LG | Alt.2.  If “up to UE implementations” is not clear, we can make the PRS processing priority to define clear order for PRS processing when the configured PRS exceeds the UE’s processing capability. |
| CATT | Prefer Alt.2 but can accept Alt.1.  With Alt.2, it gives the some capable UE the opportunity to support positioning w/o requesting MG and avoid the interruption on data communication. It does not imply the UE cannot meet the RAN4 requirements. |
| Nokia/NSB | We prefer the original Alt. 3 “The same DL PRS processing capability is assumed for both cases with and without MG”. In our view, this allows the network to configure PRS resources, for which the UE does not require measurement gaps. When no measurement gaps are configured then the LMF can assume this is an upper bound of the processing. Then if UE has power and time to receive PRS, due to no collision with other DL/UL signals, it can benefit and receive PRS in a shorter time window and thus finish earlier the measurement |
| vivo | We prefer Alt. 2 |
| Huawei/HiSilicon | Reply to CATT:  I think I need to clarify our understanding on RAN4 requirement. If RAN4 defines its requirement on PRS measurement without MG, it means as along as conditions (e.g. same SCS, BW of PRS within active BWP, etc) are met, all UE should mandatorily meet those requirement.  It should not be interpreted that those requirements are applicable to some capable UEs. The way to allow the operation that you mentioned is to introduce another capability “support of PRS processing without MG”.  Reply to Nokia:  This will result in very conservative (N,T) reporting, as the same value will be applicable for both with MG and without MG, so that UE can meet the MANDATORY requirements for with MG and for without MG. In case even with MG, UE can processing more, LMF has no idea whatsoever, and the result will very high latency for a positioning fix.  I am not sure if there is any chance of changing the main bullet “DL PRS processing capability for the case w/o MG configured is not defined”, it seems Nokia is open to do so. |
| ZTE | We Prefer Alt.2. We have define some rules in the case when MG is not configured. If we support Alt.1, spec needs to change accordingly.  For progress, Alt.1 is also acceptable for us. |
| LG | In our view, it is too restrictive that positioning is supported only when the measurement gap is configured. In consideration of different views of companies, we would like to suggest that let us first determine whether or not to support DL PRS processing for the case without measurement gap configuration. Hopefully, if it is agreeable to support of it, and then we can have further discussions on the technical details to effectively support it later. |

### Revision #2 of FL Proposal #1

Based on provided comments the following is observed

* Three companies expressed support for Alt.1 (Huawei/HiSilicon, Qualcomm, Mediatek)
* Five companies expressed support for Alt.2 (LG, CATT, vivo, ZTE, Intel)
* One company expressed support for Alt.3 in original FL proposal (Nokia)

It seems there is no consensus. May be as a compromise group can consider defining additional capability whether DL PRS processing w/o MG is supported or not but UE w/o definition of DL PRS processing capabilities for this case. Considering that it is important to close this issue the following proposal aiming to find an acceptable way forward is proposed.

**Revision #2 of FL Proposal #1**

* **Capability to indicate whether UE supports DL PRS processing for the case w/o configuration of measurement gap is defined without DL PRS Processing capability** 
  + **RAN1 assumes that no RAN4 requirements are to be defined for the case w/o configured measurement gap in Release 16**

Companies are invited to discuss the proposal above and if it is not acceptable express their view on acceptable way forward that companies may have in mind:

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| **Company Name** | **Comments** |
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### Outcome of the Call#1 on NR Positioning Enhancements

Based on discussion of the revision #2 of FL proposal #1 over an online call, the following agreement was made by RAN1 WG:

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| * UE is not expected to process DL PRS without configuration of measurement gap in Rel-16 * RAN1 assumes that no RAN4 requirements are to be defined for the case w/o configured measurement gap in Release 16 * Inform RAN4 about this agreement |

* 1. Values of X

### Initial Discussion and Proposal

At the previous RAN1 WG meeting, the following agreement was made

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| * UE capability for DL PRS processing is defined assuming the case with configured measurement gap and a maximum ratio of measurement gap length (MGL) / measurement gap repetition period (MGRP) of no more than X%   + FFS: X |

The values of X were left undefined for further discussion. The following proposals were made with respect to resolution of X in submitted contributions:

1. In [5], equation to derive the value X for DL PRS processing capability was proposed:

* Assumption:the gap period is the same the reported value T
* UE is only expected to process the PRS within the X% window, regardless of whether the capability is defined for with MG or for without MG.

1. In [6], for DL PRS processing capability, it is proposed to set value X to be not more than 30%.
2. In [7], it is proposed that RAN1 agrees on X = 15 for the MGL/MGRP which is assumed for UE capability reporting of DL PRS processing. Note: RAN4 may evaluate the value
3. In [8], the DL PRS processing capability is reported under the assumption of a maximum 1/3 of MGL/MGRP ratio. Inform RAN4 that RAN1 assumes that additional (MGL, MGRP) should be supported for NR Rel-16 Positioning processing.
4. In [9], it was proposed to define set of X values {10%, 20%, 30%}, so that UE reports one of them together with other DL PRS processing capabilities

Companies are invited to provide further comments on the preferred way to define value X. Proposals facilitating group convergence are encouraged.

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| **Company Name** | **Comments** |
| Huawei/HiSilicon | We suggest at least (6, 160) should be supported, which is aligned with LTE.  Note that we do not expect positioning in Rel-16 should have impact on communication, as LPP requested measurement latency is 1 second, of which the enhancement has been precluded in the email discussion. |
| CATT | Either defined a set of X values, e.g., {10%, 20%, 30%}, or let RAN4 to make the decision of the values. |
| Futurewei | Values for X should be defined taking the minimum performance requirement that needs RAN4 evaluation. |
| ZTE | The same view with CATT |
| Qualcomm | We are OK to define multiple values if this would be a way forward here. A maximum of ~1/3 (or 30% seems a good option), and we are OK the UE to be able to report a smaller value if this is a problem. This would need a UE capability though, and maybe already RAN4 would define capabilities for the new MGs. At this point RAN1 can agree on a maximum value and leave the rest to RAN4. |
| Vivo | We’re informed that there’re contributions and proposals/discussions in RAN4 on this X value. Given that the value of X will be tightly related to RAN4 performance requirements, we actually prefer to leave the determination of X values entirely to RAN4. |
| LG | We are fine with multiple values but we prefer that the maximum value is defined by RAN4. |

Based on comments received so far, it seems may be agreeable to define the set of values X = {10, 20, 30}% and send LS to RAN4 with a request to check and come up with any changes if necessary.

**FL Proposal#2**

* **Set of values X for DL PRS processing capability is {10, 20, 30}%**
* **Send LS to RAN4 WG:**
  + **Inform RAN4 WG, that RAN1 has discussed the set of values X for UE DL PRS processing capability and agreed on X = {10, 20, 30}%**
  + **RAN1 kindly asks RAN4 to analyse the proposed set of values with respect to MG pattern definition and apply any changes if necessary**

Companies are invited to provide further views on proposal above

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| **Company Name** | **Comments** |
| ZTE | OK with FL proposal#2 |
| Samsung | Can wait for RAN4 |
| OPPO | OK with FL proposal |
| Huawei/HiSilicon | If we need to consult RAN4, we do not need to provide the values {10%, 20%, 30%}. LTE baseline (6, 160) should be considered. |
| Nokia/NSB | We agree with QC’s comments above that RAN1 should pick a maximum value and then leave the rest to RAN4. We suggested 15% in our contribution but are okay with selecting 30% if other companies feel strongly. We prefer not to have multiple values agreed at this time in RAN1 for X. |
| CATT | Since RAN4 is responsible to make the final decision for X values, and RAN4 is working on this, it seems no urgency for RAN1 to send LS to RAN4. |
| Qualcomm | We are confused with the above proposal. If indeed we ‘ll eventually ask input from RAN4, then we can just leave it up to Ran4 all together.  The meaning “values {10,20,30}” is not clear. We are discussing what is the maximum MGL/MGRP. Having multiple values, does it mean that it is a UE capability? If yes, I think we should leave this up to RAN4 to add in their capability list. We still think that RAN1 should pick a maximum.    To Huawei: clearly 6/160 will be supported, we don’t see why this is really any progress here. We are discussing what should be the maximum value. 6/160 corresponds to 3.75%, which is really low compared to the new values (e.g. 10,20,30) that it is considered. |
| Vivo | As we commented before, we prefer to leave it entirely up to RAN4. So FL proposal #2 is not need. Furthermore, RAN4 is already working on it and no need to send an LS from RAN1. |

### Revision #1 of FL Proposal #2

Based on comments received so far, it seems concerns are raised to have a set of values X. At the same time, the value X equal to 30% seems acceptable to many companies. Given that RAN1 initiated and led the work on DL PRS processing capability, it seems that RAN1 should be responsible at least to provide the input on value of X (it was an FFS in RAN1).

**Revision #1 of FL Proposal#2**

* **For the purpose of DL PRS processing capability, the value X is set to 30%**
* **Send LS to RAN4 WG**
* **Inform RAN4 WG that RAN1 has discussed the value X for UE DL PRS processing capability and agreed on X = 30% and ask for RAN4 feedback**

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| **Company Name** | **Comments** |
| Huawei/HiSilicon | I am a bit confused by setting maximum 30 from {10, 20, 30}.  Interpretation 1: If we go with 30%, does it mean that if UE reports T=160, UE should at least support PRS span of 160\*30%=48ms, regardless of what N is.  Interpretation 2: 30% is associated with some T, e.g. if UE reports T=20ms, UE should at least support PRS span of 20\*30%=6ms, but if UE reports T=160, another X%<30% will be considered by RAN4.  Our questions for clarification is   * Q1: Should we go with interpretation 1 or interpretation 2 or something else? * Q2: If we go with interpretation 2, can it be interpreted that RAN4 will define different X% with respect to different T, but the maximum X% across all potential reported T values should be 30%?   Note that if we are talking about UE capability, there is no gap configuration at all when UE provides the corresponding capability. So I guess UE should assume a hypothetical gap for the reporting (N, T), whose MGRP is equivalent to the reported T.  Further questions for clarification are:   * Q3: Are we assuming MGRP is equivalent to the reported T for UE capability reporting? * Q4: 2Are we assuming if UE report (N, T), a different hypothetical MGRP from T may be adopted, which may or not be associated with the reported T? |
| Qualcomm | Out understanding is that there shall be at least one case in the specification for which MGL/MGRP equals to 30%. Actually there already exists one such case (MGL=6 and MGRP=20) . So, the discussion effectively for RAN4 would be: what ever additional MGL and MGRP they plan to add, it should still abide by the maximum of 30%.  **Revised Proposal from QC:**   * **For the purpose of DL PRS processing capability, the maximum MGL/MGRP supported in the specification should not be more than 30%.** * **Send LS to RAN4 WG** * **Inform RAN4 WG that RAN1 has discussed the value X for UE DL PRS processing capability and recommends that the maximum MGL/MGRP supported in the specification should not be more than 30%.**   Please note the above proposal does NOT say whether RAN4 should introduce new values or not, or whether for each T, there should be a N such that N/T=0.3, nor that there cannot be UE capabilities that a smaller X is supported by the UE. The above only says that the spec should not support more than 30%. |
| MTK | Our thinking is,  1, For Huawei’s Q3, we also support to treat MGRP being equivalent to the reported T for UE capability reporting, to make thing easier  2, Let RAN4 determine a set of X% (5%, 10%, 20%, 30%...) under max value of 30%. And the gap is for positioning purpose only. It is not to mix with doing RRM at the same gap. So we suggest to slightly modify QC’s proposal:   * **Inform RAN4 WG that RAN1 has discussed the value X for UE DL PRS processing capability and recommends that the maximum MGL/MGRP supported in the specification should not be more than 30%. It is up to RAN4 to determine a set of values for X, and the corresponding gap is for positioning purpose only** |
| CATT | Prefer the modified proposal from QC. |
| Nokia/NSB | Agree w/ CATT and prefer proposal from QC. |
| Vivo | If we have to send an LS to RAN4. Prefer the revised proposal from QC as RAN4 can do their work without feedback to RAN1 on this issue. |
| Huawei/HiSilicon | I am not sure whether RAN4 can handle this. RAN4 specifies the requirement based on actual PRS configuration and MG configuration. However, what we are discussing now is “a hypothetical gap duty cycle” prior to any PRS configuration in the UE capability reporting. |
| ZTE | Agree with the revised proposal from QC |
| LG | We prefer the modified proposal from QC |

### Revision #2 of FL Proposal #2

Based on discussion in the previous section, it seems the following proposal can be agreeable to the working group.

**Revision #2 of FL Proposal#2**

* **For the purpose of DL PRS processing capability, the maximum value of X = MGL/MGRP supported in specification should not exceed 30%**
* **Send LS to RAN4 WG**
* **Inform RAN4 WG that RAN1 WG has discussed the value X for UE DL PRS processing capability and agreed that value of X supported in specification should not exceed 30%**
* **It is up to RAN4 to discuss and define value of X within 30% upper bound**

### Outcome of the Call#1 on NR Positioning Enhancements

Based on discussion of the revision #2 of FL proposal #2 over an online call, the following agreement was made by RAN1 WG:

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| * For the purpose of DL PRS processing capability with measurement gap, the maximum value of X = MGL/MGRP supported in specification should not exceed 30% * Send LS to RAN4 WG * Inform RAN4 WG that RAN1 WG has discussed the value X for UE DL PRS processing capability with measurement gap and has agreed that value of X supported in specification should not exceed 30% * It is up to RAN4 to discuss and define value of X within 30% upper bound |

* 1. TPs to Capture Agreements on DL PRS Processing Capability

### Initial Discussion and Proposal #3

TPs to capture DL PRS processing capability were submitted in [5] and [8]. It needs to be discussed whether agreement on DL PRS processing capability should be a part of RAN1 spec (e.g. TS 38.214) or RAN2 spec (e.g. TS 38.306) it is not crystal clear now and deserves some discussion. In addition, it seems that at least some clarification is needed in terms of how it is used and by which entity.

* It is proposed to discuss the following questions
  + In which specification to capture RAN1 agreements on DL PRS processing capability?
  + Whether additional clarification is needed in terms how DL PRS processing capability is used in the system and by which entity?
  + Comments and preference on text proposals submitted in [5] and [8] are welcome (copied below for convenience):

Note: it is expected to conclude e-mail discussion on DL PRS processing capability and finalize text proposals to specification within meeting week.

Text Proposal #1 on DL PRS Processing Capability [5]

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| **TS 38.214 Clause 5.1.6.5**  ===================== Unchanged parts omitted ======================  For the purpose of DL PRS processing capability, the duration *K* msec of DL PRS symbols within any *P* msec window, is calculated by  *-* Type 1 duration calculation with  *-* Type 2 duration calculation with  *- S* is the set of slots of a serving cell within the *P* msec window in the positioning frequency layer that contains potential DL PRS resources considering the actual *nr-DL-PRS-ExpectedRSTD*, *nr-DL-PRS-ExpectedRSTD-Uncertainty* provided for each pair of DL PRS Resource Sets.  *-* For Type 1, is the smallest interval in msec within slot corresponding to an integer number of OFDM symbols of a serving cell that covers the union of the potential PRS symbols and determines the PRS symbol occupancy within slot , where the interval considers the actual *nr-DL-PRS-ExpectedRSTD*, *nr-DL-PRS-ExpectedRSTD-Uncertainty* provided for each pair of DL PRS Resource Sets (target and reference).  If UE reports (*N*, *T*) through UE capability, and if there exists a *P* msec periodic window, in which the duration *K* within each periodic occasion is calculated with the duration type 1 or type 2 based on UE capability [XX] that satisfies the following conditions  *-*  *-*  *-* The spam of the set of slots can be covered by a time domain window with a periodicity *P* and with the duration , where  *-* The number of resources in each slot in the set of slots does not exceed the UE capability provided by the higher layer parameter [XX]  UE is capable to process all PRS resources within the set of slots .  ===================== Unchanged parts are omitted ====================== |

Text Proposal #2 on DL PRS Processing Capability [8]

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| For the purpose of the DL PRS processing capability provided by [XX], the duration of DL PRS symbols (*K*) in ms within any *P* ms window, is calculated as , or for a Type 1 or Type 2 UE respectively, subject to UE capability, where   * *S* is the set of slots of a serving cell within the *P* ms window in the positioning frequency layer that contains the potential DL PRS resources considering the configured *nr-DL-PRS-ExpectedRSTD*, *nr-DL-PRS-ExpectedRSTD-Uncertainty* provided for each pair of DL PRS Resource Sets, * *for* a Type 1 UE, [Tsstart, Tsend]is the smallest interval in ms within slot corresponding to an integer *number* of OFDM symbols of a serving cell that covers the union of the potential PRS symbols and determines the PRS symbol occupancy within slot , wherein the interval [Tsstart, Tsend] is determined by the configured *nr-DL-PRS-ExpectedRSTD*, *nr-DL-PRS-ExpectedRSTD-Uncertainty* provided for each pair of DL PRS Resource Sets. |

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| **Company Name** | **Comments** |
| Huawei/HiSilicon | RAN1 should at least capture the Type 1 and Type 2 duration calculation. |
| CATT | Prefer to use the first part of TP#1 for defining Type 1 and Type 2 duration.  For the 2nd part of TP#1, we suggest the following TP:  If UE reports (*N*, *T*) through UE capability, for any time window, the UE should be capable to process all PRS resources within , if   * , and * the number of resources in each slot does not exceed the UE capability provided by the higher layer parameter [XX], and * the configured measurement gap and a maximum ratio of measurement gap length (MGL) / measurement gap repetition period (MGRP) is no more than X% reported by UE capability. |
| Futurewei | It is odd to have these texts in RAN1 specs. A UE not following this is not going to cause interoperable issues to other UEs or to the network. It is entirely that UE responsibility to ensure correct capability reporting through (N,T). Preference is to have these in 38.306. |
| ZTE | We are fine with the either TP1 or TP2. |
| Qualcomm | We should at least capture the Type-1 Type-2 which was the intention in TP#2. The 2 TPs look the same to me with respect to this aspect.  With respect to the 2nd part of TP#2, the “DL PRS processing capabilities” it is not the only capabilities that need to be met for a UE to be able to process all the PRS resources. For example, there are the “max number of PRS reosurces/sets/TRPs/layers”, and there is a discussion in the other ED, whether there is a priority defined. Similarly, if the UE does not support joint processing of Angle+Timing methods, then the UE may process some resources TDMed. There may be further reasons/conditions for which the UE may not process some of the resources. We have a preference at this point to not add this description in 38.214; maybe adding it as part of 38.306 within the description of the specific UE capability field would be a better option. |
| vivo | We have a slight preference of TP#2.  Regarding where to capture this, we’d like to echo the comments from Futurewei and Qualcomm. It’s odd to capture this into 38.214 given this whole paragraph is just about UE DL PRS processing capability and nothing “Physical layer procedures for data” per se. We also prefer to capture this as part of 38.306 in the context of UE capability reporting and assumption alignment between UE and LMF. |
| LG | We are fine with TP2. This description is highly related to the UE capability so we prefer to capture this to a part of 38.306. |

**FL Proposal#3**

* **RAN1 prepares text proposals for the TS 38.306 to capture RAN1 agreements on DL PRS processing capability**

Companies are invited to provide further views on proposal above

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| ZTE | OK with FL proposal#3 |
| OPPO | Open to capture in RAN1 spec or TS 38.306 |
| Huawei/HiSilicon | Actually Type 1 and Type 2 duration calculation has nothing to do the capability; it is calculated based on PRS configuration, and the calculation is for (K, P).  The equation itself is pretty much RAN1, at least the first part of TP#1 or TP#2 should go to TS 38.214.  TS 38.306 only explains the (N, T) and the corresponding type reporting.  The second part of TP#1 can be in either TS 38.214 or TS 38.133. |
| Nokia/NSB | We don’t feel that capturing these TPs in TS 38.306 is the best place. It would fit better in our view to go to TS 38.214. There are similar texts on PDCCH monitoring capabilities in TS 38.213 clause 10. |
| CATT | Open to capture in RAN1 spec or TS 38.306 |
| Qualcomm | Definition of Type 1 and 2 makes sense to keep it in 38.214, the rest, that is the description of (N,T), it should be in 38.306. |
| vivo | The whole purpose of Type 1 and Type 2 duration calculation is to align between UE and LMF regarding the reported UE DL PRS processing capability.  Support FL proposal#3. |

### Revision #1 of FL Proposal #3

**Revised FL Proposal#3**

* **Prepare text proposals to capture agreements on UE DL PRS processing capability**
  + **Continue discussion on whether and what is captured in TS 38.214 or TS 38.306 during TP preparation phase**

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei/HiSilicon | OK |
| Qualcomm | OK |
| LG | OK |
| CATT | OK |
| Nokia/NSB | OK. |
| vivo | OK |
| ZTE | OK |

### Revision #2 of FL Proposal #3

Based on discussion in previous sub-section, it seems necessary to decide whether and what needs to be captured on DL PRS processing capability and in which specification. Considering provided comments, it seems reasonable to capture part of DL PRS processing capability agreements in the TS 38.214 (related to definition and types of buffering) and other details in the TS 38.306:

Companies are invited to provide views on the following two TPs below for the TS 38.214 and TS 38.306

**Text Proposal #1 - capture at the end of Clause 5.1.6.5 in the TS 38.214**

|  |
| --- |
| ================================= Unchanged parts omitted ==================================  The UE does not expect to process the DL PRS in the same symbol where other DL signals and channels are transmitted to the UE when there is no measurement gap configured to the UE.  UE is not expected to process DL PRS without configuration of measurement gap and there is no UE DL PRS processing capability defined for this scenario.  For the case when measurement gap is configured, the UE DL PRS processing capability is defined in [TS 38.306 Clause 4.2.7.2]. For the purpose of DL PRS processing capability, the duration *K* msec of DL PRS symbols within any *P* msec window, is calculated by  *-* Type 1 duration calculation with UE symbol level buffering capability  *-* Type 2 duration calculation with UE slot level buffering capability  *- S* is the set of slots of a serving cell within the *P* msec window in the positioning frequency layer that contains potential DL PRS resources considering the actual *nr-DL-PRS-ExpectedRSTD*, *nr-DL-PRS-ExpectedRSTD-Uncertainty* provided for each pair of DL PRS Resource Sets.  *-* For Type 1, is the smallest interval in msec within slot corresponding to an integer number of OFDM symbols of a serving cell that covers the union of the potential PRS symbols and determines the PRS symbol occupancy within slot , where the interval considers the actual *nr-DL-PRS-ExpectedRSTD*, *nr-DL-PRS-ExpectedRSTD-Uncertainty* provided for each pair of DL PRS Resource Sets.  ================================= Unchanged parts omitted ================================== |

**Text Proposal #2 - Capture in the Clause 4.2.7.2 of the TS 38.306**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Definitions for parameters | Per | M | FDD-TDD  DIFF | FR1-FR2  DIFF | | --- | --- | --- | --- | --- | | ***maxDL-PRSBandwidth***  Maximum DL PRS bandwidth in MHz, which is supported and reported by UE. Values reported for FR1 bands are selected from {5, 10, 20, 40, 50, 80, 100} MHz. Values reported in for FR2 bands are selected from {50, 100, 200, 400} MHz | Band | No | No | No | | ***bufferingTypeDL-PRS***  UE indicates whether it supports Type-1 or Type-2 UE capability, where Type 1 – sub-slot/symbol level buffering of DL PRS and Type 2 – slot level buffering for DL PRS | Band | No | No | No | | ***maxNumDL-PRSResources***  Max number of DL PRS resources that UE can process in a slot. Values reported by the UE for FR1 bands are selected from: {1, 2, 4, [6], 8, 12, 16, [24], 32, [48], 64} for each SCS: 15kHz, 30kHz, 60kHz. Values reported by the UE for FR2 bands are selected from: {1, 2, 4, [6], 8, 12, 16, [24], 32, [48], 64} for each SCS: 60kHz, 120kHz | Band | No | No | No | | ***processingCapDL-PRS***  The UE DL PRS processing capability defined as a 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.   1. Values of *T*: {8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms 2. Values of N: {0.125, 0.25, 0.5, 1, 2, 4, 8, 12, 16, 20, 25, 30, 35, 40, 45, 50} ms   Notes:   1. UE reports one combination of (N, T) values per band, where N is a duration of DL PRS symbols in ms processed every T ms for a given maximum bandwidth (B) in MHz supported by UE 2. UE is not expected to support DL PRS bandwidth that exceeds the reported DL PRS bandwidth value 3. UE DL PRS processing capability is defined for a single positioning frequency layer. UE capability for simultaneous DL PRS processing across positioning frequency layers is not supported in Rel.16 (i.e. for a UE supporting multiple positioning frequency layers, a UE is expected to process one frequency layer at a time) 4. UE DL PRS processing capability is agnostic to DL PRS comb factor configuration 5. The reporting of (N, T) values for maximum BW in MHz is not dependent on SCS   Note: The above parameters are reported assuming a configured measurement gap and a maximum ratio of measurement gap length (MGL) / measurement gap repetition period (MGRP) of no more than X% [TS 38.133, TBD].  If UE reports DL PRS processing capability (*N*, *T*), for any time window defined in TS 38.306 Clause 5.6.5.1, the UE should be capable to process all DL PRS resources within , if  - where K is defined in the TS 38.306 Clause 5.6.5.1, and  - the number of resources in each slot does not exceed the UE capability provided by the higher layer parameter *maxNumDL-PRSResources*, and  - the configured measurement gap and a maximum ratio of measurement gap length (MGL) / measurement gap repetition period (MGRP) is no more than *X*% [TS 38.133, TBD] | Band | No | No | No | |

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Nokia/NSB | On TP#1:  Should remove “and there is no UE DL PRS processing capability defined for this scenario” as this is not needed.  In the agreement we have “(target and reference)” after the DL PRS resource sets in the last two bullets. Maybe it is good to also have that here to clarify.  On TP#2:  Change “time window defined in TS 38.306” to “time window defined in TS 38.214” and also in first bullet below that part change this. |
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1. UL SRS Capability
   1. Capability of SRS Carrier Switching

### Initial Discussion and Proposal #4

In [R1-2003522](file:///E:\1%20Meetings\RAN1\2020%2005_TSRR1_101\Inbox\R1-2003522.doc), it was proposed to define the switching capability for SRS for positioning and if it is concluded to be supported make additional agreements on proposals below:

1. If carrier switching for SRS for positioning is supported, reuse current capabilities SRS-SwitchingTimeNR and srs-SwitchingTimesListNR to indicate carrier switching time capability for SRS for positioning.
2. If carrier switching for aperiodic SRS for positioning is supported, reuse current the capability tpc-SRS-RNTI to indicate support of aperiodic SRS for positioning with carrier switching triggered by DCI format 2\_3.
3. If carrier switching for SRS for positioning is supported, support UE capability reporting to indicate number of SRS resources for positioning per BWP and per BWP per slot on a cell in either FeatureSetUplink or FeatureSetDownlink.
4. The capability of SRS for positioning with carrier switching is only applicable to aperiodic SRS for positioning triggered by DCI format 2\_3, if it is introduced.

Note: periodic SRS and semi-persistent SRS for positioning with carrier switching are implicitly supported if UE reports srs-SwitchingTimesListNR per band pair in a band combination, and reports supported SRS resources in the FeatureSet.

Based on discussions above companies are invited to express views on support of carrier switching for SRS for positioning and other proposals:

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei/HiSilicon | We suggest to only introduce the following capability:   * Aperiodic SRS for positioning triggered by DCI format 2\_3 reported per UE.   And the prerequisite FGs are the following three   * srs-SwitchingTimesListNR * tpc-SRS-RNTI * FG13-8a   FG13-8, and FG13-8b can be reused with the existing capabilities srs-SwitchingTimesListNR to indicate support for periodic and semi-persistent SRS with carrier switching, respectively. |
| CATT | The motivation to support the carrier switching for SRS for positioning is unclear to us.  For SRS, the carrier switching is usually used to support DL CSI acquisition for the DL carrier that does not have corresponding UL carrier (e.g., when there are more DL carriers than UL carriers). In this case, UE may be instructed switching to the PUSCH-less SCell (the carrier w/o UL data/control) for supporting the channel estimation. However, for SRS for positioning, it is unclear why the UE needs to perform carrier switching for positioning;  In addition, when carrier switching takes place, which can be done in a very short duration, as defined srs-SwitchingTimesListNR, all neighboring cells need to be informed of the carrier switch of the SRS for positioning in order to measure the SRS for positioning. This requires high-layer signaling support and may potentially have significant impact on the high-layer signaling design (e.g., NPPa), which may need to be first discussed in RAN2/RAN3. |
| ZTE | We don’t think SRS carrier switching can work well for positioning. The reasons are listed here:   1. As CATT pointed out, SRS for carrier switching is only configured in DL CC (without PUCCH/PUSCH), it is quite weird to configured SRS for positioning in DL CC. 2. In DCI format 2\_3, most bits are used to indicate TPC commands for close loop power control. These information are useless for positioning SRS since only open loop power control is supported for positioning. 3. The current RRC signaling for Rel-15 carrier switching is still unclear, we have no idea how could carrier switching work based on the current 38.331 for Rel-15 carrier switching. 4. The SRS transmission order for carrier switching is based on the configured serving cell order. What if SRS for carrier switching and SRS for positioning are configured in different CCs ? e.g. what behavior it is if some carriers are configured with SRS antenna switching but not for SRS positioning. 5. Some other details are unclear, e.g. are both carrier switching type A and B supported for positioning ? SRS positioning and carrier switching should be configured with the same type ?   Based on the above questions/comments which are hard to be solved in the maintenance stage, we suggest not to support SRS carrier switching for positioning purpose in Rel-16. |
| Qualcomm | For IoDT purposes, we prefer to also add a separate capability also whether the UE supports P/SP SRS for positioning with carrier switching (and not just for AP SRS for positioning with carrier switching).  We are OK to reuse the existing capabilities with respect to the switching times though.  So replies to the points 1-5:   1. The DL-only CC may have larger BW than the CC that has DL+UL. 2. The UE would disregard the TPC commands 3. We don’t see what is unclear in current specification. 4. The UE follows the order of the CCs. When it switches to a CC, transmits the SRS for positioning + SRS for antenna switching that it has configured in that CC. Recall that each SRS has a slot-offset also, so we don’t see any problem here. 5. We can assume both types are supported as It is shown now in the endorsed 38.212, there is no need to exclude a specific type. |
| vivo | Before agreeing a new UE capability for SRS carrier switching for positioning, we’d like to understand the motivation and benefit of it.  One argument for carrier switching for SRS for positioning is that DL-only CC may have larger BW than DL+UL CC. On this part, it’s not clear to us why carrier switching is better than say trigger another SRS for positioning on that DL-only CC. Given that SRS for positioning is intended to be received not only by the serving gNB but also neighboring gNBs, carrier switching triggered by the serving gNB seems complicated and may not achieve the expected benefit.  Our preference is not to define a UE capability for SRS carrier switching for positioning in Rel-16. |

Based on comments received so far it seems there is no consensus to support carrier switching for SRS for positioning in Release 16.

**FL Proposal#4**

* **Carrier switching for aperiodic SRS for positioning is not supported in Release 16**
  + **Note: periodic SRS and semi-persistent SRS for positioning with carrier switching are implicitly supported if UE reports srs-SwitchingTimesListNR per band pair in a band combination, and reports supported SRS resources in the FeatureSet**

Companies are invited to provide further views on proposal above

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| ZTE | Support the main bullet of FL proposal#4.  The note seems unnecessary since it does not have any spec impact. |
| Samsung | OK |
| OPPO | Ok with FL proposal |
| Huawei/HiSilicon | We are OK with the proposal.  If it is ageed, does it mean that we need a TP to remove changes to 38.212 or it is up to spec editor? |
| CATT | Support the main bullet of FL proposal#4.  For the Note, the meaning and the intention of the Note are unclear. It seems to say that  “if UE reports srs-SwitchingTimesListNR per band pair in a band combination, and reports supported SRS resources in the FeatureSet”, then   1. *periodic SRS* with carrier switching are implicitly supported; and 2. *semi-persistent* *SRS for positioning* with carrier switching are implicitly supported**.**   Item a) is not related to the issue we are discussing here; and Item b) is controversy to the main bullet. |
| Qualcomm | Do not support. |
| vivo | Okay with FL proposal #4 including the note. |
| CATT | We like to have a further discussion on the Note.  We assume the intention of the note is to say both periodic SRS for positioning, and semi-persistent semi-persistent SRS for positioning are always coupled with the carrier switching that is configured for data communication. We do have concern on this implicit behaviour. CA and carrier switch between CCs are configured associated with the serving cells for supporting data communication. When UE is instructed to switch to another serving cell in another carrier, it is because there is a need to do so for data communication but may not for positioning. We should not expect that the neighbouring cell in another carrier, which may be configured for other purpose but not positioning, always to be ready for the reception of the SRS for positioning from the UE. |
| Huawei/HiSilicon | We would like to address CATT’s comments one by one.  We assume the intention of the note is to say both periodic SRS for positioning, and semi-persistent semi-persistent SRS for positioning are always coupled with the carrier switching that is configured for data communication.  [HW] Whether it is associated with carrier switching depends on whether the UL carrier is configured with PUSCH/PUCCH, and whether UE reports FeatureSetUplink on the band, which in turn help gNB to configure PUSCH/PUCCH on the UL carrier in that band. If a carrier is configured with PUSCH/PUCCH, this carrier will not be the target carrier for SRS carrier switching if SRS is also configured on that carrier.  CA and carrier switch between CCs are configured associated with the serving cells for supporting data communication.  [HW] As I explained, if the carrier is configured with PUSCH/PUCCH, transmitting SRS on that carrier is not carrier switching. I would refer to clause 6.2.1.3 of TS 38.214 for spec interpretation.  When UE is instructed to switch to another serving cell in another carrier, it is because there is a need to do so for data communication but may not for positioning.  [HW] I am not sure I understand correctly. For PUSCH/PUCCH transmission, there is no such need of carrier switching, as UE reports FeatureSetUplink per band in a band combination indicating simultaneous transmission of PUSCH across component carriers across bands, except NUL and SUL which is still under discussion in agenda 5.1. Carrier switching only happens that UE stops/suspends PUSCH/PUCCH Tx on a specific carrier (UE is not able to transmit PUSCH/PUSCH on that carrier) in order to transmit SRS on another carrier not configured with PUSCH/PUCCH, and gNB configures which carrier can be suspended in order to transmit SRS on another carrier via SRS-CarrierSwitching.  We should not expect that the neighbouring cell in another carrier, which may be configured for other purpose but not positioning, always to be ready for the reception of the SRS for positioning from the UE.  [HW] The neighbouring gNB will receive SRS configuration from LMF via MEASUREMENT REQUEST message (terminated at gNB-CU), which provides the SRS periodicity and offset for periodic and semi-persistent SRS. Since the schedule is predetermined, neighbouring gNB is aware of when to receive SRS, and thus if the neighbouring gNB is not able/ready to receive the SRS, it can simply return MEASUREMENT FAILURE to LMF.  To us, receiving AP-SRS by the neighbouring gNB is very challenging, which is why we constantly suggest AP-SRS should not be supported for this release. In addition, the benefit of low latency will be compromised by the delay introduced in signaling flow from serving gNB – AMF – LMF – AMF – neighbouring gNB. |

### Revision #1 of FL Proposal #4

Considering that concerns on the note are raised companies are invited to express their view on what is their understanding with respect to carrier switching for periodic SRS and semi-persistent SRS for positioning. It seems majority of the companies accept the previous FL proposal to not support carrier switching for AP-SRS for positioning.

**Revision #1 of FL Proposal#4**

* **Carrier switching for aperiodic SRS for positioning is not supported in Release 16**

Companies are invited to express their view on what is their understanding with respect to carrier switching for periodic SRS and semi-persistent SRS for positioning as well as revised proposal.

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei/HiSilicon | OK. |
| Qualcomm | Not OK. |
| MTK | OK for proposal #4 |
| LG | OK. |
| CATT | OK |
| vivo | OK |
| ZTE | OK |
|  |  |

### Revision #2 of FL Proposal #4

Based on provided feedback above only one company expressed concern. Considering that other companies accepted the proposal from FL, it proposed to agree on the first bullet of the proposal and continue discussion on carrier switching support for P-SRS and SP-SRS for positioning

**Revision #2 of FL Proposal#4**

* **Carrier switching for aperiodic SRS for positioning is not supported in Release 16**
* **Continue discussion on carrier switching for periodic SRS and semi-persistent SRS for positioning**

Companies are invited to express their view on what is their understanding with respect to support of carrier switching for periodic SRS and semi-persistent SRS for positioning.

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| **Company Name** | **Comments** |
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### Outcome of the Call#1 on NR Positioning Enhancements

Based on discussion of the revision #2 of FL proposal #4 over an online call, the following agreement was made by RAN1 WG:

|  |
| --- |
| * Carrier switching for aperiodic SRS for positioning is not supported in Release 16 |

1. Conclusions

TBD

1. References

1. [R1-2004726](E:\\1 Meetings\\RAN1\\2020 05_TSRR1_101\\Inbox\\R1-2004726.doc), FL summary #1 on DL Reference Signals for NR Positioning, Moderator (Intel Corporation)

1. [R1-2004718](E:\\1 Meetings\\RAN1\\2020 05_TSRR1_101\\Inbox\\R1-2004718.doc), Feature lead summary for [UL Reference Signals](x-apple-data-detectors://0) for NR Positioning, Moderator(Ericsson)

1. [R1-2004683](E:\\1 Meetings\\RAN1\\2020 05_TSRR1_101\\Inbox\\R1-2004683.doc), FL Summary of Remaining issues on NR Positioning Measurements, Moderator (CATT)
2. [R1-2004720](E:\\1 Meetings\\RAN1\\2020 05_TSRR1_101\\Inbox\\R1-2004720.doc), Summary of 7.2.8.4: Physical-layer procedures to support UE/gNB measurements, Moderator (Qualcomm Incorporated)

1. [R1-2003521](E:\\1 Meetings\\RAN1\\2020 05_TSRR1_101\\Inbox\\R1-2003521.doc), Finalizing DL PRS, Huawei, HiSilicon

1. [R1-2003632](E:\\1 Meetings\\RAN1\\2020 05_TSRR1_101\\Inbox\\R1-2003632.doc), Remaining issues on DL PRS for NR Positioning, CATT

1. [R1-2003716](E:\\1 Meetings\\RAN1\\2020 05_TSRR1_101\\Inbox\\R1-2003716.doc), Maintenance on DL reference signals for NR Positioning Nokia, Nokia Shanghai Bell

1. [R1-2004469](E:\\1 Meetings\\RAN1\\2020 05_TSRR1_101\\Inbox\\R1-2004469.doc), Maintenance on DL Reference Signals for NR Positioning, Qualcomm Incorporated

1. [R1-2003758](E:\\1 Meetings\\RAN1\\2020 05_TSRR1_101\\Inbox\\R1-2003758.doc), On UE Features for NR Positioning, Intel Corporation
2. [R1-2003522](file:///E:\1%20Meetings\RAN1\2020%2005_TSRR1_101\Inbox\R1-2003522.doc), Finalizing SRS for NR positioning, Huawei, HiSilicon