**3GPP TSG-RAN WG4 Meeting # 102-e R4-22XXXXX**

**Electronic Meeting, February 21 – March 3, 2022**

**Agenda item:** 10.21.2

**Source:** Moderator (CATT)

**Title:** Email discussion summary for [102-e][231] NR\_pos\_enh\_2

**Document for:** Information

# Introduction

This email discussion summary contains agenda 10.21.2.1, 10.21.2.3 and 10.21.2.5 which include the following topics:

* Topic 1: UE Rx/Tx and/or gNB Rx/Tx timing delay mitigation
* Topic 2: Measurement in RRC\_INACTIVE state
* Topic 3: Enhancements of A-GNSS positioning (*No documents submitted*)

# Topic #1: UE Rx/Tx and/or gNB Rx/Tx timing delay mitigation

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2203883 | CATT | **Proposal 1: Define the same margin for all TEGs per UE/TRP.** **Proposal 2: The margin associated with all TEGs per UE/TRP can be choosen according to the following approach:** * + **LMF indicate an expected margin value to UE/TRP based on the demand**
	+ **UE/TRP report a used margin value which is not smaller than the indicated value based on its implementation**

**Proposal 3: The Rx TEG framework is defined as below:** * **Step #1: RAN4 define multiple candidate values {TE1, TE2, …} in the spec.**
* **Step #2: UE/TRP has multiple Rx TEGs (TEG#1, TEG#2, …) associated with the same value M, which means the timing error difference between the measurements within the same Rx TEG is within the margin M.**
	+ **M is selected from {TE1, TE2, …}**
* **Step #3: LMF indicate an expected margin value to UE/TRP based on the demand and UE/TRP report the used margin value M which is not smaller than the indicated value based on its implementation.**
* **Step #4: UE/TRP reports the measurement with associated Rx TEG ID.**
* **Step #5: The applicability of reported UE Rx TEG is limited to the measurements contained within the measurement report in which the Rx TEG information is provided.**
* **Step #6: RRM accuracy requirements will be defined based on the different values {TE1, TE2, …}.**

**Proposal 4: The candidate values {TE1, TE2, …} defined in RAN4 spec is applied for UE/TRP Rx TEG, Tx TEG and RxTx TEG.** **Proposal 5: The applicability of reported UE Rx TEG agreed in last meeting can be reused for UE/TRP Tx TEG and RxTx TEG i.e. The applicability of reported UE/TRP Tx/RxTx TEG is limited to the measurements contained within the measurement report in which the Tx/RxTx TEG information is provided. And it applies only to the measurements that are tagged with the corresponding Tx/RxTx TEG ID.** **Proposal 6: There is no impact on the core requirements from TEG framework.** **Proposal 7: For the report of the measurement without TEG association, both options are fine to us.**  |
| R4-2204300 | OPPO | **Proposal 1: Same TEG margins are used regardless of time stamp.** **Proposal 2: Same TEG margin for all TEGs should be used as baseline and the TEG margin should be determined by UE/TRP itself.****Proposal 3: UE/TRP shall report the used TEG margins to network, if supporting multiple candidate TEG margins.** |
| R4-2204408 | Intel Corporation | ***Proposal 1: The timing error margin is the same for all Rx TEGs if a UE/TRP has multiple TEGs .******Proposal 2: Whether NW can configure the margins and UE needs to report them to NW is up to RAN1/2.******Proposal 3: When the network configured TEG margin is out of UE’s capability , UE can override it and report the new one based on UE implementation itself.******Proposal 4: Reuse the values of UE/TRP Tx TEG for the UE/TRP Rx TEG.*****Observation 1: Whether to define time variant (semi-static or dynamic) TEGs can be up to RAN1’s agreements.****Observation 2: The exact TEG from UE can be changed time to time. RAN4 can investigate the impacts due to the static TEG within the acceptable variance within a specific duration.** ***Proposal 5: Whether the time variant TEG is upto RAN1/2. The static TEG within a specific time window can be taken as the start point.*** |
| R4-2204463 | Qualcomm Incorporated | **Proposal 1: The UE/TRP selects the timing error margins for TEGs by itself, from a set of values defined in the specification, based on its implementation.****Proposal 2: The UE/TRP can select a different timing error margin value for each TEG.****Proposal 3: For UE-assisted positioning, the LMF may recommend a subset of values or a maximum value of timing error margin that the UE may use when it reports TEGs.****Proposal 4:** **RAN4 should finalize margins for RSTD and UE Rx-Tx measurement accuracy in Rel-16 before deciding on timing error margins for Rx, RxTx and Tx TEGs.****Proposal 5: Use the same approach as Rx TEG for time-variant (semi-static or dynamic) RxTx TEGs.****Proposal 6: RAN4 should wait until RAN2 makes further progress on how to signal a change in association between SRS resources to Tx TEGs.****Proposal 7: Association of transmissions/measurements to TEGs is optional. If a measurement or transmitted signal is not associated with a TEG, then no further assumption about relative timing between said measurement/signal and other measurements/signals can be made beyond what is already implied by measurement accuracy requirements in Rel-16.****Proposal 8: Subject to UE capability, if the LMF requests the UE to optionally measure the same DL PRS resource of a TRP with N different UE Rx TEGs and report the corresponding multiple RSTD measurements, the measurement period shall be extended. FFS whether a detailed measurement period requirement is specified in that case.** |
| R4-2204642 | vivo | **Proposal 1: Support that UE/TRP has multiple Rx TEGs associated with the same value M, i.e., Option C.****Proposal 2: For whether NW can configure requested margin to UE/TRP based on positioning demand, i.e., Step #6 from Option C, even the margin can be requested by LMF, the margin that reported by UE is dependent on UE.****Proposal 3: It is up to RAN2 to decide how to indicate the change of the Tx TEG association.****Proposal 4: The positioning measurement delay may be longer if the maximum TEG number that a UE can support to measure the same DL PRS of a TRP is more than the maximum number of UE TEGs for measuring the same DL PRS resource simultaneously.****Proposal 5: If a measurement/transmission cannot be associated with any TEG, no assumption can be made on the mitigation of UE Rx timing delays errors, i.e., Option 2.** |
| R4-2205379 | Huawei, HiSilicon | **Proposal 1: Rx TEG margin value is indicated by LMF among the candidate values defined in 38.133.****Proposal 2: Timing error margin is the same for all Rx TEGs if UE/TRP has multiple Rx TEGs.****Proposal 3: Adopt the following for Rx TEG framework (option D).*** **Step #1: RAN4 define multiple candidate values {TE1, TE2, …} in the spec.**
* **Step #2: LMF selects one value M from {TE1, TE2, …} and indicate to UE/TRP**
* **Step #3: UE/TRP has multiple Rx TEGs (TEG#1, TEG#2, …) associated with the same value M, which means the timing error difference between the measurements within the same Rx TEG is within the margin M.**
* **Step #4: The applicability of reported UE Rx TEG is limited to the measurements contained within the measurement report in which the Rx TEG information is provided, and only to measurements that are tagged with a Rx TEG ID.**
* **Step #5: RRM requirements will be defined based on the different values {TE1, TE2, …}.**

**Proposal 4: Define 4 TEG margin values for each TEG type (Rx TEG, Tx TEG and RxTx TEG), and the exact values for each TEG can be discussed in Perf part.****Proposal 5: The temporal validity of Tx TEG and RxTx TEG is up to RAN2.** **Proposal 6a: The existing measurement period is scaled by N/k if UE is requested to measure same PRS resource with N different UE Rx TEGs, where k is the value UE reports for 27-1-4a.****Proposal 6b: The existing accuracy requirements do not apply if UE is requested to measure same PRS resource with N different UE Rx TEGs.****Proposal 7: RAN4 not to further how to report the measurement without TEG association since RAN1 already has made agreements.** |
| R4-2205380 | Huawei, HiSilicon | CR on measurement period requirements with multiple Rx TEGs |
| R4-2205396 | ZTE Corporation | Proposal 1: Support Option C which allows the NW to configure requested margin to UE/TRP based on positioning demand.Proposal 2: How to report transmissions/measurements which cannot be associated with any TEG shall be discussed in RAN2. |
| R4-2205602 | Ericsson | **Proposal #1:** Same margin applies to measurements with different time stamps.**Proposal #2**: Support option C on timing margin for multiple TEGs.**Proposal #3**: Reuse values of UE/TRP Rx TEG for UE/TRP Tx and RxTx TEGs if applicable.**Proposal #4**: Do not support network-based margin configuration to UE/TRP and UE/TRP reporting margin to network.**Proposal #5**: Use the same approach as Rx TEG for time-variant Tx TEGs and RxTx TEGs.**Proposal #6.a**: TEG framework will impact all core requirements: in connected with and without gaps with and without latency reduction, and also in RRC\_INACTIVE mode positioning.**Proposal #6.b**: PRS measurement period requirement for RSTD measurement depending on the maximum number of different UE Rx TEGs () can be expressed as: .**Proposal #6.c**: PRS measurement period requirement for PRS-RSRP measurement depending on the maximum number of different UE Rx TEGs () can be expressed as: .**Proposal #6.d**: PRS measurement period requirement for UERxTx measurement depending on the maximum number of different UE Rx TEGs () can be expressed as: .**Proposal #7**: Association of transmissions/measurements to TEGs is optional. |
| R4-2205940 | Nokia, Nokia Shanghai Bell | 1. This feature targets to mitigate residual timing error after calibrations including baseband timing compensation. The residual timing offset includes residual timing error in baseband and RF impairment error.
2. The TEG feature, specified by RAN1, attempts to mitigate this residual timing error after calibrations.

Following proposals are made:1. Tx TEG, RxTx TEG and Rx TEG grouping methodology is based on N groups with different TE margin Mi for each TEG after calibration M1, M2, …, MN , where Mi = ki\*Tc.
2. The number N of supported groups for Tx TEG, RxTx TEG and for Rx TEG is implementation specific for UE/TRP.
3. From minimum performance requirements perspective, UE / TRP needs to satisfy Rel-16 accuracy requirements.
4. The TEG association information for the timing measurements RSTD and UL-RTOA includes Rx TEG information and corresponding Tx TEG information added by the transmitter. The Rx TEG information is forwarded to LMF along the measurement. The Tx TEG information is reported to LMF in implementation-specific manner in case of RSTD, else for UL-RTOA, requested by serving TRP with a configured periodicity or triggered by UE and forwarded via serving TRP to LMF. The TEG association information for the timing measurements UE Rx-Tx time difference and gNB Rx-Tx time difference will include RxTx TEG information and will be reported to LMF along the measurement.
5. Rx TEG is intended to refer to measurements over the same measurement period, which are conveyed in the same measurement report to LMF.
6. For issue 1-1-1 in RAN4 #101bis-e WF [2], RAN4 to agree on option A1 as depicted in section 2.2.1.
7. RAN4 to agree not to reuse TE margins specified for Rx TEG for Tx TEG and RxTx TEG.
8. Deprioritize the issue ‘whether NW can configure requested margins to UE/TRP based on demand’ for Rel-17.
9. No reporting of used margins to NW by UE/TRP based on implementation is needed.
10. The same approach as Rx TEG for time-variant (semi-static or dynamic) is used for Tx TEGs and RxTx TEGs.
11. Whether there is impact on the core requirements from TEG framework, can be assessed once the TEG framework is settled in alignment with RAN1 and RAN2.
12. To support the case transmission/measurements cannot be associated with any TEG, allow TEG association in measurement report to be optional.
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## Open issues summary

### Sub-topic 1-1 TEG framework

**Issue 1-1-0: The framework of UE/TRP Rx TEG (for information, no need to comment)**

* Option 1: (CATT, Intel, OPPO, vivo, ZTE, Ericsson)
	+ Step #1: RAN4 define multiple candidate values {TE1, TE2, …} in the spec.
	+ Step #2: UE/TRP has multiple Rx TEGs (TEG#1, TEG#2, …) associated with the same value M, which means the timing error difference between the measurements within the same Rx TEG is within the margin M.
		- M is selected from {TE1, TE2, …}
	+ Step #3: UE/TRP reports selected margin M before the measurement (e.g. after receiving the location request) and only report the Rx TEG ID during the measurement report.
		- FFS LMF may recommend the margin value to UE/TRP and UE reported value can override the value indicated by LMF.
	+ Step #4: The applicability of reported UE Rx TEG is limited to the measurements contained within the measurement report in which the Rx TEG information is provided.
	+ Step #5: RRM accuracy requirements will be defined based on the different values {TE1, TE2, …}.
* Option 2: (QC)
	+ Step #1: RAN4 define multiple candidate values {TE1, TE2, …} in the spec.
	+ Step #2: UE/TRP has multiple Rx TEGs (TEG#1, TEG#2, …) associated with multiple values (M1, M2, …), which means the timing error difference between the measurements within the TEG#i is within the margin Mi where i=1,2,….
		- Mi is selected from {TE1, TE2, …}
		- Mi can be same as or different from each other
	+ Step #3: UE/TRP reports the corresponding margin together with Rx TEG ID during the measurement report.
		- For UE-assisted positioning, the LMF may recommend a subset of values or a maximum value of timing error margin that the UE may use when it reports TEGs.
	+ Step #4: The applicability of reported UE Rx TEG is limited to the measurements contained within the measurement report in which the Rx TEG information is provided.
	+ Step #5: RRM accuracy requirements will be defined based on the different values {TE1, TE2, …}.
* Option 3 (Nokia):
	+ Step #1: RAN4 defines multiple candidate values for the timing error margin {TE1, TE2, …} in the spec.
	+ Step #2: UE/TRP has multiple Rx TEGs (TEG#1, TEG#2, …) associated with multiple TE margin values (M1, M2, …), which means the timing error difference between the measurements within the TEG#i is within the TE margin ±Mi where i=1,2,….
		- Mi is selected from {TE1, TE2, …} and is implementation specific for UE/TRP.
		- Mi can be same or different from each other
	+ Step #3: UE/TRP reports the corresponding margin as indicated by the Rx TEG ID during the measurement report and associates the respective measurements.
	+ Step #4: The applicability of reported UE Rx TEG is limited to the measurements contained within the measurement report in which the Rx TEG information is provided, and only to measurements that are tagged with a Rx TEG ID.
	+ Step #5: RRM accuracy requirements will be defined based on the different values {TE1, TE2, …}.
* Option 4: (HW)
	+ Step #1: RAN4 define multiple candidate values {TE1, TE2, …} in the spec.
	+ Step #2: LMF selects one value M from {TE1, TE2, …} and indicate to UE/TRP
	+ Step #3: UE/TRP has multiple Rx TEGs (TEG#1, TEG#2, …) associated with the same value M, which means the timing error difference between the measurements within the same Rx TEG is within the margin M.
	+ Step #4: The applicability of reported UE Rx TEG is limited to the measurements contained within the measurement report in which the Rx TEG information is provided, and only to measurements that are tagged with a Rx TEG ID.
	+ Step #5: RRM requirements will be defined based on the different values {TE1, TE2, …}.

*Moderator: Based on the framework in issue 1-1-0 to discuss issue 1-1-1 to issue 1-1-5.*

**Issue 1-1-1 Whether to define different timing error margins for each Rx TEG (FFS for step #2)**

Proposals

* Option 1: (QC, Nokia)
	+ Yes. The UE/TRP can select a different timing error margin value for each Rx TEG
* Option 2: (CATT, OPPO, Intel, vivo, Huawei, ZTE, Ericsson)
	+ No. The same timing margin is used for all Rx TEGs per UE/TRP.
* Recommended WF
	+ *Need more discussion*

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| **Issue 1-1-1 Whether to define different timing error margins for each Rx TEG (FFS for step #2)** |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | In our view, same timing error margin can be used for all Rx TEGs. Scenario under which same Rx TEG will result timing errors that falls under different margins is not clear. |
| Nokia | In our view, issue 1-1-0 on the framework of UE/TRP Rx TEG should be further discussed. Different options indicate different understanding of companies on the purpose of the TEG framework. Regarding Rx TEG, in case UE/TRP supports multiple Rx TEGs, they may have same or different timing error margins. We present an illustration of the TEG groups in our contribution.  |
| Qualcomm | Option 1.It has been agreed already to define multiple candidate values of timing error margin. Given that agreement, we don’t see a strong justification for limiting the number of timing error margins to one value per positioning session as proposed in option 1 above. Also, note that step#3 in option 1 is not currently supported by LPP. There is no existing message after location request and before measurement reporting that can be leveraged for this purpose. Therefore, is would be more convenient to report the timing error margins in the measurement report itself.We do agree that the LMF should have a say in the timing error margins that the UE may report. As proposed in our paper, for UE-assisted positioning, the LMF may recommend a subset of values or a maximum value of timing error margin that the UE may use when it reports TEGs. This provision should address one concern raised by the some of the supporters of option 2, that TEGs are only useful if the LMF is interested. |
| vivo | Option 2. Prefer the same timing margin is used for all Rx TEGs per UE/TRP. |
| Intel | Option 2. |
| ZTE | Already have agreement in GTW. |
| Huawei | Follow GTW agreement. |
| CATT | Follow the GTW agreement.  |

**Issue 1-1-2 How to decide the used value of timing error margin(s) associated with Rx TEGs (FFS for step #3)**

Proposals

* Option 1: (CATT, Intel, OPPO, QC, vivo, ZTE)
	+ The timing error margin value is decided by UE/TRP among the candidate values defined in 38.133 based on its implementation.
* Option 1a: (QC)
	+ For UE-assisted positioning, the LMF may recommend a subset of values or a maximum value of timing error margin that the UE may use when it reports TEGs.
* Option 1b: (CATT, Intel)
	+ When the network configured TEG margin is out of UE’s capability, UE can override it and report the new one based on UE implementation itself.
* Option 1c: (Ericsson, Nokia)
	+ No reporting of used margins to NW by UE/TRP based on implementation is needed
* Option 1d: (Nokia)
	+ Deprioritize the issue ‘whether NW can configure requested margins to UE/TRP based on demand’ for Rel-17 (i.e. NW will not configure the requested timing error margins to UE/TRP in R17.)
* Option 2: (Huawei)
	+ Rx TEG margin value is indicated by LMF among the candidate values defined in 38.133
* Recommended WF
	+ *Need more discussion*

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| **Issue 1-1-2 How to decide the used value of timing error margin(s) associated with Rx TEGs (FFS for step #3)** |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | We support option 1c and 1d. We are also ok to support option 1. In rest of the options network configured margin value is being considered. Since network is not aware of UE implementation and we do not see how network can expect support of margin that it wants to configure UE with. Therefore, we do not see feasibility of option 1a, option 1b and option 2. |
| Nokia  | We support options 1, 1c and 1d. Same understanding as Ericsson. Also, the Rel-17 timeline needs to be taken into account, i.e. avoid too many specification / design impacts from TEG framework. |
| Qualcomm | Our view is that the UE/TRP can select a different timing error margin value for each TEG. For UE-assisted positioning, the LMF may recommend a subset of values or a maximum value of timing error margin that the UE may use when it reports TEGs. |
| vivo | Support Option 1. Option 1b is fine.We are OK that NW can recommend some margins to UE/TRP. However, the reported time error margin value is based on the UE/TRP capability. |
| Intel | We are fine if companies agree these margins can be indicated by LMF. But these recommended margin can be overridden by UE themselves if out of UE’s implementation capability.  |
| OPPO | Support option 1 and 1d. If the target margin is configured by network, how to handle the misalignment between UE capability and network configuration. |
| ZTE | Option 1. As we previously agreed that TEG is up to UE/TRP implementation, actually it means similar meaning with Option 1. |
| Huawei | Follow GTW agreement.On 1a, 1b and 1d, if UE can report a larger margin value than what is recommended by LMF (as in option 1b), we do not see much value for LMF to make the recommendation. On 1c, given we agreed to specify multiple margin values in the spec, we think it is necessary for UE/TRP and LMF to have common understanding on what margin is used by UE/TRP for grouping the measurements, as it may impact how LMF is to use the measurements for positioning fix. |
| CATT | Since we have agreed that the margin is decided by UE/TRP itself. This selected value need to be reported to NW so that the NW and UE can have the same understanding on the timing error margin and accuracy requirements. Considering the timeline we are fine to not include the LMF recommendation. For the proponents of option 1c, we would like to understand how NW will know the values UE used and which accuracy requirements the UE measurement shall meet. So would like to suggest the following: * The timing error margin value is decided by UE/TRP among the candidate values defined in 38.133 based on its implementation.
* UE/TRP will report the selected value to NW.
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**Issue 1-1-3 The timing error margins associated with UE/TRP Tx TEGs**

*Moderator: to Qualcomm (option 3), the exact value of the margin(s) will be decided in performance part. But this issue is discussing whether to use the same candidate value(s) for Rx TEG and Tx TEG and is not going to decide the exact value, so please focus on the difference between Rx TEG and Tx TEG if identified.*

Proposals

* Option 1: (CATT, Intel, Ericsson)
	+ The candidate values {TE1, TE2, …} defined for UE/TRP Rx TEG can also be applied for UE/TRP Tx TEG.
* Option 2: (Nokia)
	+ Not to reuse TE margins specified for Rx TEG for Tx TEG
* Option 3: (Qualcomm)
	+ RAN4 should finalize margins for RSTD and UE Rx-Tx measurement accuracy in Rel-16 before deciding on timing error margins for Rx, RxTx and Tx TEGs.

Recommended WF

* + *Need more discussion*

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| **Issue 1-1-3 The timing error margins associated with UE/TRP Tx TEGs**  |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | In our understanding margin values are defined to keep measurement error within a tolerance limit. Therefore, in our point of view, candidate values defined for Rx TEG can also be applied for Tx TEG. We also agree with option 3. The margin values shall be discussed and finalized during the performance part of WI. |
| Nokia  | In our view, the margins for Rx TEG and Tx / TxRx TEG may or may not be different, hence the candidate values for these margins can be same or different as intended by option 2. If the candidate values in spec include candidate values for Rx TEG and for Tx/TxRx TEG, then the same set of candidate values can be specified for these groups.  |
| Qualcomm | Option 3 |
| vivo | Prefer Option 2. In our understanding, the Rx TEG, the Tx TEG and the RxTx TEG is independent. The values for Rx TEG cannot be directly reused for Tx TEG. |
| Intel | Option 1 and 3  |
| OPPO | Slight prefer option 2 and 3. Maybe we can postpone this issue to perf part when discussing the exact values for Tx and Rx margins.  |
| Huawei | We support option 3, i.e. to decide the margin values, including whether to use same set of values for Rx TEG and Tx TEG, in the perf part. |
| CATT | Option 1. Agree with Ericsson that the tolerance limit of should be same for Rx and Tx. And from UE implementation perspective, we think the Rx and Tx should have no big difference. Although the final selected value for each report can be different, the candidate value should be the same.  |

**Issue 1-1-4 The timing error margins associated with UE/TRP RxTx TEGs?**

*Moderator: to Qualcomm (option 3), the exact value of the margin(s) will be decided in performance part. But this issue is discussing whether to use the same candidate value(s) for Rx TEG and RxTx TEG and is not going to decide the exact values, so please focus on the difference between Rx TEG and RxTx TEG if identified.*

Proposals

* Option 1: (CATT, Ericsson)
	+ The candidate values {TE1, TE2, …} defined for UE/TRP Rx TEG can also be applied for UE/TRP RxTx TEG.
* Option 2: (Nokia)
	+ Not to reuse TE margins specified for Rx TEG for RxTx TEG
* Option 3: (Qualcomm)
	+ RAN4 should finalize margins for RSTD and UE Rx-Tx measurement accuracy in Rel-16 before deciding on timing error margins for Rx, RxTx and Tx TEGs.
* Recommended WF
	+ *Need more discussion*

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| **Issue 1-1-4 The timing error margins associated with UE/TRP RxTx TEGs?**  |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | For the reasoning similar to issue 1-1-3 we support the proposal in option 1. We also agree with option 3. The margin values shall be discussed and finalized during the performance part of WI.  |
| Nokia | Same as for issue 1-1-3. |
| Qualcomm | Option 3 |
| vivo | Prefer Option 2. In our understanding, the Rx TEG, the Tx TEG and the RxTx TEG is independent. The values for Rx TEG cannot be directly reused for RxTx TEG. |
| OPPO | Same as for issue 1-1-3. |
| Huawei | Same comment as for issue 1-1-3 |
| CATT | Same as issue 1-1-3.  |

**Issue 1-1-5 The number of timing error margins to be defined for each TEG type (Rx TEG, Tx TEG and RxTx TEG)?**

*Moderator: to Qualcomm (option 2), the exact value of the margin(s) will be decided in performance part. For this issue please focus on the number of timing error margins to be defined.*

Proposals

* Option 1: (Huawei)
	+ Define 4 TEG margin values for each TEG type (Rx TEG, Tx TEG and RxTx TEG), and the exact values for each TEG can be discussed in Perf part.
* Option 2: (Qualcomm)
	+ RAN4 should finalize margins for RSTD and UE Rx-Tx measurement accuracy in Rel-16 before deciding on timing error margins for Rx, RxTx and Tx TEGs.
* Recommended WF
	+ *Need more discussion*

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| **Issue 1-1-5 The number of timing error margins to be defined for each TEG type (Rx TEG, Tx TEG and RxTx TEG)?**  |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | Proposal in option 1 looks fine. Number of TEG margin values for each TEG type can be FFS and discuss during performance part of WI. |
| Nokia | We agree, option 1 can be used as baseline for core requirements. |
| Qualcomm | Ideally, we would prefer option 2 but we agree that this has impact on signalling and may need to be prioritized. We’re not sure if agreeing on the number of values is sufficient to address the impact to RAN2. Is the proposal to define some labels in ASN.1 and then define the values corresponding to those labels elsewhere in the specification? |
| vivo | We are fine with determining the number of timing error margins for each TEG type. However the exact numbers can be FFS which depends on the UE/TRP implementation and positioning accuracy request. We can discuss this during performance part of WI. |
| Intel | For Option 1, did 4 values represent the 4 types of accuracy required by LMF (e.g. high, medium, low)? |
| OPPO | Share the same view as Ericsson and vivo, the number of timing error margin values can be FFS in perf part.  |
| Huawei | Support option 1 at least for the Rx TEG. We need to decide the number of margin values because it has impact on RAN2/3 signaling, and our proposal is 4. To QC, yes, the intention is to “define some labels in ASN.1 and then define the values corresponding to those labels elsewhere in the specification”.On Tx TEG and RxTx TEG, we are not so sure because RAN4 has not discussed the framework and the agreements so far are only for Rx TEG. |
| CATT | Fine with option 1. And option 1 and option 2 are not exclusive and the exact value can be decided in perf part after the margins are finalized in R16.  |

### Sub-topic 1-2 The temporal validity of TEG

Agreements in RAN4#101bis-e meeting:

* The applicability of reported UE Rx TEG is limited to the measurements contained within the measurement report in which the Rx TEG information is provided. And it applies only to the measurements that are tagged with the corresponding Rx TEG ID.

**Issue 1-2-1 The temporal validity of UE/TRP Tx TEGs**

Proposals

* Option 1: (CATT, Ericsson, Nokia)
	+ The applicability of reported UE Rx TEG agreed in last meeting can be reused for UE/TRP Tx TEG i.e. The applicability of reported UE/TRP Tx TEG is limited to the measurements contained within the measurement report in which the Tx TEG information is provided. And it applies only to the measurements that are tagged with the corresponding Tx TEG ID.
* Option 2: (QC, vivo, Intel, Huawei)
	+ wait RAN2 progress on how to signal a change in association between SRS resources to Tx TEGs
* Recommended WF
	+ *Need more discussion*

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| **Issue 1-2-1 The temporal validity of UE/TRP Tx TEGs**  |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | Option 1 refers to the scenario where Tx TEG ID is reported in the measurement report and the validity of reported Tx TEG ID is limited to the measurement report. Option 2 is mainly about the problem of change in Tx TEG association. In our view proposal in option 1 does not impact proposal in option 2 and we are ok to support both of them. |
| Nokia | We support Option 1 with regard to measurement reporting. Option 2 is valid with regard to higher layer signalling, which also affects the temporal validity of the Tx TEG association.  |
| Qualcomm | Option 2. RAN1 has asked RAN2 to address this aspect of the TEG framework.  |
| vivo | Support Option 2. According to the LS from RAN1, when there is change in association between SRS resources to Tx TEGs, UE/TRP can indicate the change by signaling designed by RAN2. |
| Intel | Option 2.  |
| OPPO | Option 2. |
| Huawei | Option 2. |
| CATT | Support option 1 and we think the two options are not exclusive since RAN1 is saying that the reported TEG ID is only applied for the current report which is only for single association report, while option 2 is addressing the association change which will be another report. So we are also fine with option 2.  |

**Issue 1-2-2 The temporal validity of UE/TRP RxTx TEGs?**

Proposals

* Option 1: (CATT, QC, Ericsson, Nokia)
	+ The applicability of reported UE Rx TEG agreed in last meeting can be reused for UE/TRP RxTx TEG i.e. The applicability of reported UE/TRP RxTx TEG is limited to the measurements contained within the measurement report in which the RxTx TEG information is provided. And it applies only to the measurements that are tagged with the corresponding RxTx TEG ID.
* Option 2: (Intel, Huawei)
	+ Up to RAN2.
* Recommended WF
	+ *Need more discussion*

|  |
| --- |
| **Issue 1-2-2 The temporal validity of UE/TRP RxTx TEGs?**  |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | Our understanding and reasoning are similar to issue 1-2-1 to support option 1. |
| Nokia | Same as for issue 1-2-1. |
| Qualcomm | Option 1. |
| Vivo | Option 2. We understand the temporal validity of RxTx TEGs is similar to Tx TEGs since it is also related to SRS resources. |
| Intel | Option 2.  |
| OPPO | Option 2. |
| Huawei | Option 2, similar view as vivo. |
| CATT | Same as issue 1-2-1.  |

### Sub-topic 1-3 RRM requirements

**Issue 1-3-1 The impact of TEGs (including Rx/Tx/RxTx TEG) on PRS measurement core requirements.**

*Moderator: RAN1 feature list on UE Rx TEGs is captured as below.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Note | Mandatory/Optional |
| 27. NR\_pos\_enh | 27-1-4 | Support of UE Rx TEGs for measuring the same DL PRS resource | The maximum number of different UE Rx TEGs that a UE can support to measure the same DL PRS of a TRP | The candidate values are {2, 3, 4, 6, 8}Need for location server to know if the feature is supported | Optional with capability signalling |
| 27. NR\_pos\_enh | 27-1-4a | Support of UE Rx TEGs for measuring the same DL PRS resource simultaneously | The maximum number of UE Rx TEGs for measuring the same DL PRS resource simultaneously | The candidate values are {1,2,3,4,6,8}Need for location server to know if the feature is supported. | Optional with capability signalling |

Proposals

* Option 1: (CATT)
	+ There is no impact on the core requirements from TEG framework
* Option 2: (QC)
	+ Subject to UE capability, if the LMF requests the UE to optionally measure the same DL PRS resource of a TRP with N different UE Rx TEGs and report the corresponding multiple RSTD measurements, the measurement period shall be extended.
	+ FFS whether a detailed measurement period requirement is specified in that case.
* Option 3: (vivo)
	+ The positioning measurement delay may be longer if the maximum TEG number that a UE can support to measure the same DL PRS of a TRP is more than the maximum number of UE TEGs for measuring the same DL PRS resource simultaneously.
* Option 4: (Huawei)
	+ The existing measurement period is scaled by N/k if UE is requested to measure same PRS resource with N different UE Rx TEGs, where k is the value UE reports for 27-1-4a.
	+ The existing accuracy requirements do not apply if UE is requested to measure same PRS resource with N different UE Rx TEGs.
* Option 5: (Ericsson)
	+ TEG framework will impact all core requirements: in connected with and without gaps with and without latency reduction, and also in RRC\_INACTIVE mode positioning
	+ The existing measurement period is scaled by N if UE is requested to measure same PRS resource with N different UE Rx TEGs.
* Option 6: (Nokia)
	+ Whether there is impact on the core requirements from TEG framework, can be assessed once the TEG framework is settled in alignment with RAN1 and RAN2.
* Recommended WF
	+ *Need more discussion*

|  |
| --- |
| **Issue 1-3-1 The impact of TEGs (including Rx/Tx/RxTx TEG) on PRS measurement core requirements.**  |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | In our view the TEG framework has an impact on core RAN4 requirement. We therefore support option 5. Based on UE feature 27-4-1 in our view the measurement will scale depending on the number of Rx TEGs at UE that can be expressed as:...TEG framework will also have an impact on RRC\_INACTIVE mode positioning core requirements.For UE feature 27-4-1a we support options 3 and 4 (first part). In our understanding accuracy requirement is impacted by the margin value (to be discussed during performance part of WI) of Rx TEG and not the number. Therefore, we are not very clear on second part of option 4. Can Huawei clarify on the proposal?  |
| Nokia | We agree there is impact on measurement period requirements and measurement reporting requirements depending on the realization of the TEG framework. Impacts on Rx TEG, TxRx TEG and Tx TEG can be distinguished in the further discussion.  |
| Qualcomm | Except for option 1, all other options acknowledge that the measurement period needs to be extended. So we think at least option 2 should be agreeable by companies supporting options 3-5.FFS whether to specify a detailed measurement period requirement.Option 3 seems to be aligned with the first bullet of option 4. One concern with those proposals is that they don’t seem to account for the UE PRS processing capability {N, T, N’}. e.g. if a PRS resource has duration of L ms and K\*L > N or K > N’, where N is the buffering capability and N’ is the max. resources processed per slot, then it would not be possible to process the K measurements of the PRS resource simultaneously. The PRS processing capability would be exceeded. That is unless RAN1’s interpretation is that if the UE signals K > 1 in feature 27-1-4a it means that the equivalent PRS processing capability is {K\*N, T, K\*N’}The second bullet in option 5 could be considered for UEs that support feature 27-1-4.However, note that in either case reporting measurements with multiple TEGs is optional and the UE may not do it for all PRS resources in the assistance data. |
| vivo | Support Option 3. Only when the maximum TEG number that a UE can support to measure the same DL PRS of a TRP is more than the maximum number of UE TEGs for measuring the same DL PRS resource simultaneously, the positioning measurement delay need to be longer.For Option 4, we are fine with the first bullet in addition the scaled factor should be revisited to . For the second bullet, we think there is no impact on accuracy requirements if UE is requested to measure same PRS resource with N different UE Rx TEGs. |
| Intel | In principle , we agree there is some impacts on the measurement period if UE was requested to report multiple TEG. But since there are many types of measurement period in current release (e.g. reduced samples, gap-less), whether and what the impacts on the different core requirements can be FFS. |
| Huawei | Option 4On the first bullet, to QC, we are not sure if reporting K>1 means processing capability is also scaled, and it should be up to UE implementation how to report those capabilities {N,T,N’} and K. For requirements, we can simply follow current definition of 27-1-4a, otherwise it seems 27-1-4a will becomes useless.On the second bullet, the rationale is that in Rel-16 the accuracy requirements are defined based on 2Rx assumption, while when UE is requested to measure same resource with multiple Rx TEGS, it is likely to be measured with 1Rx. |
| CATT | Based on the UE features, we are fine with option 2 that the measurement period will be extended. If the exact requirements are going to be defined, we are fine with the first bullet of option 4. To QC’s comment on UE processing capability, we think it has been considered in the current requirements, and if the UE has reported the support for k parallel measurements in 27-1-4a, UE should have the capability to perform the processing and no need to mix the two capabilities.  |

### Sub-topic 1-4 Report for the measurement without TEG association

**Issue 1-4-1 How to report transmissions/measurements which cannot be associated with any TEG**

RAN1 agreements:

* If the UE does not include RxTEG-ID associated with a measurement, no assumption can be made on the mitigation of UE Rx timing delays errors for this measurement.

Proposals

* Option 1: (CATT, ZTE)
	+ Whether and how to report the measurement without TEG association should be within RAN1/2 scope.
* Option 2: (CATT, QC, vivo, Ericsson, Nokia)
	+ Association of transmissions/measurements to TEGs is optional.
		- If a measurement or transmitted signal is not associated with a TEG, then no further assumption about relative timing between said measurement/signal and other measurement/signals can be made beyond what is already implied by measurement accuracy requirements in Rel-16.
* Option 3: (Huawei)
	+ RAN4 not to further discuss how to report the measurement without TEG association since RAN1 already has made agreements.
* Recommended WF
	+ *Need more discussion*

|  |
| --- |
| **Issue 1-4-1 How to report transmissions/measurements which cannot be associated with any TEG** |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | In line with RAN1 agreement we support option 2 and option 3. |
| Nokia  | Option 2. |
| Qualcomm | We support options 2 and 3. Option 2 is consistent with the agreement in RAN1. |
| vivo | Option 2. This is RAN1’s conclusion.We are fine with Option 1 and Option 3. |
| Intel |  Option 2 is fine for us. |
| OPPO | Option 2. |
| ZTE | No need to further discuss (Option 1 and 3). |
| Huawei | All options are same, and we do not think RAN4 needs to make additional agreement for this issue. |
| CATT | Option 2 and option 3. We are fine with option 2 but since RAN1 has already had the agreements, we suggest not to do it repeatedly.  |

## Companies views’ collection for 1st round

### Open issues

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2205380 (Huawei)CR on measurement period requirements with multiple Rx TEGs | Qualcomm: Pending issue 1-3-1 |
| Company B |
| Ericsson:This draft CR is not in the work split. Proposed addition to spec needs to be first agreed. Output of 102-e shall be considered to revise the proposed text. |
|  | CATT: pending on issue 1-3-1, if the agreement can be reached, we are fine to have this CR to capture the conclusion. |
|  | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic #1-1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |
| **Sub-topic #1-2** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |
| **Sub-topic #1-3** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |
| **Sub-topic #1-4** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |
| **Sub-topic #1-5** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

### CRs/TPs

## Discussion on 2nd round (if applicable)

# Topic #2: Measurement in RRC\_INACTIVE state

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2203887 | CATT | **Proposal 1: RAN4 deprioritize the discussion for PRS measurement requirements when RRC state transition occurs during the measurement period.** **Proposal 2: For the collision condition between PRS and other signals in RRC\_INACTIVE state, X = 1 is suggested.** **Proposal 3: The UE shall restart the UE Rx-Tx measurement after the cell reselection.** **Proposal 4: Do not define exact measurement period for RSTD, PRS-RSRP and PRS-RSRPP if the cell reselection occurs during the UE Rx-Tx measurement period. Add a general note that the measurement period requirements can be longer.** **Proposal 5: No gNB measurement requirements are defined in RRC\_INACTIVE state.** **Proposal 6: Support the reduced number of samples for PRS measurement in RRC\_INACTIVE state.** **Proposal 7: Use option 1 for Tavailable\_PRS,i calculation when drafting CR and it can be revisited after receiving RAN1 reply.** **Proposal 8: The same approach as R16 can be used for Teffect calculation.** **Proposal 9: If PRS measurement is performed with the same engine as RRM measurement, Kcarrier\_PRS = Kcarrier\_RRM = Kcarriers + 1.** **Proposal 10: If PRS measurement is performed with dedicate engine, Kcarrier\_PRS = 1 and Kcarrier\_RRM = Kcarrier.** |
| R4-2203888 | CATT | **Draft CR on PRS-RSRPP measurement requirements in RRC\_INACTIVE state** |
| R4-2204261 | CMCC | ***Proposal 1: it is proposed to consider latency reduction in RRC\_INACTIVE state.******Proposal 2: it is proposed to define two sets of PRS measurement period for inactive state, one set with 4-sample and the other set with reduced number of samples.******Proposal 3: replace CSSF with Kcarrier for inactive state PRS measurement requirements, Kcarrier is the total number of configured carriers for mobility measurements and CA measurements plus one positioning frequency layer.*** |
| R4-2204304 | OPPO | **Proposal 1: Deprioritize the PRS measurement requirements when RRC state transition.****Proposal 2: The UE shall restart the UE Rx-Tx time difference measurement after cell reselection and SRS reconfiguration on the target cell is completed.****Proposal 3: The measurement period for RSTD, PRS-RSRP and PRS-RSRPP can be longer under cell change.****Proposal 4: No gNB measurement period requirements are defined in RRC\_INACTIVE state, and the existing accuracy requirements in Rel-16 can be reused for SRS measurement in RRC\_INACTIVE state.****Proposal 5: Replace CSSF with Kcarrier and Nlayer for RRC\_INACTIVE state measurement requirements, only one positioning frequency layer is accounted into Kcarrier and Nlayer**. |
| R4-2204410 | Intel Corporation | ***Proposal 1 : If there is status transition (e.g. RRC\_INACTIVE 🡪RRC\_CONNECT) during one successful measurement reporting period, UE measurement requirements can be based on the behaviour below.**** ***UE restarts the PRS measurement***

**Observation 1: If UE support the reduce number of samples in RRC\_CONNECT state, the reduce sample can be applied, which is also desirable by UE because of power consumption benefits**.***Proposal 2: The requirements with reduced number of PRS measurement samples can be defined for NR positioning measurement in RRC\_INACTIVE upon UE capability.******Proposal 3: FFS on Tavailable\_PRS,I upon RAN1’s confirmation******Proposal 4: The UE behaviour during UE Rx-Tx measurement period if cell change happened can be :**** ***The UE shall restart the UE Rx-Tx measurement after the cell reselection***
 |
| R4-2204465 | Qualcomm Incorporated | **Proposal 1: If there is state transition from RRC\_INACTIVE to RRC\_CONNECTED (or vice-versa) during the measurement period:*** **For DL only positioning, the UE continues performing the measurements and the measurement period is extended.**
* **For multi-RTT, the UE stops performing measurements and reports an error.**

**Proposal 2: Measurement requirements do not apply to any PRS resource that collides/overlaps with other DL signals/channels that have higher priority in RRC\_INACTIVE. Collision/overlap between a PRS resource and other DL signals/channels in RRC\_INACTIVE state occurs when*** **Any other signal/channel occurs within X1 ms before the expected start time of (the first repetition of) a PRS resource.**
	+ **X1 = RRT + expected RSTD-uncertainty of the PRS resource**
	+ **RRT = [0.5] ms for serving cell in FR1, [0.25] ms for serving cell in FR2.**
	+ **FFS if and under what conditions the retuning time RRT can be excluded from X1**
* **Any other signal/channel occurs within X2 ms after the expected start time of (the first repetition of) a PRS resource.**
	+ **X2 = X1 + T**
	+ **T is the duration of PRS processing of the UE PRS processing capability in RRC\_INACTIVE**

**Proposal 3: The UE shall stop the UE Rx-Tx measurements after the cell reselection and reports an error.****Proposal 4: When cell reselection occurs while the UE is performing PRS measurements for DL-only positioning (RSTD, PRS-RSRP, PRS-RSRPP), the measurement period is extended.****Proposal 5: gNB requirements for positioning measurements apply regardless of the RRC state of the UE.****Proposal 6: Tavailable\_PRS,i equals the least common multiple of TPRS and DRX cycle length.****Proposal 7: Working assumption*** **The measurement requirements in RRC\_INACTIVE are based on a separate UE PRS processing capability (N, T) for inactive state, where N is the maximum duration of PRS in msec that can be buffered by the UE, assuming the maximum supported PRS bandwidth in the frequency band, and T-N (>0) is the corresponding processing time assuming PRS samples are already buffered in memory.**

**Proposal 8: For PFL *i*, the UE measures and processes up to PRS duration of msec in each measurement/processing occasion of length , where the PRS resources are received during a measurement interval of length and they are processed by the UE during a processing interval of length , immediately following the measurement interval.****Observation 1: The length of the measurement interval within measurement/processing occasion must account for ±expectedRSTD-uncertainty.****Proposal 9: The LMF may request , the length of the measurement/processing occasion for PFL *i*, in the location request. requested by the LMF must be larger than signalled in the UE capability, otherwise measurement requirements do not apply.****Proposal 10: msec.****Proposal 11: If the LMF does not request the length of the measurement/processing occasion, then is used to calculate the measurement period requirement, where is the UE capability applicable to PFL *i*.****Proposal 12:** * **For requirements in RRC\_INACTIVE, replace the factor in the Rel-16 PRS measurement period formulas with , where**
* **is defined as the number of measurement/processing occasions required to cover all the PRS resources in , taking into account that the UE can process at most PRS duration of ms per occasion.**

**Proposal 13: For the Rel-16 approach can be used as the baseline. This approach can be revisited once RAN1 finalizes the new UE PRS processing capability for RRC INACTIVE state.****Proposal 14: Replace CSSF in the Rel-16 measurement period formula with a factor K with two possible values depending on UE capability.*** **Baseline capability: K = Kcarrier + 1 (or Nlayer + 1 when only higher priority layers need to be measured),**
* **Advanced capability: K=1, for a UE that has a dedicated PRS processing engine.**

**Proposal 15: A reduced number of PRS samples for measurements in RRC\_INACTIVE may supported subject to UE capability (different from the UE capability for RRC\_CONNECTED)** |
| R4-2204466 | Qualcomm Inc. | **DraftCR – RSTD measurement requirements in RRC\_INACTIVE state** |
| R4-2204637 | vivo | **Draft CR to 38.133 Introduction of PRS RSRP measurement requirements in RRC INACTIVE state** |
| R4-2204641 | vivo | **Proposal 1: Prefer that UE restarts the PRS measurement if there is status transition during the measurement period.****Proposal 2: After the cell reselection, the measurement period can be longer. In the current stage, no need to define the exact requirements for the cell change case, i.e., Option 2.****Proposal 3: Introduce a new UE capability to support the reduced number of samples for positioning in RRC\_INACTIVE state.****Proposal 4: Replace CSSF with Kcarrier for inactive state PRS measurement requirements with some clarification, e.g., if Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, Kcarrier is the total numbers of higher priority carriers plus one positioning frequency layer, otherwise, Kcarrier is the total number of configured carriers for mobility measurements and CA measurements plus one positioning frequency layer.** |
| R4-2205383 | Huawei, HiSilicon | **Proposal 1: For the case when state transition occurs during RSTD and PRS-RSRP(P) measurement period, state that measurement period can be longer without defining exact requirements.****Proposal 2: UE shall re-start UE Rx-Tx measurement when state transition occurs during the measurement period and after it obtains SRS configuration and TA from the serving cell.****Proposal 3: UE shall restart the UE Rx-Tx measurement after the cell reselection and after it obtains SRS configuration and TA from the new serving cell.****Proposal 4: For the case when cell change occurs during RSTD and PRS-RSRP(P) measurement period, state that measurement period can be longer without defining exact requirements.****Proposal 5: RAN4 not to define UE behaviour or requirements for the case when cell selection is triggered during PRS measurement period.****Proposal 6: X=0 if PRS is within initial DL BWP; X=0.5ms if PRS is outside initial DL BWP.****Proposal 7: UE is not expected to receive PDSCH on PRS resources or on symbols for RF-retuning within Y symbols after a DCI.** **Proposal 8: RAN4 not to discuss prioritization between SRS transmission for positioning and other UL signals/channels (which is RAN1 scope).****Proposal 9: Define PRS measurement requirements with both 4-sample and reduced sample number for RRC\_INACITVE.*** **The requirements with reduced sample number are applicable when UE supports measurement with reduced sample number in RRC\_INACTIVE and is requested by LMF to perform measurement with reduced sample number.**

**Proposal 10: RAN4 waits for RAN1 conclusion regarding measurement window before concluding on Tavailable\_PRS,i.****Proposal 11: Teffect is defined in the same way as in Rel-16 requirements.****Proposal 12: Replace CSSF with Kcarrier and Nlayer for RRC-INACTIVE state measurement requirements, only one positioning frequency layer is accounted into Kcarrier and Nlayer.** |
| R4-2205384 | Huawei, HiSilicon | **CR on general requirements for PRS measurements in RRC Inactive** |
| R4-2205398 | ZTE Corporation | Observation 1: The UE behavior in INACTIVE mode with respect to positioning measurement is similar with the UE behavior under measurement gap in CONNECTED mode.**Proposal 1: Tavailable could be the common multiple between TPRS and DRX cycle.** |
| R4-2205941 | Nokia, Nokia Shanghai Bell | 1. If there is state transition (e.g. RRC\_INACTIVE to RRC\_CONNECT) during the measurement period, UE measurement requirements are based on the UE behaviour restarting the PRS measurement.
2. UE shall restart the UE Rx-Tx measurement after cell reselection.
3. In case of cell reselection, the measurement period for RSTD, PRS-RSRP and PRS-RSRPP, should be based on the longest of the Kcarrier and DRX cycles used among the old serving cell before the cell reselection and the new serving cell after the cell reselection. In case of cell selection for the selected PLMN, the UE behaviour should be defined by RAN1/2.
4. RAN4 to not define gNB measurement requirements for UE in RRC\_INACTIVE state.
5. Support of reduced PRS samples should be bound to UE capability. A UE that supports reduced number of PRS samples in RRC\_CONNECTED state should also support the feature in RRC\_INACTIVE state, if it supports positioning measurement in RRC\_INACTIVE state.
6. For Tavailable\_PRS,I determination in RRC\_INACTIVE, wait on RAN1’s reply on the applicability of the PRS processing window in RRC\_INACTIVE.
7. For Teffect,i determination in RRC\_INACTIVE, wait on RAN1's reply on the applicability of the PRS processing window in RRC\_INACTIVE.
8. Replace CSSF with Kcarrier for inactive state PRS measurement requirements, Kcarrier is the total number of configured carriers for mobility measurements and CA measurements plus one positioning frequency layer.
 |
| R4-2206027 | Ericsson | **Applicability of PRS measurement requirements under PRS collisions:*** **Observation #1**: If PFL is the same as serving carrier then UE will have to switch between the PRS resource and the initial BWP if the PRS is not within the initial BWP.
* **Observation #2**: If PFL is different than the serving carrier then UE will have to switch between the serving carrier and the PFL for perfoming PRS measurements.
* **Observation #3**: To receive DL signals/channels other than PRS, no RF switching should take place during the time when DL signals/channels are transmitted or configured.
* **Proposal #1**: X should correspond to RF switching time for switching between initial BWP and PRS resource (if PFL is same as serving carrier) or between serving carrier and PFL (if PFL is different than serving carrier).
* **Proposal #2**: Define same value of X to cover all RF switching scenarios.
* **Proposal #3**: X should corresponds to 0.5 ms for FR1 and 0.25 ms for FR2, which can be expressed in symbols according to Table 1:

**Table 1: X number of symbols before or after the PRS resource**

|  |  |  |
| --- | --- | --- |
| **FR** | **SCS** | **X number of symbols** |
| FR1 | 15 kHz | 7 |
| 30 kHz | 14 |
| 60 kHz | 28 |
| FR2 | 60 kHz | 14 |
| 120 kHz | 28 |

**PRS measurement requirements with reduced number of samples:*** **Observation #4**: It was agreed that PRS measurement requirements with reduced number of samples are applicable only for UE which supports PRS measurements with reduced number of samples.
* **Proposal #4**: PRS measurement requirements with reduced number of samples are specified in RRC\_INACTIVE and are applicable only for UE which supports PRS measurements with reduced number of samples.
* **Proposal #5**: PRS measurement requirements with reduced number of samples in RRC\_INACTIVE are defined under the same side conditions as agreed for RRC CONNECTED state.

**PRS measurement period requirements:*** **Observation #5**: PRS processing window (PPW) is not applicable for PRS measurements in RRC inactive state.
* **Proposal #6**: Tavailable\_PRS,i should be the least common multiple between TPRS and DRX cycle.
* **Observation #6**: The 3 components of DL PRS processing capabilities in RRC inactive state are identified to those for DL PRS Processing Capability outside MG.
* **Proposal #7**: Teffect,i in RRC inactive state is based on Rel-16 approach.
* **Observation #7**: Nlayers defined in 38.133 is the combined total number of higher priority NR and E-UTRA carrier frequencies broadcasted in system information and carriers configured for idle mode CA measurements.
* **Proposal #8**: CSSF should be replaced with Kcarrier. Where Kcarriers is sum of NR inter-frequency and inter-RAT LTE carriers configured for mobility measurements, NR inter-frequency and inter-RAT LTE carriers configured for CA/DC measurements and one positioning frequency layer.
* **Proposal #9**: PRS measurement period in RRC\_INACTIVE state is expressed as follows:

 ,Where:* + is the total number of configured positioning frequency layers, NR inter-frequency carriers for mobility measurements, inter-RAT carriers for mobility measurements, NR inter-frequency carriers for CA measurements and inter-RAT carriers for CA measurements.
	+ *,* the least common multiple between and .
	+ Other parameters are the same as in the existing requirements for RSTD, PRS-RSRP and UE Rx-Tx time difference in Rel-16.

**PRS measurement requirements under RRC state transition:*** **Observation #8**: UE configured with PRS measurements may change its RRC state any time.
* **Observation #9**: RAN2 procedures allow the UE to transmit PRS measurement results to LMF for PRS measurements performed in RRC inactive state as well as in RRC connected state.
* **Observation #10**: UE behavior related to PRS measurements under RRC state transition impacts the PRS measurement performance and requires RAN4 expertise.
* **Observation #11**: SRS are reconfigured after the RRC state transition.
* **Proposal #10**: The UE behaviour for PRS measurements under RRC state transition can be defined as follows:
	+ **Option 1:**
		- If the RRC state transition occurs from RRC\_INACTIVE to RRC\_CONNECTED state during the RSTD, PRS-RSRP, PRS-RSRPP or UE Rx-Tx time difference measurement period then the UE shall restart the corresponding measurement.
	+ **Option 2:**
		- If the RRC state transition occurs from RRC\_INACTIVE to RRC\_CONNECTED state during the RSTD, PRS-RSRP or PRS-RSRPP measurement period then the UE shall continue the corresponding measurement. In this case the corresponding measurement period can be longer.
		- If the RRC state transition occurs from RRC\_INACTIVE to RRC\_CONNECTED state during the UE Rx-Tx time difference measurement period then the UE shall restart the UE Rx-Tx time difference measurement measurement.
	+ We prefer Option 1; but Option 2 is also acceptable.

**PRS measurement applicability requirements under cell change:*** **Observation #12**: In both RRC inactive and connected states, the TA becomes invalid after the cell reselection and HO respectively. In both case the UE is configured with new SRS configuration including TA in new serving cell.
* **Proposal #11**: The UE shall restart the UE Rx-Tx measurement after the cell reselection.

**PRS measurement requirements under cell change:*** **Observation #13**: UE performing PRS measurements in RRC inactive state may perform cell reselection.
* **Observation #14**: The number of carriers configured for measurement (Kcarruer) and DRX cycle may be different in the old serving cell before the cell reselection and in the new serving cell after the cell reselection.
* **Proposal #12**: The measurement period for RSTD, PRS-RSRP and PRS-RSRPP, should be based on the longest of the Kcarriers and DRX cycles used among the old serving cell before the cell reselection and the new serving cell after the cell reselection.
* **Observation #15**: UE performing PRS measurements in RRC inactive state may initiate cell selection to the selected PLMN according to section 4.2.2.2 in TS 38.133.
* **Proposal #13**: Send LS to RAN2 to inquire about UE behaviour regarding PRS measurement if the UE initiates the cell selection for the selected PLMN.

**PRS measurement requirements under DRX cycle change:*** **Observation #16**: DRX cycle can change during the PRS measurement period either based on the UE request or by the gNB autonomously.
* **Proposal #14**: If during the PRS measurement period the DRX cycle is reconfigured then the PRS measurement period can be longer.
 |
| R4-2206028 | Ericsson | CR on UE Rx-Tx measurement requirements in RRC inactive state (clause 5.5.4) |

## Open issues summary

### Sub-topic 2-1 PRS collision

**Issue 2-1-1 The value of X regarding collision of other functions.**

Agreement in RAN4#101bis-e meeting:

* + Longer PRS measurement period is expected when there is collision/overlap between other DL signals/channels and PRS resources in RRC\_INACTIVE state.
	+ Collision/overlap between other DL signals/channels and PRS resources in RRC\_INACTIVE state occurs when:
		- Any other DL signals/channel occurs within the PRS resource or
		- Any other signals/channel occurs within X symbols before the PRS resource or
		- Any other signals/channel occurs within X symbols after the PRS resource.
		- X=FFS.

Proposals

* Option 1: (CATT)
	+ X=1 symbol
* Option 2: (QC)
	+ Collision/overlap between a PRS resource and other DL signals/channels in RRC\_INACTIVE state occurs when
		- Any other signal/channel occurs within X1 ms before the expected start time of (the first repetition of) a PRS resource.
			* X1 = RRT + expected RSTD-uncertainty of the PRS resource
			* RRT = [0.5] ms for serving cell in FR1, [0.25] ms for serving cell in FR2.
			* FFS if and under what conditions the retuning time RRT can be excluded from X1
		- Any other signal/channel occurs within X2 ms after the expected start time of (the first repetition of) a PRS resource.
			* X2 = X1 + T
			* T is the duration of PRS processing of the UE PRS processing capability in RRC\_INACTIVE
* Option 3: (Huawei)
	+ X=0 if PRS is within initial DL BWP; X=0.5ms if PRS is outside initial DL BWP
* Option 4: (Ericsson)
	+ X should correspond to RF switching time for switching between initial BWP and PRS resource (if PFL is same as serving carrier) or between serving carrier and PFL (if PFL is different than serving carrier).
	+ Define same value of X to cover all RF switching scenarios.
	+ X should corresponds to 0.5 ms for FR1 and 0.25 ms for FR2, which can be expressed in symbols according to Table 1:

**Table 1: X number of symbols before or after the PRS resource**

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| --- | --- | --- |
| **FR** | **SCS** | **X number of symbols** |
| FR1 | 15 kHz | 7 |
| 30 kHz | 14 |
| 60 kHz | 28 |
| FR2 | 60 kHz | 14 |
| 120 kHz | 28 |

* Recommended WF
	+ *Need more discussion*

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| **Issue 2-1-1 The value of X regarding collision of other functions.**  |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | We support Option 4.In our view X is the time to retune between initial BWP and PRS resource which is on PFL. We suggest to have X applicable for all scenarios since in most cases the PRS will not be in initial BWP.  |
| Qualcomm | There is commonality between options 2 and 4. Both propose to include returning time in the value X. Option 2 also includes the expected RSTD-uncertainty of the PRS resource and that’s because the guard period is defined with respect to the expected TOA of the resource.In addition, option 2 proposes asymmetric guard times (X1 and X2) to account for PRS processing time. This is consistent with our proposals for measurement requirements in RRC\_INACTIVE.At least there seems to be agreement on the fact that retuning time needs to be included. |
| Huawei | Support option 3a (update to option 3):* X=0 if PRS is within initial DL BWP;
* X=0.5ms if PRS is outside initial DL BWP, and one or both of the serving cell and PFL is in FR1
* X=0.25ms if PRS is outside initial DL BWP, and both the serving cell or PFL are in FR2

This is similar as option 4, but the condition to apply 0.25ms should consider both serving cell and the PFL. On option 2, we agree that expected RSTD and uncertainty should be considered when defining the collision, but it may be better to address it in the definition of “PRS resource” rather than in the value of X. In fact, based on some offline discussion, **we think the definition of “PRS resource” should be clarified**. First, it should account for the expected RSTD and uncertainty; second, it should account for the PRS processing type (slot level or symbols level as indicated by dl-PRS-BufferType-r16). |
| CATT | Fine with option 3 and option 4 to consider the retuning time. For expected RSTD and “uncertainty of PRS resource”(although we think more clarifications are needed), we prefer not to include. The option 3a proposed by Huawei is also acceptable.  |

**Issue 2-1-2 PRS collision with PDSCH.**

Proposals

* Option 1: (Huawei)
	+ UE is not expected to receive PDSCH on PRS resources or on symbols for RF-retuning within Y symbols after a DCI.
* Recommended WF
	+ *Need more discussion*

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| **Issue 2-1-2 PRS collision with PDSCH.**  |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | We do not support Option 1. No DL signal/channel should be dropped in PRS.During RRC Inactive state, the UE can receive PDSCH for paging or SIBs. They are higher priority than PRS. The UE should not start retuning to PRS resource before the end of resources containing PDSCH. If UE cannot retune in time and misses PRS, then PRS measurement period will be extended.  |
| vivo | We have the same view with Ericsson. In RRC\_INACTIVE state, the PRS shall be lower priority than other downlink signals/channels. |
| Huawei | Option 1.We agree that in INACTIVE, PRS is of lowest priority, but we need to consider the issue that for dynamically scheduled PDSCH, UE may have already scheduled PRS measurement if the DCI is too close to the symbol where PRS and PDSCH overlap. |
| Qualcomm | We agree that this issue needs to be addressed. It is being discussed in RAN1 currently. RAN4 should wait for agreements in RAN1. |

### Sub-topic 2-2 The PRS measurement requirements applicability in RRC\_INACTIVE state

**Issue 2-2-1 The PRS measurement requirements applicability in RRC\_INACTIVE state regarding state transition.**

Proposals

* Option 1: (CATT, OPPO)
	+ RAN4 deprioritize the discussion for PRS measurement requirements when RRC state transition occurs during the measurement period.
* Option 2: (Intel, vivo, Nokia, Ericsson)
	+ If there is status transition (e.g. RRC\_INACTIVE 🡪RRC\_CONNECT) during the measurement period, UE measurement requirements can be based on the behaviour below.
		- UE restarts the PRS measurement
* Option 3: (QC)
	+ If there is state transition from RRC\_INACTIVE to RRC\_CONNECTED (or vice-versa) during the measurement period:
		- For DL only positioning, the UE continues performing the measurements and the measurement period is extended.
		- For multi-RTT, the UE stops performing measurements and reports an error.
* Option 4: (Huawei, Ericsson)
	+ If there is state transition from RRC\_INACTIVE to RRC\_CONNECTED (or vice-versa) during the measurement period:
		- For RSTD and PRS-RSRP(P) measurement, UE continue the measurement and measurement period can be longer without defining exact requirements.
		- For UE Rx-Tx measurement, UE shall re-start the measurement after it obtains SRS configuration and TA from the serving cell.
* Recommended WF
	+ *Need more discussion*

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| **Issue 2-2-1 The PRS measurement requirements applicability in RRC\_INACTIVE state regarding state transition.**  |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | We prefer to support Option 2. But we can also compromise to Option 4. We do not see any reason to down prioritize this issue. The UE behaviour needs to be cleared since PRS measurements are supported in RRC inactive and RRC connected state. This also does not require any major work.On Option 3: there is no reason to stop the UE Rx-Tx measurement after the RRC state transition. At least the UE should be able to restart. Stopping means LMF has to send new assistance data and this will significantly increase the positioning delay. |
| Qualcomm | We support option 3.Options 3 and 4 agree on the first bullet point. |
| vivo | Support Option 2. We prefer that UE restarts the PRS measurement when there is status transition. |
| Intel | Option 2 and 4 are fine for us. |
| OPPO | Can compromise to option 4. |
| Huawei | Option 4.On UE Rx-Tx, we understand that UE could re-start the measurement after it obtains SRS configuration and TA from the serving cell. As the LPP session is ongoing, UE should not stop the measurement by itself. |
| CATT | Can compromise to option 2 and option 4.  |

**Issue 2-2-2 UE behavior for UE Rx-Tx time difference measurement under cell reselection.**

Proposals

* Option 1: (CATT, Intel, Nokia, Ericsson)
	+ The UE shall restart the UE Rx-Tx measurement after the cell reselection.
* Option 1a: (OPPO)
	+ The UE shall restart the UE Rx-Tx time difference measurement after cell reselection and SRS reconfiguration on the target cell is completed.
* Option 1b: (Huawei)
	+ UE shall restart the UE Rx-Tx measurement after the cell reselection and after it obtains SRS configuration and TA from the new serving cell.
* Option 2: (QC)
	+ The UE shall stop the UE Rx-Tx measurements after the cell reselection and reports an error.
* Recommended WF
	+ *Need more discussion*

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| **Issue 2-2-2 UE behavior for UE Rx-Tx time difference measurement under cell reselection.**  |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | We support Option 1. Options 1a and 1b also fine. The SRS reconfiguration has to be accompanied by new TA.  |
| Qualcomm | Option 2 |
| vivo | Prefer Option 1. |
| Intel | Option 1.  |
| OPPO | Support option 1a and 1b. |
| Huawei | Option 1a and 1b. On option 2, same comment as for Issue 2-1-1. |
| CATT | Fine with option 1 and 1b |

**Issue 2-2-3 PRS measurement requirements applicability under cell reselection.**

Proposals

* Option 1: (CATT, OPPO, QC, vivo, Huawei)
	+ Do not define exact measurement period for RSTD, PRS-RSRP and PRS-RSRPP if the cell reselection occurs during the measurement period. Add a general sentence that the measurement period requirements can be longer.
* Option 2: (Nokia, Ericsson)
	+ In case of cell reselection, the measurement period for RSTD, PRS-RSRP and PRS-RSRPP, should be based on the longest of the Kcarrier and DRX cycles used among the old serving cell before the cell reselection and the new serving cell after the cell reselection.
* Recommended WF
	+ *Need more discussion*

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| **Issue 2-2-3 PRS measurement requirements applicability under cell reselection.**  |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | We support Option 2. It does not define exact measurement period. But without this clarification the requirement is too vague. Option 1 and Option 2 can be combined as follows: “The measurement period can be longer and is based on longest of the Kcarrier and DRX cycles used among the old serving cell before the cell reselection and the new serving cell after the cell reselection.” |
| Qualcomm | We support option 1 as a minimum requirement. |
| Vivo | Support Option 1.  |
| Intel | Option 1 |
| OPPO | Option 1 |
| Huawei  | Option 1. |
| CATT | Option 1. To Ericsson’s comment, in our understanding, based on longest Kcarrier means the requirements will be defined by replacing the current scaling factor with max{ Kcarrier}, this is already the exact measurement period.  |

**Issue 2-2-4 PRS measurement requirements applicability under cell selection.**

Proposals

* Option 1: (Huawei)
	+ RAN4 not to define UE behaviour or requirements for the case when cell selection is triggered during PRS measurement period.
* Option 2: (Nokia, Ericsson)
	+ In case of cell selection for the selected PLMN, the UE behaviour should be defined by RAN1/2.
* Recommended WF
	+ *Need more discussion*

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| **Issue 2-2-4 PRS measurement requirements applicability under cell selection.**  |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | We support Option 2. We suggest to send LS to RAN2 and ask their feedback.  |
| Qualcomm | Does option 1 propose that PRS measurement requirements should not apply in that case? |
| vivo | Prefer Option 1.  |
| Intel | In principle, the UE behavior shall be defined by RAN1/2Option 1 and 2 seems same on UE behavior? |
| Huawei | We understand two options are same. From requirement side, we suggest PRS measurement requirements should not apply. |
| CATT | Option 1. This is not typical case and may not need to trigger RAN1/2 work.  |
| Ericsson2 | We are fine with the suggestion from QC and HW i.e. “*PRS measurement requirements do not apply when the UE initiates cell selection procedures for the selected PLMN*.”In our view RAN2 needs to define the UE behaviour. Our preference is to inform RAN2 about above agreements so they can define UE behaviour.  |

**Issue 2-2-5 PRS measurement requirements applicability under DRX change.**

Proposals

* Option 1: (Ericsson)
	+ If during the PRS measurement period the DRX cycle is reconfigured then the PRS measurement period can be longer.
* Recommended WF
	+ *Need more discussion*

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| **Issue 2-2-5 PRS measurement requirements applicability under DRX change.**  |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | We support Option 1.In RRC connected state there is similar rule for change in MG configuration. Since UE is measuring once every DRX, so such behavior ensures the UE continues the PRS measurement after the DRX reconfiguration. |
| Qualcomm | We can support option 1. |
| vivo | Fine with Option 1. |
| Intel | Option 1. |
| Huawei | Fine with Option 1. |
| CATT  | Fine with option 1.  |

### Sub-topic 2-3 SRS measurement requirements in RRC\_INACTIVE state

**Issue 2-3-1 SRS measurement period requirements in RRC\_INACTIVE state**

Proposals

* Option 1: (CATT, OPPO, Nokia)
	+ No gNB measurement period requirements are defined in RRC\_INACTIVE state.
* Recommended WF
	+ *Agree on option 1.*

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| **Issue 2-3-1 SRS measurement period requirements in RRC\_INACTIVE state** |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | We support Option 1.RRC states are for UE. RRC states are irrelevant for gNB.Nothing needs to be done in any gNB positioning accuracy requirements.  |
| Qualcomm | Support the recommended WF. |
| vivo | Agree with Option 1. |
| OPPO | Support the recommended WF. |
| Huawei | Support the recommended WF. |
| CATT | Support the recommended WF.  |

**Issue 2-3-2 SRS measurement accuracy requirements in RRC\_INACTIVE state**

Proposals

* Option 1: (OPPO, QC)
	+ The existing accuracy requirements in Rel-16 can be reused for SRS measurement in RRC\_INACTIVE state.
* Recommended WF
	+ *Need more discussion*

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| **Issue 2-3-2 SRS measurement accuracy requirements in RRC\_INACTIVE state** |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | Firstly: accuracy requirements are part of performance part. This should be discussed in performance part.It is not clear what is meant by: SRS measurement? I guess proponents mean UE Rx-Tx? In principle we agree accuracy requirements are to be kept as they are in R16. But for latency reduction (reduced samples) some of the side conditions will be different than R16. In any case this issue should be postponed to performance part. |
| Qualcomm | Option 1. |
| vivo | Agree with Option 1.Reply Ericsson: we understand SRS measurement should be gNB RX-Tx time difference or SRS RSRP measurement. The existing accuracy requirements in Rel-16 can be reused in RRC\_INACTIVE state. |
| OPPO | Option 1. For the question raised by Ericsson, we agree with vivo, SRS measurement should be gNB RX-Tx time difference or SRS RSRP measurement. |
| Huawei | Option 1 is fine based on above clarification from vivo and OPPO. |
| CATT | Fine with option 1.  |
| Ericsson2 | Option 1 is fine. One clarification: this means no update is needed in sections on gNB Rx-Tx and SRS-RSRP requirements i.e. we should NOT state that they also apply in RRC inactive because RRC states are for UE and not for BS. |

**Issue 2-3-3 Prioritization between SRS transmission for positioning and other UL signals/channels**

Proposals

* Option 1: (Huawei)
	+ RAN4 not to discuss prioritization between SRS transmission for positioning and other UL signals/channels (which is RAN1 scope).
* Recommended WF
	+ *Agree on option 1.*

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| **Issue 2-3-3 Prioritization between SRS transmission for positioning and other UL signals/channels** |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | Support Option 1 |
| Qualcomm | Support the recommended WF. |
| vivo | Agree with Option 1. |
| OPPO | Agree with option 1 |
| Huawei | Support the recommended WF. |
| CATT | Support the recommended WF.  |

### Sub-topic 2-4 Measurement period requirements for positioning measurement in RRC\_INACTIVE state

**Issue 2-4-1 Whether to support the reduced number of samples in RRC\_INACTIVE state**

Proposals

* Option 1: (CATT, CMCC)
	+ Yes.
* Option 2: (Intel, Nokia, Ericsson)
	+ upon UE capability (same UE capability as that in RRC\_CONNECTED state)
* Option 2a: (Ericsson)
	+ PRS measurement requirements with reduced number of samples are applicable only for UE which supports PRS measurements with reduced number of samples.
	+ PRS measurement requirements with reduced number of samples in RRC\_INACTIVE are defined under the same side conditions as agreed for RRC CONNECTED state.
* Option 3: (QC, vivo, Huawei)
	+ upon UE capability (different UE capability from that in RRC\_CONNECTED state)
* Option 3a: (Huawei)
	+ The requirements with reduced sample number are applicable when UE supports measurement with reduced sample number in RRC\_INACTIVE and is requested by LMF to perform measurement with reduced sample number.
* Recommended WF
* *Tentative agreement:*
	+ *Support of the reduced number of samples in RRC\_INACTIVE state is UE capability*
	+ *PRS measurement requirements with reduced number of samples in RRC\_INACTIVE state are applicable only for UE which supports PRS measurements with reduced number of samples.*
* *Companies are encouraged to share views on the tentative agreements and following FFS part:*
	+ *FFS whether the same capability as that in RRC\_CONNECTED state is used.*
	+ *FFS PRS measurement requirements with reduced number of samples in RRC\_INACTIVE are defined under the same side conditions as agreed for RRC CONNECTED state.*
	+ *FFS The requirements with reduced sample number are applicable when UE is requested by LMF to perform measurement with reduced sample number.*

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| **Issue 2-4-1 Whether to support the reduced number of samples in RRC\_INACTIVE state** |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | Support tentative agreement.* *FFS whether the same capability as that in RRC\_CONNECTED state is used.*

[Ericsson]: Yes it is important to have same capability since the UE may be switched between different states and conditions are the same e.g. propagation, etc. It does not add any UE complexity since UE is either in inactive or connected state. * *FFS PRS measurement requirements with reduced number of samples in RRC\_INACTIVE are defined under the same side conditions as agreed for RRC CONNECTED state.*

[Ericsson]: Yes, because the motivation for reduced number of samples is certain conditions. They do not change if UE changes the RRC state* *FFS The requirements with reduced sample number are applicable when UE is requested by LMF to perform measurement with reduced sample number.*

[Ericsson]: Yes. Since conditions are specific for reduced number of samples. So LMF can decide and indicate in the assistance data. But it should be the same mechanism / principle in RRC inactive and connected state.  |
| Qualcomm | We support options 3 and 3a. |
| vivo | We agree with the tentative agreement. For the FFS part, we would like to analysis one by one.For the first bullet, we understand the capability in RRC\_CONNECTED state may be not directly reused in RRC\_INACTIVE state. There exists big difference between RRC\_INACTIVE state and RRC\_CONNECTED state, e.g., the measurement is performed with gap or without gap in RRC\_CONNECTED and the measurement is performed based on DRX cycle in RRC\_INACTIVE. UE can support the reduced sample number in RRC\_CONNECTED state but not support the reduced sample number in RRC\_INACTIVE state. So the capabilities of two states should be dependent.We agree with the second and the third bullet. |
| Intel | The recommended WF is fine for us. And further views on FFS* + *FFS whether the same capability as that in RRC\_CONNECTED state is used.*

*Same capability** + *FFS PRS measurement requirements with reduced number of samples in RRC\_INACTIVE are defined under the same side conditions as agreed for RRC CONNECTED state.*

*The side condition can be different** + *FFS The requirements with reduced sample number are applicable when UE is requested by LMF to perform measurement with reduced sample number*

No. But LMF shall obtain UE capability to support reduced number of samples, it doesn’t make sense to request UE to do so if UE can’t. |
| OPPO | Agree with the tentative agreement. For the 1st FFS, we prefer to use the same UE capability.For the 2nd FFS, we think different side condition may be needed. So far, PRS bandwidth and RSRP difference between serving cell and neighboring cells are agreed as side conditions to reduce AGC samples. And these two conditions need to be reconsidered for RRC inactive states. For the 3rd FFS, pending on issue 1-1-2.  |
| Huawei | In principle fine with tentative agreement, but it needs to be updated based on the outcome from the FFS parts.* *FFS whether the same capability as that in RRC\_CONNECTED state is used.*

We understand it is RAN1 discussion* *FFS PRS measurement requirements with reduced number of samples in RRC\_INACTIVE are defined under the same side conditions as agreed for RRC CONNECTED state.*

Yes. The accuracy may be different, but this can be discussed in perf part.* *FFS The requirements with reduced sample number are applicable when UE is requested by LMF to perform measurement with reduced sample number.*

Yes, and LMF can only request this from capable UE. |
| CATT | Support the recommended WF. For the 1st FFS, we prefer to use the same UE capability but this is under RAN1 discussion, we think we don’t need to further discuss.For the 2nd FFS, the SINR side condition can be same, but the condition for reduced AGC samples is different since the condition is defined that the PRS bandwidth is within active BWP which is not applied for RRC\_INACTIVE state. For the 3rd FFS, yes and can follow the conclusion in RRC\_CONNECTED state.  |
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**Issue 2-4-2 Tavailable\_PRS,i calculation for PRS measurement requirements in RRC\_INACTIVE state**

Proposals

* Option 1: (CATT, QC, ZTE, Ericsson)
	+ Tavailable\_PRS,i could be the least common multiple between TPRS and DRX cycle.
* Option 1a: (CATT)
	+ Use option 1 for Tavailable\_PRS,i calculation when drafting CR and it can be revisited after receiving RAN1 reply.
* Option 2: (Intel, Huawei, Nokia)
	+ FFS waiting for RAN1 confirmation.
* Recommended WF
	+ *Check if option 1a can be acceptable.*

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| **Issue 2-4-2 Tavailable\_PRS,i calculation for PRS measurement requirements in RRC\_INACTIVE state** |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | Option 1 |
| Qualcomm | Option 1. It can be left in square brackets in the CR for now. |
| vivo | Option 1a is fine. |
| Intel | If RAN1 confirm that no any PPW used for RRC\_INACTIVE measurement, Option 1 is fine. |
| OPPO | Option 1 |
| ZTE | Fine with Qualcomm suggestion to leave it in square brackets. |
| Huawei | Option 2, but we can go with option 1a for the CR with editor note.  |
| CATT | Take option 1 as baseline to draft CR.  |

**Issue 2-4-3 Teffct,i calculation for PRS measurement requirements in RRC\_INACTIVE state**

Proposals

* Option 1: (CATT, QC, Huawei, Ericsson)
	+ The same approach as R16 can be used.
* Recommended WF
	+ *Agree on option 1.*

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| **Issue 2-4-3 Teffct,i calculation for PRS measurement requirements in RRC\_INACTIVE state** |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | Support the WF i.e. Option 1 |
| Qualcomm | Support the recommended WF. |
| vivo | Agree with Option 1. |
| Intel | Support the recommended WF. |
| OPPO | Option 1 |
| Huawei | Support the recommended WF. |
| CATT | Support the recommended WF.  |

**Issue 2-4-4 How to define carrier specific scaling factor (Kcarrier\_PRS) for PRS measurement requirements in RRC\_INACTIVE state**

Proposals

* Option 1: (CATT)
	+ If PRS measurement is performed with the same engine as RRM measurement, Kcarrier\_PRS = Kcarrier\_RRM = Kcarrier + 1.
	+ If PRS measurement is performed with dedicated engine, Kcarrier\_PRS = 1 and Kcarrier\_RRM = Kcarrier
* Option 2: (CMCC, Nokia)
	+ Replace CSSF with Kcarrier for inactive state PRS measurement requirements, Kcarrier is the total number of configured carriers for mobility measurements and CA measurements plus one positioning frequency layer.
* Option 3: (OPPO, Huawei)
	+ Replace CSSF with Kcarrier and Nlayer for RRC\_INACTIVE state measurement requirements, only one positioning frequency layer is accounted into Kcarrier and Nlayer
* Option 4: (QC)
	+ Replace CSSF in the Rel-16 measurement period formula with a factor K with two possible values depending on UE capability.
		- Baseline capability: K = Kcarrier + 1 (or Nlayer + 1 when only higher priority layers need to be measured),
		- Advanced capability: K=1, for a UE that has a dedicated PRS processing engine.
* Option 5: (vivo)
	+ Replace CSSF with Kcarrier for inactive state PRS measurement requirements with some clarification, e.g., if Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, Kcarrier is the total numbers of higher priority carriers plus one positioning frequency layer, otherwise, Kcarrier is the total number of configured carriers for mobility measurements and CA measurements plus one positioning frequency layer.
* Option 6: (Ericsson)
	+ CSSF should be replaced with Kcarrier. Where Kcarriers is sum of NR inter-frequency and inter-RAT LTE carriers configured for mobility measurements, NR inter-frequency and inter-RAT LTE carriers configured for CA/DC measurements and one positioning frequency layer.
* Recommended WF
* *Check if the following understanding is common:*
	+ *For the UE sharing the same measurement engine as RRM measurement for PRS measurement:*
		- *Update the definition of Kcarrier in 4.2.2.4 and Nlayer in 4.2.2.7 by adding one positioning frequency layer.*
		- *If Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, Kcarrier\_PRS equals to updated Nlayer in 4.2.2.7*
		- *If Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ, Kcarrier\_PRS equals to updated Kcarrier in 4.2.2.4*
	+ *FFS whether to define: For the UE with dedicated measurement engine for measurement:*
		- *Do not update the definition of Kcarrier in 4.2.2.4 and Nlayer in 4.2.2.7.*
		- *Kcarrier\_PRS equals to1.*

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| **Issue 2-4-4 How to define carrier specific scaling factor (Kcarrier\_PRS) for PRS measurement requirements in RRC\_INACTIVE state** |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | *If Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ* then we agree Kcarrier\_PRS = Nlayer + 1 But if:If Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ, then,UE will measure only inter-frequency as well as inter-RAT LTE carriers. Therefore:Kcarrier\_PRS = Sum of inter-frequency carriers configured for mobility, inter-frequency carriers configured for CA/DC, inter-RAT LTE carriers configured for mobility and inter-RAT LTE carriers configured for DCIn other words: Kcarrier\_PRS = Kcarrier in section 4.2.2.4 + NEUTRA\_carrier in section 4.2.2.5 + 1 (PFL)Note: Kcarrier in 4.2.2.4 only covers NR inter-frequency carriers i.e.*“The parameter Kcarrier for a UE configured with idle mode CA measurements (while T331 is running), is the combined number of NR inter-frequency carriers indicated by the serving cell and the number of NR inter-frequency carriers configured for idle mode CA measurements”* |
| Qualcomm | We support the following:* *For the UE sharing the same measurement engine as RRM measurement for PRS measurement:*
	+ *Update the definition of Kcarrier in 4.2.2.4 and Nlayer in 4.2.2.7 by adding one positioning frequency layer.*
	+ *If Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, Kcarrier\_PRS equals to updated Nlayer in 4.2.2.7*
	+ *If Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ, Kcarrier\_PRS equals to updated Kcarrier in 4.2.2.4*
* *~~FFS whether to define:~~ For the UE with dedicated measurement engine for measurement:*
	+ *Do not update the definition of Kcarrier in 4.2.2.4 and Nlayer in 4.2.2.7.*

*Kcarrier\_PRS equals to1.*  |
| Vivo | Agree with the first bullet of the Recommended WF. |
| Intel | Already discussed in GTW |
| Huawei | Follow GTW agreement.We suggest following for the FFS part in Capability #1:* + For Capability #1 UEs:
		- ~~FFS:~~ Update the definition of Kcarrier in 4.2.2.4 and Nlayer in 4.2.2.7 by adding one positioning frequency layer.
		- If Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, Kcarrier\_PRS equals to ~~updated~~ Nlayer + 1 in 4.2.2.7
		- If Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ, Kcarrier\_PRS is Kcarrier + NEUTRA\_carrier +1

On the UE capability, we assume it is only about the scaling of measurement period requirements, so supporting capability#2 does not mean UE can receive DL signals/channels (including SSB and SMTC) and perform PRS measurement in parallel.  |
| CATT | Based on the GTW discussion, summarize the scaling factor for RRM and PRS as following: * + UE capabilities for PRS measurements in RRC\_INACTIVE state
		- Capability #1: UE not performing parallel PRS measurements (note: this is the default capability for UE supporting PRS measurements in RRC\_INACTIVE state)
		- Capability #2: UE performing parallel PRS measurements
		- UE capability signalling details are in issue 2-4-7.
	+ For Capability #1 UEs:
		- ~~FFS:~~ Update the definition of Kcarrier in 4.2.2.4 and Nlayer in 4.2.2.7 by adding one positioning frequency layer.
		- If Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, Kcarrier\_PRS equals to updated Nlayer ~~+ 1~~ in 4.2.2.7
		- If Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ, Kcarrier\_PRS is ~~FFS~~*updated Kcarrier in 4.2.2.4*
	+ For Capability #2 UEs:
		- Do not update the definition of Kcarrier in 4.2.2.4 and Nlayer in 4.2.2.7.
		- Kcarrier\_PRS equals to1.

NEUTRA\_carrier is not included to be updated because after further check, the inter-frequency and inter-RAT measurement requirements in RRC\_INACTIVE state are defined separately except the high priority layers and didn’t consider the impact to each other. So when accounting for PRS measurement, we think we need only to include the PRS layers in one of them (either inter-frequency or inter-RAT). Since the PRS layer is NR layer, we suggest to consider it in the inter-frequency measurement.  |
| Ericsson2 | After further checking we agree with CATT that PFL is treated as part of NR inter-frequency carriers and therefore only Kcarrier needs to include 1 PFL. * For Capability #1 UEs:
	+ ~~FFS:~~ Update the definition of Kcarrier in 4.2.2.4 and Nlayer in 4.2.2.7 by adding one positioning frequency layer.
	+ If Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, Kcarrier\_PRS equals to ~~updated~~ Nlayer + 1 in 4.2.2.7
	+ If Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ, Kcarrier\_PRS is ~~FFS~~  Kcarrier +1
* For Capability #2 UEs:
	+ Do not update the definition of Kcarrier in 4.2.2.4 and Nlayer in 4.2.2.7.
	+ Kcarrier\_PRS equals to1.
 |

**Issue 2-4-5 Working assumption for the PRS measurement requirements in RRC\_INACTIVE state**

Proposals

* Option 1: (QC)
	+ The measurement requirements in RRC\_INACTIVE are based on a separate UE PRS processing capability (N, T) for inactive state, where N is the maximum duration of PRS in msec that can be buffered by the UE, assuming the maximum supported PRS bandwidth in the frequency band, and T-N (>0) is the corresponding processing time assuming PRS samples are already buffered in memory.
* Recommended WF
	+ *Need more discussion*

|  |
| --- |
| **Issue 2-4-5 Working assumption for the PRS measurement requirements in RRC\_INACTIVE state** |
| **Company** | **Comments** |
| XXX |  |
| Ericsson | We prefer to use existing UE PRS processing capability (N, T) used in RRC connected state |
| Qualcomm | We propose this working assumption so that RAN4 may make further progress with the PRS measurement requirements in RRC\_INACTIVE. |
| Intel | Check RAN1 |
| Huawei | Same view as Ericsson. We suggest to keep existing framework which is more generic. |
| CATT | This is UE implementation issue and no need to have such agreements. The UE processing capability is under discussion in RAN1 and the same principle as R16 can be used.  |

**Issue 2-4-6 PRS processing procedure for the PRS measurement requirements in RRC\_INACTIVE state**

Proposals

* Option 1: (QC)
	+ The LMF may request , the length of the measurement/processing occasion for PFL *i*, in the location request. requested by the LMF must be larger than signalled in the UE capability, otherwise measurement requirements do not apply.
		- msec.
		- If the LMF does not request the length of the measurement/processing occasion, then is used to calculate the measurement period requirement, where is the UE capability applicable to PFL *i*.
	+ For PFL *i*, the UE measures and processes up to PRS duration of msec in each measurement/processing occasion of length , where the PRS resources are received during a measurement interval of length and they are processed by the UE during a processing interval of length , immediately following the measurement interval.
	+ For requirements in RRC\_INACTIVE, replace the factor in the Rel-16 PRS measurement period formulas with , where
		- is defined as the number of measurement/processing occasions required to cover all the PRS resources counted in , taking into account that the UE can process at most PRS duration of ms per occasion.
* Recommended WF
	+ *Need more discussion*

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| --- |
| **Issue 2-4-6 PRS processing procedure for the PRS measurement requirements in RRC\_INACTIVE state** |
| **Company** | **Comments** |
| Qualcomm | We support option 1. The motivation is to limit the amount of time that the UE is expected to spend measuring and processing PRS during each DRX cycle (or T\_available PRS, i). |
| Huawei | Same comment as Issue 2-4-5. We suggest to keep existing framework which is more generic. |
| CATT | No need to define this procedure. The same principle as R16 can be used.  |
| Ericsson | We also agree with HW and CATT to keep the existing R16 framework. No need to change the PRS processing procedure as suggested by QC.  |

## Companies views’ collection for 1st round

### Open issues

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2203888 (CATT)Draft CR on PRS-RSRPP measurement  | Company A |
| Company B |
| Ericsson:PRS-RSRPP measurements are also used in DL-TDoA positioning method. Therefore, we propose to have a note at the end of draft CR. Otherwise the proposed changes are fine. Note: Section 5.5.5 will be revisited to capture the agreement from stage 2 running CR in RAN2. |
| Huawei: 1. suggest to put the collision condition in general section so we do not need to repeat it for each measurement. 2. suggest to add editor note regarding the measurement window (pending on RAN1 feedback). 3. Nsample should be updated based on M1=1 and M2=0 or 1.4. Kprs needs to be updated based on Issue 2-4-4. |
| Qualcomm: Pending agreements on the measurement period formulation in RRC\_INACTIVE.Applicability conditions need to be finalized as well. |
| R4-2204466 (QC) DraftCR – RSTD measurement  | Ericsson:There are number of issues related to PRS measurement RRC inactive under discussion. The CR needs to be updated based on the agreements. |
|  Huawei: 1. suggest to put the collision condition in general section so we do not need to repeat it for each measurement. 2. suggest to add editor note regarding the measurement window (pending on RAN1 feedback). 3. Nsample should be updated based on M1=1 and M2=0 or 1.4. Kprs needs to be updated based on Issue 2-4-4.5. changes related to Issue 2-4-6 should not be included before agreement. |
|  |
| R4-2204637 (vivo) Draft CR to 38.133 Introduction of PRS RSRP measurement  | Ericsson:There are number of issues related to PRS measurement RRC inactive under discussion. The CR needs to be updated based on the agreements. |
| Huawei: 1. suggest to put the collision condition in general section so we do not need to repeat it for each measurement. 2. suggest to add editor note regarding the measurement window (pending on RAN1 feedback). 3. Nsample should be updated based on M1=1 and M2=0 or 1.4. Kprs needs to be updated based on Issue 2-4-4. |
| Qualcomm: Pending agreements on the measurement period formulation in RRC\_INACTIVE.Applicability conditions need to be finalized as well. |
| R4-2205384 (Huawei) CR on general requirements for PRS measurements in RRC Inactive | Ericsson:This condition is not aligned with the agreement, "no cell reselection occurs during the measurement period". It is already agreed that UE continues RSTD, RSRP and RSRPP after cell selection. For UE Rx-Tx the rule is under discussion. In summary it is agreed to define requirements under cell reselection. So it should be removed. For overlapping condition we prefer to keep 0.25ms for FR2 and preferably express in symbols.  |
| Huawei: To Ericsson, On the cell reselection, we understand it is related to Issue 2-2-1. The wording in the CR is to say the detailed requirements do not apply for the case of cell reselection. We agree that UE continues RSTD, RSRP and RSRPP, and we are open to find a better wording for this issue.On overlapping condition, we are fine to consider 0.25ms for FR2 as commented for Issue 2-1-1, and also ok to define in number of symbols. |
| Qualcomm: The applicability conditions need to be updated according to agreements and pending issues. The wording needs some refinement to avoid misinterpretation. E.g. saying that the requirements apply provided “PRS resources are not overlapped with other DL signals/channels” may give the false impression that no requirements apply if any PRS resources overlap with other DL signals/channels. |
| R4-2206028 (Ericsson) CR on UE Rx-Tx measurement requirements in RRC inactive state (clause 5.5.4) | Huawei: 1. suggest to put the collision condition in general section so we do not need to repeat it for each measurement. 2. suggest to add editor note regarding the measurement window (pending on RAN1 feedback). 3. Nsample should be updated based on M1=1 and M2=0 or 1.4. Kprs needs to be updated based on Issue 2-4-4. |
| Qualcomm: Pending agreements on the measurement period formulation in RRC\_INACTIVE.Applicability conditions need to be finalized as well. |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic #2-1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |
| **Sub-topic #2-2** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |
| **Sub-topic #2-3** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |
| **Sub-topic #2-4** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

### CRs/TPs

## Discussion on 2nd round (if applicable)

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-2203888 | Draft CR on PRS-RSRPP measurement requirements in RRC\_INACTIVE state | CATT |  |  |
| R4-2204466  | DraftCR – RSTD measurement requirements in RRC\_INACTIVE state | Qualcomm |  |  |
| R4-2204637  | Draft CR to 38.133 Introduction of PRS RSRP measurement requirements in RRC\_INACTIVE state | vivo |  |  |
| R4-2205380  | CR on measurement period requirements with multiple Rx TEGs | Huawei |  |  |
| R4-2205384 | CR on general requirements for PRS measurements in RRC Inactive | Huawei |  |  |
| R4-2206028  | UE Rx-Tx measurement requirements in RRC inactive state (clause 5.5.4) | Ericsson |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
	1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
	2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
	1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
	2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
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Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)